

The Impact of Department of Defense Funding on Industry Clusters in the State of Maryland

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Acronyms and Abbreviations

BLS	Bureau of Labor Statistics
CBP	County Business Patterns
Commerce	Maryland Department of Commerce
DoD	Department of Defense
DHS	Department of Homeland Security
DIA	Defense Industry Adjustment
DLOGS	Defense Logistics Agency
DUNS	Data Universal Numbering System
FIPS	Federal Information Processing Standard Code
GDP	Gross Domestic Product
IARPA	Intelligence Advanced Research Projects Activity
IBM	International Business Machines
JHU	Johns Hopkins University
LAUS	Local Area Unemployment Statistics
LEHD	Longitudinal Employer-Household Dynamics
MDN	Maryland Defense Network
MIT	Massachusetts Institute of Technology
NAICS	North American Industry Classification System
NASA	National Aeronautics and Space Administration
NIH	National Institutes of Health
NIST	National Institute of Standards and Technology
NSA	National Security Agency
NSF	National Science Foundation
O*Net	Occupational Information Network
OEA	Office of Economic Adjustment
OES	Occupational Employment Statistics
PSC	Product or Service Code
QCEW	Quarterly Census of Employment and Wages
R&D	Research and Development
REMI	Regional Economic Models, Inc.
RESI	Regional Economic Studies Institute
SAIC	Science Applications International Corporation
SBIR	Small Business Innovation Research
SOC	Standard Occupational Classification
SNA	Social Network Analysis
STTR	Small Business Technology Transfer
SWOT	Strengths, Weaknesses, Opportunities, Threats
UMB	University of Maryland, Baltimore
UMBC	University of Maryland, Baltimore County

UMCP
USDA

University of Maryland, College Park
United States Department of Agriculture

1.0 Executive Summary

The Regional Economic Studies Institute (RESI) of Towson University was tasked by the Maryland Department of Commerce (Commerce) to conduct an industry cluster analysis of Maryland's economy, focusing on those parts of the state economy that receive defense-related spending. With potential future fluctuations in defense-related spending in the state of Maryland, the importance of this study lies in preparing Commerce to support industry clusters that have a significant economic impact in Maryland and may also be vulnerable to these fluctuations. For the purposes of this study, an industry cluster is defined as a grouping of industries that are related in terms of products, or are interdependent for producing goods or services that are defined by researchers to enable analysis.¹ Given the number of ways that defense-related funding impacts industry clusters in Maryland, RESI grouped industry sectors into clusters (groups of industries that interact to produce certain types of goods) to better analyze the state's economic activity at a detailed level. For example, the Payroll Services, Engineering Services, and Passenger Car Leasing industry sectors were grouped into the Business Services cluster to provide a more detailed analysis.

Given the significant amount of Department of Defense (DoD) spending received by the state of Maryland, approximately \$18 billion obligated annually, this study focuses on those clusters that received a relatively large share of this funding. At the state level, this study emphasizes the description of clusters that received over \$300 million per year. Due to the large variations in overall DoD spending at the regional level, this study emphasizes the top ten clusters by DoD spending in each region. RESI's analysis examined overall employment and wage trends by industry cluster at the state and regional levels. Employment and wage numbers demonstrate the relative overall impact of an industry on a region's economy. In addition, to obtain an understanding of the collaboration occurring within these clusters, RESI subcontracted Tertius Analytics to conduct a social network analysis (SNA) of defense-related innovation in Maryland.

Building on the analysis of the existing data, RESI used the Regional Economic Models Inc. (REMI) PI+ economic model to forecast the future employment impacts of DoD funding on Maryland's economy. These impacts consist primarily of the jobs that are estimated to be supported based on current DoD funding levels. RESI's forecasts consider the employment impacts under three scenarios: if DoD funding to Maryland remains the same over time, if DoD funding to Maryland increases by 10 percent over time, and if DoD funding to Maryland decreases by 10 percent over time. Each forecast focuses on a ten-year period, using a five-year average of the existing DoD spending in Maryland.

¹ Mercedes Delgado, Michael E. Porter, and Scott Stern, "Defining Clusters of Related Industries," *Journal of Economic Geography* 16 no. 1 (2015): 1, accessed December 28, 2016, <http://www.clustermapping.us/resource/defining-clusters-related-industries-2016>.

This cluster analysis was conducted as part of a larger study that RESI is executing with the same aim of understanding the state's reliance on DoD funding to prepare for potential future fluctuations in this funding. The other components of this study—including a statewide survey of firms receiving DoD funding; an analysis of the strengths, weaknesses, opportunities, and threats (SWOT) to Maryland relating to DoD funding; and the development of the Maryland Defense Network (MDN) online interactive platform—will be integrated into this analysis as needed.²

1.1 Statewide Findings

With nearly \$18 billion in obligated DoD funding received by Maryland businesses per year from 2011–2015, equating to 5.3 percent of the average state GDP during that time, Maryland's economy is significantly impacted by DoD funding levels.³ The federal government budget sequestration in 2013 affected DoD spending during the 2011–2015 time period for this analysis. For example, as shown in Figure 6 in Section 2.2, there is a noticeable difference between spending at the beginning of the analyzed time period in 2011 and at the end of the period in 2015. While it is important to recognize that these fluctuations do exist, the relationship between this reduction in funding and its direct impact on industry clusters in Maryland is difficult to assert given external factors such as funding coming to companies outside of the DoD or the federal government.⁴ Recognizing the changes to DoD spending during this period, this section will focus on reviewing the major industry clusters in the state as well as a forecast of the economic impact of this funding over the next ten years.

1.1.1 Overview of State Clusters Supported by DoD Funding

The DoD funding received by businesses in Maryland is not distributed equally to industry clusters in the state. To gain an understanding of this distribution, RESI reviewed the secondary data on industry clusters to define the clusters in the state, and then analyzed USA Spending data to determine the level of DoD funding, if any, that was attributed to the industry clusters from 2011 to 2015.⁵ These clusters were defined using North American Industry Classification System (NAICS) codes at the six-digit level. RESI assumed that the DoD funding, at the contract level, was used entirely within the six-digit NAICS classification of the contract presented in USA

² Regional Economic Studies Institute of Towson University, "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape."

³ "Regional Economic Accounts," U.S. Bureau of Economic Analysis, accessed December 12, 2016, <http://www.bea.gov/regional/>.

⁴ The dataset utilized for this report does not allow for a causal analysis of the direct impacts that sequestration had on any particular sector. Further, sequestration impacted overall government spending, and many Maryland companies are dependent on non-DoD revenues for their business.

⁵ "Download Center," USA Spending, accessed January 4, 2017, <https://www.usaspending.gov/DownloadCenter/Pages/default.aspx>.

Spending.⁶ Figure 1 highlights the distribution of funding to the major industry clusters, noting its impact on jobs during this period.

Figure 1: Maryland Clusters Ranked by DoD Allocations, 2011–2015

Cluster Name	Statewide Job Estimate, 2014	Statewide Average Wage, 2015	Average Annual Dollars Obligated, 2011–2015	Jobs Supported by DoD Spending
Business Services	315,659	\$76,688	\$7,299,282,121	35,446
Education and Knowledge Creation	78,237	\$75,859	\$1,864,276,683	9,152
Local Real Estate, Construction, and Development	233,818	\$49,519	\$1,487,297,165	11,185
Aerospace Vehicles and Defense	10,881	\$85,290	\$1,240,767,978	5,418
Communications Equipment and Services	10,725	\$73,561	\$1,103,423,851	5,586
Water Transportation	4,469	\$60,708	\$871,676,614	5,347
Local Utilities	29,055	\$67,836	\$659,778,570	3,622
Local Health Services	346,345	\$54,877	\$500,422,212	3,396
Information Technology and Analytical Instruments	12,456	\$94,160	\$438,013,070	1,732
Local Commercial Services	178,526	\$47,021	\$396,081,575	3,137
Transportation and Logistics	17,892	\$51,069	\$322,011,737	2,348
Subtotal	1,238,062	\$60,713	\$16,183,031,576	86,369
State Total	2,460,086	\$52,546	\$17,968,243,321	101,263

Sources: BLS OES; Delgado, Porter, and Stern; RESI; USA Spending; U.S. Census

In Figure 1, the first column presents the names of the industry clusters, listed in descending order based on the average annual dollars obligated from the DoD (fourth column). While there are more industry clusters active in the state, these clusters were the major focus as their annual DoD obligation exceeded \$300 million. The second column shows the estimated number

⁶ For each contract entry in USA Spending, activities will not always occur entirely within the primary NAICS code of the contractor, and hence could be counted for employment in a different cluster. However, to evaluate the spending under each contract and reclassify the associated NAICS codes to a higher specificity than reported is not feasible due to the number of contracts in the database.

of Maryland jobs available in each cluster, followed by the average wage for these positions in the third column.⁷ As noted above, the fourth column corresponds to the average annual DoD funding obligated to the cluster. The data in the second through fourth columns was used to calculate the job impacts shown in the fifth, gold-colored column. The fifth and final column shows the estimated number of jobs supported by DoD's spending on the cluster. It should be noted that the jobs that the DoD spending to the cluster supports may not necessarily be in that cluster. For example, the 35,446 jobs supported by DoD spending on Business Services are not confined to the Business Services cluster; these jobs represent a wide range of occupations in the region. This estimated employment supported by DoD funding by cluster (in the fifth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C for a more detailed overview of the methodology.

Focusing briefly on the rows in Figure 1, the subtotal section of the chart is the summation of the 11 clusters shown in the chart. It shows that the top 11 clusters received the majority of Maryland's DoD obligated funding, over \$16 billion, as shown in the subtotal row, of the state's total of approximately \$18 billion. The subtotal row also shows that about half of Maryland's workers are employed in the clusters receiving the highest amounts of DoD funding.

Using data from the U.S. Census 2014 County Business Patterns (CBP) dataset for each cluster in the state, RESI estimated the number of jobs each cluster supports. The 2014 CBP data were the most recently available data by that source and were used in lieu of more recent data such as Quarterly Census of Employment and Wages (QCEW), due to data suppression issues in the latter source.⁸ As seen in the second column of Figure 1, the two largest clusters based on state employment levels were Business Services and Local Health Services. Considering that the Business Services cluster received over \$7 billion in average annual obligated funding—roughly 40.6 percent of the state's total DoD funding from 2011 to 2015—the high number of individuals employed in this cluster is expected. However, the Local Health Services cluster, which received \$500 million, or 6.9 percent of the average annual funding that the Business Services cluster received from the DoD, employed more individuals within the state. This highlights that the Local Health Services cluster in Maryland is less dependent on DoD funding, and therefore better insulated against potential future funding fluctuations than other clusters.

Using USA Spending data categorized by industry sector, RESI calculated the overall economic impacts of DoD spending in Maryland. To estimate cluster-level impacts, RESI multiplied the

⁷ Wages represents the average annual wage for the total employment in each cluster, according to OES data for 2015. REMI calculates wages without distinction between full- and part-time employment, resulting in an underestimation of wages.

⁸ Data can be suppressed for a number of reasons, including but not limited to: classified information, concerns over acquisitions of small companies, and concerns of competition for specialized workers.

salary-weighted DoD funding for each category by the estimated overall employment impacts.⁹ This allows for detailed impacts based on spending at the cluster level to be estimated and can be used to better understand how potential policy changes relating to spending allocations will effect Maryland. DoD spending in the top 11 clusters provided approximately 85 percent of the estimated employment impact in Maryland, supporting over 86,000 total jobs, including direct, indirect, and induced jobs.¹⁰

For the top clusters shown in Figure 1, it is important to note that many of these clusters are high-wage clusters, exceeding the state's 2015 average annual wage of \$52,402.¹¹ The Business Services cluster, for instance, captured 40.6 percent of total DoD funding in Maryland and boasted an average annual wage of approximately \$76,668. However, this was not the case for three of these clusters: Local Real Estate, Construction, and Development; Local Commercial Services; and Transportation and Logistics. It should be noted that the 2015 wage data was analyzed alongside the 2014 occupational data because it allowed for the most up-to-date information available from both data sources to be used. In addition, combining these sources enables RESI to get the most comparable estimates of the conditions today.

Figure 1 highlights two important points to consider for the remainder of this report. First, the obligated DoD spending was one of many sources of funding to the industry clusters in the state. Due to variations in DoD funding obligations between 2011 and 2015 and differing cluster dependence on this funding, the impacts to individual clusters resulting from fluctuations in defense spending varied. Second, this figure makes clear that the impacts of DoD spending were not limited to traditionally-defined defense contractors. While expected clusters such as Aerospace and Defense and Water Transportation (this category includes shipbuilding) were present, clusters like local health services, which includes hospitals were also present. This contrast highlights the non-traditional aspects of DoD funding in Maryland.

Through further analysis of the information provided in Figure 1, RESI calculated location quotients to better understand how these clusters impact the state's economy.¹² Analyzing clusters by location quotient is helpful because it reveals the concentration of a local industry relative to the national concentration of that industry. Moreover, location quotients provide important information for economic developers when assessing local strengths. Location

⁹ These figures were calculated by using the spending levels divided by the average wages in each cluster, divided by the total spending levels, divided by the average wages summed for all clusters. This methodology is outlined in more detail, including equations, in Appendix C.4.

¹⁰ The REMI model separates direct effects (jobs supported and dollars spent as a direct result of DoD contracts) from indirect and induced effects (jobs and output supported by direct employees' and businesses' purchases either for business or from personal salaries).

¹¹ RESI estimated state-level average annual wages using CBP employment estimates and OES wage data from CBP county-level data. See Appendix A for a detailed methodology.

¹² Location quotients for each cluster were calculated using CBP data for the state, as described in Appendix C.5.

quotients greater than 1.0 show that there is more employment in that cluster relative to the national average, while location quotients less than 1.0 indicate an employment concentration that is lower than the national average. In general, an industry with a location quotient higher than 1.25 is expected to be an export industry, meaning the industry is expected to produce more than is consumed in the region.^{13,14} Maryland is home to five clusters with a location quotient meeting the 1.25 threshold.¹⁵ These clusters are Business Services; Education and Knowledge Creation; Local Education and Training; Local Personal Services (Non-Medical); and Local Real Estate, Construction, and Development.

Beyond the clusters outlined in Figure 1, RESI's analysis also accounted for emerging clusters or clusters that were not easily defined by the identified groupings used in NAICS codes, as these clusters cut across NAICS code groupings. For example, while the design of a product may be classified as engineering, the actual production of a prototype may be classified as manufacturing. Thus, to estimate characteristics of these clusters, RESI used a combination of NAICS codes to define these industries. Section 3.4.2 includes more details on these NAICS codes. Relying solely on NAICS codes and the traditional NAICS codes industry groupings, clusters such as Research and Development (R&D) or Information Technology/Cyber Security may be overlooked. However, through the review of the existing literature including the concurrent SWOT analysis, RESI found that R&D spending was especially vulnerable to funding changes and that Information Technology/Cyber Security was likely to be a growth industry. Both are important points to consider for further policy analysis.¹⁶

Spending in the R&D and Information Technology/Cyber Security categories was not limited to the comprehensive NAICS industry definitions used in this report. For example, spending on Information Technology/Cyber Security occurred in a number of clusters, including Business Services, Communications Equipment and Services, Education and Knowledge Creation, and Local Utilities. As such, custom categories were adopted to further determine how these

¹³ William Shuffstall, "Using Location Quotients to Identify Local Strengths, Opportunities, and Industry Clusters," Penn State Extension (2016): 1, accessed October 14, 2016, <http://extension.psu.edu/community/ecd/understanding-economic-change-in-your-community/use-location-quotients>.

¹⁴ Location quotients compare the proportion of employment in a specific industry in a region to the proportion of employment in that specific industry at the national level. By definition, a location quotient of 1.0 means that the same ratio of industry employment occurs at the local and national level, while location quotients less than 1.0 indicate an employment concentration lower than the national average. Location quotients over 1.0 indicates that regional labor is producing more goods than are being consumed in the region. Experts typically accept any industries with a value over 1.25 as being exporting industries.

¹⁵ Note that the number of industries with a location quotient over 1.25 is different for the State of Maryland than for each region. Location quotients are calculated based on geography, therefore one region may have a greater concentration than the state as a whole.

¹⁶ Regional Economic Studies Institute of Towson University, "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape."

spending categories affect Maryland. To capture R&D and Information Technology/Cyber Security, RESI created customized cluster definitions to capture the employment impacts of this spending. More details on these clusters can be found in Sections 4.1.4, 3.4, and the SWOT analysis.¹⁷ RESI estimates that between 2011 and 2015:

- The R&D cluster in Maryland received an average of nearly \$2.7 billion annually in spending obligations and employed over 195,000 individuals in Maryland.
- The Information Technology/Cyber Security cluster in Maryland received an average of nearly \$1.8 billion in annual spending obligations and employed over 203,000 individuals.

Due to the fact that the NAICS codes represented in the R&D cluster and the Information Technology/Cyber Security cluster overlap with the industry-wide definitions utilized from Delgado, Porter, and Stern, these estimates were not explicitly displayed in Figure 1. Although the NAICS codes from these clusters overlap with each other, the spending amounts do not since they are based on unique DoD identified product or service code funding categories. These customized clusters are considered for the remainder of this report, and are elaborated upon in the SWOT analysis.¹⁸

1.1.2 Forecast of DoD Funding Economic Impact

Thus far, Section 1 has focused on the current impact of DoD funding in the State of Maryland for the 2011-2015 period. RESI used the average level of funding during this five-year period and forecasted the impact of this funding, if it remained at the current levels without adjusting for inflation, over the next ten years. The long-term forecast provides insight on the number of Maryland jobs that could be supported by DoD spending in the future. To do this, RESI utilized the REMI PI+ software.

The REMI PI+ model is a high-end dynamic modeling tool that helps RESI to build a sophisticated model that is calibrated to the specific demographic features of the state. This model enumerates the economic and fiscal impacts of each dollar earned and spent by the following: employees relating to the economic events, other supporting vendors (business services, retail, etc.), each dollar spent by these vendors on other firms, and each dollar spent by the households of the event's employees, other vendors' employees, and other businesses' employees. The model features the ability to capture price effects, wage changes, and behavioral effects through time. This allows RESI to capture the effects occurring between industries and minimize the potential for double counting in employment, output, and wages. The ability to capture effects throughout a span of time provides a detailed representative of an

¹⁷ Regional Economic Studies Institute of Towson University, "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape."

¹⁸ Ibid.

economic event over time and its effects on the study area. Further information on the model and assumptions is provided in Appendix C.

Using this model, RESI found the employment impact of DoD funding to be significant, estimating that this funding will continue to support an average of 101,000 direct, indirect, and induced Maryland jobs for each of the next ten years.¹⁹ The impact is particularly noticeable in certain Maryland regions—Central and Capital—and within specific industry clusters. For example, the Business Services cluster is estimated to create over 35,000 direct, indirect, and induced jobs on average per year, or 35 percent of all new jobs supported by DoD funding. This analysis takes a closer look at activity within these clusters at both the state and regional levels.

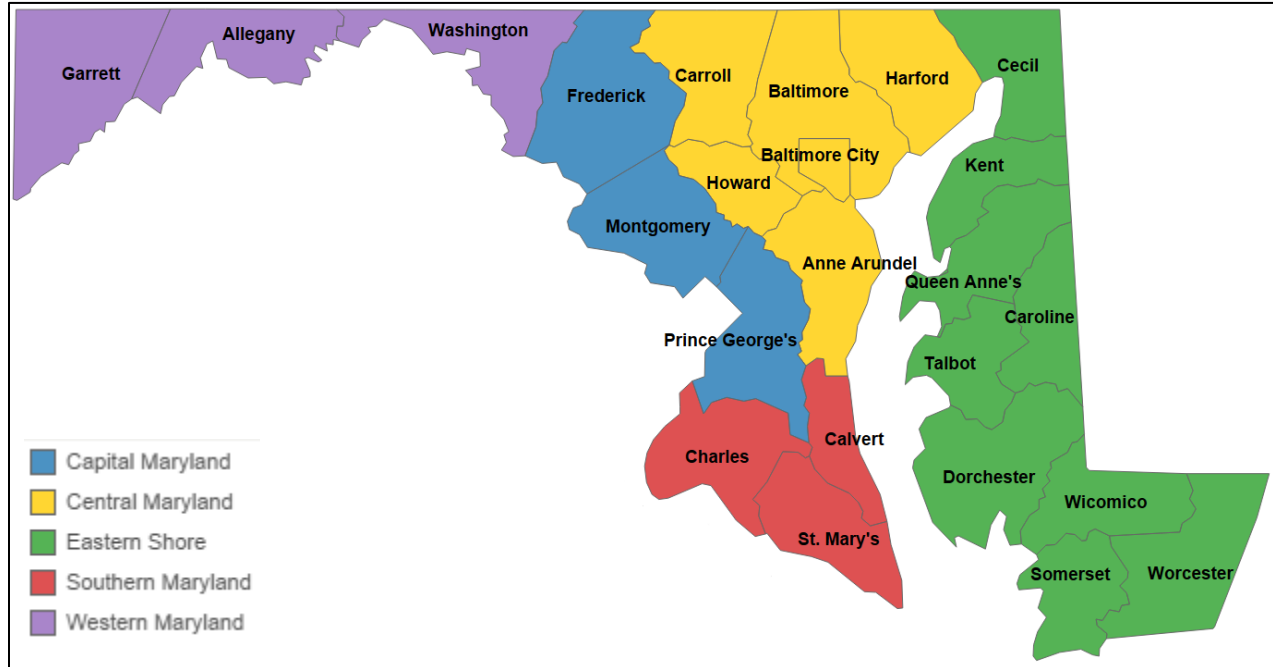
1.2 Regional Findings

In addition to the statewide analysis, RESI assessed cluster employment activity at the regional level. The five regions detailed in this analysis were the Capital, Central, Eastern Shore, Southern Maryland, and Western Maryland regions, shown below in Figure 2. The counties that comprise these regions are as follows (regions in alphabetical order):

1. Capital region – Frederick, Montgomery, and Prince George’s Counties
2. Central region – Anne Arundel, Baltimore, Carroll, Harford, Howard Counties and Baltimore City
3. Eastern Shore – Cecil, Caroline, Dorchester, Kent, Queen Anne’s, Somerset, Talbot, Wicomico, and Worcester Counties
4. Southern Maryland – Calvert, Charles, and St. Mary’s Counties
5. Western Maryland – Allegany, Garrett, and Washington Counties

¹⁹ RESI’s estimate for the total number of jobs drops below 100,000 jobs after year five due to growing expected wages in the economic model, which creates diminishing returns in the impacts of the same spending levels over time.

Figure 2: Maryland Counties in Five Regions Used for Analysis



Source: RESI

Maryland's regions are diverse in terms of rural and urban populations, and this is largely reflected in the number of jobs estimated to be in each region. The Eastern Shore, Southern Maryland, and Western Maryland regions are the more rural areas of the state, while the Capital and Central regions are more urban. Taking the geographical illustration of the regions in Figure 2, Figure 3 provides the basic economic data, focusing on jobs and population at the regional level.

Figure 3 shows the large disparity in the number of jobs in each region, which is related to overall population and population density between the Capital and Central regions and the rest of the state. When job estimates were combined for the Capital and the Central regions, these two areas comprised over 2 million of the total 2.4 million jobs assigned at the regional level.²⁰ Also, it is noted that the average wages were higher for the Capital and Central regions than the rest of the state, at approximately \$54,199 and \$52,630, respectively.²¹ The Eastern Shore and Western Maryland were the two-lowest wage areas of the state, at an average of approximately \$45,157 and \$47,662, respectively. In general, this aligns with the pattern that

²⁰ Note that due to data suppression that occurs at the county level, the totals for the regions do not add up to the total for the state, and the state average salary is higher due to inclusion of data for the state that is assigned to the "999" county code for privacy purposes.

²¹ RESI estimated state-level average annual wages using CBP employment estimates and OES wage data from CBP county-level data. See Appendix A for more details.

rural areas tend to have a lower cost of living and lower wages than urban areas. Southern Maryland fell in between the two extremes in terms of wages, having a value of approximately \$49,017. Southern Maryland is rural, yet still has a close proximity to Washington, D.C., which gives the area a geographic competitive advantage and results in a higher average wage than other rural areas in the state.

Figure 3: Regional Overview—Total Jobs, Average Annual Wages, DoD Funding, and Employment Impact²²

Region	Regional Job Estimate, 2014	Regional Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending	Percent Jobs DoD Dependent
Central	1,214,807	\$52,630	\$8,082,350,494	51,344	4.32%
Capital	875,165	\$54,199	\$7,685,333,309	40,324	4.85%
Southern Maryland	89,020	\$49,017	\$1,942,834,383	7,664	8.88%
Eastern Shore	146,615	\$45,157	\$173,764,748	1,195	0.90%
Western Maryland	102,308	\$47,662	\$77,359,941	736	1.08%
Total	2,427,915	\$52,402	\$17,961,642,875	101,263	4.39%

Sources: RESI, U.S. Census CBP

In addition to having the highest number of jobs and wages in the state, the Central and Capital regions received the vast majority of Maryland's DoD funding obligations, at an average of over \$15.5 billion annually between 2011 and 2015. During this time, the majority of the remaining funding went to Southern Maryland, which received an annual average of nearly \$2 billion. The Eastern Shore and Western Maryland regions received relatively low amounts of annual DoD Spending, averaging approximately \$174 million and over \$77 million, respectively, between 2011 and 2015.

To show the relative dependency of each region on DoD funding, RESI calculated the percentage of jobs that are DoD dependent for each region.²³ This analysis found that Southern Maryland is the most dependent on funding, while the Eastern Shore and Western Maryland are the least-dependent regions. Proportionally, the Southern Maryland region receives the largest share of DoD spending obligations in terms of funding-to-jobs ratio. Due to this reliance

²² Note that due to data suppression that occurs at the county level, the totals for the regions do not add up to the total for the state, and the state average salary is higher due to inclusion of data for the state that is assigned to the "999" county code for privacy purposes.

²³ Note that this ratio in this report uses the estimated employment impact from REMI outputs and the total number of jobs in a region as estimated by CBP data, described in the Methodology section and Appendix A.

on DoD funding to support jobs, the Southern Maryland region would be most affected by a reduction in DoD funding and less likely to rebound from DoD spending fluctuations.

RESI's impact analysis (using REMI PI+) indicates that DoD funding in the Capital region is predicted to support approximately 40,000 direct, indirect, and induced jobs annually over the next ten years. This amounts to 4.9 percent of the region's job base of more than 875,000 estimated private non-farm jobs in 2014. DoD funding for the Central region is predicted to support more than 51,000 direct, indirect, and induced jobs annually over the next ten years. This represents roughly 4.3 percent of the region's total employment of 1.2 million in 2014. In Southern Maryland, DoD funding is expected to support 7,600 direct, indirect, and induced jobs annually or approximately 8.9 percent of the region's total private non-farm job base of 89,000 in 2014. Again, these estimates assume current spending levels will be maintained and do not account for inflation.

The DoD funding provided to each region is unevenly distributed across industry clusters outlined in each region, as outlined in Figure 4. This figure highlights the top cluster for each region of the state by DoD funding levels. In all of the regions, the top cluster had annual wages greater than the average for the entire state (\$52,402 annually in 2015).²⁴ The Business Services cluster received the largest level of DoD funding, both in the state (as shown in Figure 1), and in the three regions that received the most DoD funding. This cluster received more than \$3.7 billion in average annual funding in the Capital region and employed over 155,000 people. In the Central region, the Business Services cluster received over \$2.1 billion in the Central region and employed more than 166,000 people. In Southern Maryland, this cluster received over \$1.3 billion and employed over 15,000 people. The top cluster for Western Maryland was Local Commercial Services, which received over \$25 million in funding obligations and employed over 5,600 individuals. Education and Knowledge Creation was the top cluster for the Eastern Shore, which received nearly \$25 million annually in funding obligations and employed approximately 2,000 people.

²⁴ RESI estimated state-level average annual wages using CBP employment estimates and OES wage data from CBP county-level data. See Appendix A for more details.

Figure 4: Estimated Jobs and Average Wage for Top Regional Cluster by Average Annual DoD Funding

Region	Cluster Name	Average Annual Dollars Obligated, 2011-2015	Job Estimate, 2014	Estimated Average Wage, 2015
Capital	Business Services	\$3,764,580,776	155,491	\$80,110
Central	Business Services	\$2,153,631,370	166,779	\$79,025
Southern Maryland	Business Services	\$1,352,852,319	15,089	\$78,107
Western Maryland	Local Commercial Services	\$25,187,985	5,668	\$52,743
Eastern Shore	Education and Knowledge Creation	\$24,841,118	1,980	\$62,875

Sources: BLS OES; Delgado, Porter, and Stern; RESI; USA Spending; U.S. Census

1.3 Social Network Analysis Findings

To understand the collaborative activity occurring across Maryland, RESI subcontracted Tertius Analytics to conduct a social network analysis (SNA). SNA identifies and explores connections between entities, organizations, and people, to determine how they interact to create new products and services. It could be argued that the SNA is similar to an x-ray of the cluster, showing how companies, universities, and government organizations comprising the cluster connect with one another. Clusters that have little to no activity between their members are most likely geographic agglomerations of firms, and are not benefiting from their involvement in the cluster.²⁵ In reviewing the defense-related clusters in the state, Tertius Analytics' SNA found significant collaboration between large defense contractors and major universities in Maryland, notably: Johns Hopkins University (JHU); University of Maryland, Baltimore (UMB); University of Maryland, Baltimore County (UMBC); and University of Maryland, College Park (UMCP). Major defense contractors in the state include Lockheed Martin, International Business Machines (IBM), Boeing, and Honeywell International. A more exhaustive list of collaborators identified in the SNA from both in the state and outside of the state can be found in Section 6. Collaborations between universities and defense contractors are an asset to the state and foster innovation within the defense industry.

According to the SNA, the main industry clusters supporting innovation in Maryland included Aerospace Vehicles and Defense, Biopharmaceuticals, Business Services, Communications Equipment and Services, and Information Technology and Analytical Instruments. From RESI's analysis of these specific clusters, they collectively employed over 355,000 individuals and paid

²⁵ Philip Cooke, "Regional Innovation Systems, Clusters, and the Knowledge Economy," *Industrial and Corporate Change* 10 no.4 (2001): 945-974, doi: 10.1093/icc/10.4.945.

an average annual wage of approximately \$77,444.²⁶ The SNA also showed an emerging Materials cluster, which is supported by the defense industry and has originated from the Aerospace and Defense network, the Bio network, and the Telecommunications network.

The SNA also found that certain innovation networks appear vulnerable to funding fluctuations due to their dependence upon a single company that connects members of the network. For example, the Communications Equipment and Services cluster is entirely dependent on Telecommunications Systems, Inc. This dependency is a significant threat, since any innovation originating from this cluster would suffer a serious shock if the central company were to cease operations.

²⁶ Cluster employment data was estimated using U.S. Census CBP data for 2014. Wage estimates were calculated using occupation profile and wage data for industries in Maryland from BLS OES data for 2015. In both cases the data used was the most recent available.

2.0 Introduction

The Regional Economic Studies Institute (RESI) of Towson University was tasked by the Maryland Department of Commerce (Commerce) to conduct an industry cluster analysis of Maryland's economy, focusing on those parts of the state economy that receive defense-related spending.²⁷ The Department of Defense's (DoD) Office of Economic Adjustment (OEA) Defense Industry Adjustment (DIA) Program has 40 ongoing state- and regional-level projects throughout the U.S.²⁸ These projects are tailored to meet the needs of each locality, however, funding is generally used to examine the economic impact of potential future fluctuations in DoD funding and how the locality will prepare for this change. While some states have already completed their assessment, such as Washington and Virginia, other states, such as Hawaii, are only beginning their assessment.

While these projects are occurring across the country, the importance of this research at the state level cannot be overstated. Using data gathered through USA Spending, from 2011 to 2015, RESI estimated that the DoD obligated approximately \$18 billion per year to companies in the State of Maryland.²⁹ According to the FY15 OEA report on DoD funding by state, Maryland ranks fourth in the U.S. for DoD funds spent in the state.^{30,31} In addition, during the same fiscal year, Maryland ranks fifth after Virginia, Hawaii, Alaska, and Alabama for defense spending as a percent of state GDP.³² While sequestration has had an impact on the funding to the state during this period, the average contribution of DoD funding to Maryland is approximately 5.3 percent of state GDP.

This funding is a valuable economic engine for growth in the state, and is also an important resource for private companies, academic institutions, economic developers, military installations, and policymakers in the State of Maryland. The direct, indirect, and induced jobs and wages associated with the defense industry highlight the economic impact of DoD funding in Maryland. Recognizing the contribution of this funding to the state, the findings from this report, as well as the wider study being conducted by RESI, will prepare Commerce to support industry clusters that have a significant economic impact in Maryland and may also be vulnerable to future DoD funding fluctuations.

²⁷ For the purposes of this study, an industry cluster is defined as a grouping of industries related in terms of products produced, or are interdependent for producing goods or services, and are defined and organized by researchers to enable analysis.

²⁸ "OEA Project Profiles," U.S. Department of Defense, Office of Economic Adjustment, accessed December 31, 2016, <http://www.oea.gov/how-we-do-it/projects?program=defense+industry+adjustment&state=all&view=grid>.

²⁹ "Download Center," USA Spending.

³⁰ Ibid.

³¹ U.S. Department of Defense, Office of Economic Adjustment, "Defense Spending by State Fiscal Year 2015," 3, accessed December 31, 2016, http://www.oea.gov/sites/default/files/resources/fy2015-statesonly-508-final-sm_0.pdf.

³² Ibid.

The research questions that are leading the analysis throughout the remainder of this report include the following:

- What are the major industry clusters—at the state and regional levels—that received DoD funding in Maryland from 2011-2015?
- What were the economic impacts—jobs, wages—of these clusters in the state and in the individual regions from 2011-2015?
- How reliant are these major industry clusters on DoD funding?
- Over the next ten years, what will the economic impact of DoD funding be on the identified industry clusters in Maryland?

This section will continue as follows. The next subsection will review the existing literature on industry clusters, highlighting how RESI determined which clusters would be used for this analysis. This will be followed by a subsection outlining the historic trends in defense spending. The final subsection will be signposting for the remainder of this report, including the Appendices.

2.1 Defining a Cluster

Through a review of the secondary literature, RESI found that academics, policymakers, and companies have a variety of ways of defining clusters and defining cluster analysis. In terms of cluster definitions, the most basic and earliest definition of a cluster was an “industrial district” or a group of companies that are competitors as well as collaborators.³³ Since this early conceptualization of clusters, academics have sought to redefine clusters accounting for the relationship between industries instead of firms, the proximity of firms within the cluster, the lack of proximity of firms within the cluster, and the role of entrepreneurship in cluster development.^{34,35} Examples of clusters exist to support each definition from around the globe at all skills levels ranging from high-tech development in Silicon Valley and biotechnology in Greater Boston, to specialized cheese production in Parma, Italy and woodworking in Salling, Denmark. Regardless of the location of the firms in the cluster, the number of firms in the cluster, or the start-ups derived from the cluster, clusters require companies and industries to work together in a collaborative manner. This collaboration can compose a supply chain or be for the purposes of innovation.

From an economic development approach, a cluster often refers to grouping different industries in a region based on similar or complimentary products that companies create.³⁶ These groupings are often customized to specific industries present in a given area. This

³³ Alfred Marshall, *Industry & Trade* (London: Macmillan, 1919).

³⁴ M.E. Porter, *On Competition* (Boston: Harvard Business School Press, 1998).

³⁵ Philip Cooke and Kevin Morgan, *The Associational Economy: Firms, Regions, and Innovation* (Oxford: Oxford University Press, 1998).

³⁶ Delgado, Porter, and Stern, "Defining Clusters of Related Industries," 1.

“similarity” noted for the products can also include parallels in the necessary skills that occupations within different industries have in common.³⁷ For example, if there is a glass manufacturing company and a satellite manufacturing company, the “similarity” may be in the glass worker who has the knowledge and skills to create specialized glass to make satellites lighter and more durable. The groupings among industries based on skillset or product similarity can be done on a case-by-case basis, deeply analyzing a specific region to understand the interdependencies of industries at a local level. An example of this approach would be the San Diego’s Cyber Security cluster analysis produced by the San Diego Regional Economic Development Corporation.³⁸

The groupings of similarities can also be performed using larger datasets across different regions, such as the work done by Delgado, Porter, and Stern, who created clusters and subclusters based on observed linkages and occupational similarities.³⁹ An example of this method’s use in cluster studies can be found in a 2016 report by Cooper, Sedgwick, and DeWitt, which analyzed the aerospace industry in Southern California.⁴⁰

In terms of analyzing the clusters, RESI used the Delgado, Porter, and Stern approach for the overall analysis of Maryland’s economy (at both the state and regional levels). This analytical technique was developed by a team of researchers from Harvard, MIT, and Temple, utilizing funding from the U.S. Department of Commerce’s Economic Development Administration.⁴¹ Delgado, Porter, and Stern, three researchers from the aforementioned institutions, describe this approach in a 2015 paper.⁴² Their methodology utilizes national co-location patterns, occupational data, and industry input-output tables to define their clusters.⁴³ Further information on the analysis of the clusters can be found in Section 3, Methodology.

2.2 Defense Spending Patterns

The pattern of behavior observed in Congress over the past five years suggests that, while there appears to be majority support for increasing the defense budget, that desire is being tempered by divisions over the nondefense portion of the budget. Overall trends are difficult to predict due to the large number of variables impacting DoD funding obligations to Maryland

³⁷ Delgado, Porter, and Stern, "Defining Clusters of Related Industries," 1.

³⁸ San Diego Regional Economic Development Corporation, “Cybersecurity in San Diego: An Economic Impact and Industry Assessment,” accessed December 31, 2016, <http://www.sandiegobusiness.org/sites/default/files/Cyber%20Security%20Final%20Report.pdf>.

³⁹ Delgado, Porter, and Stern, “Defining Clusters of Related Industries,” 2-3.

⁴⁰ Christine Cooper, Shannon Sedgwick, and Wesley DeWitt, “The Changing Face of Aerospace in Southern California: The Future is Here,” Los Angeles County Economic Development Corporation and San Diego Regional EDC (March 2016): accessed December 31, 2016, http://laedc.org/wp-content/uploads/2016/02/LAEDC_Aerospace_FINAL_20160301.pdf.

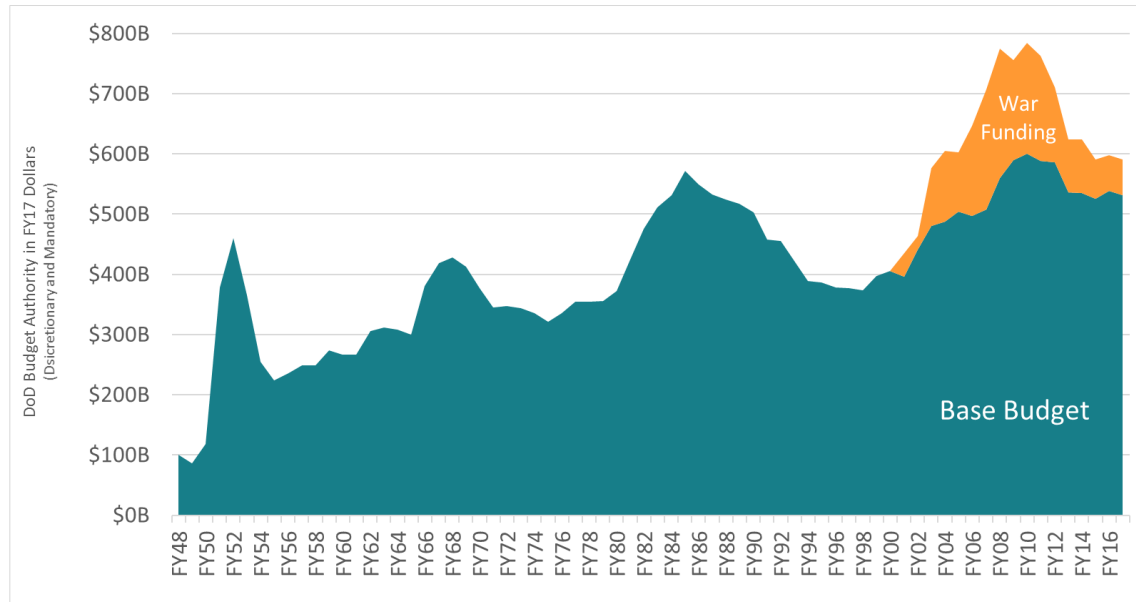
⁴¹ "About the Project," U.S. Cluster Mapping, accessed October 6, 2016, <http://clustermapping.us/about>.

⁴² Delgado, Porter, and Stern, “Defining Clusters of Related Industries,” 23-30.

⁴³ Ibid, 3.

contractors. These include priorities on how allocated defense funding is spent, and political priorities between defense spending, tax cuts and other expenditures. As shown in Figure 5, defense spending has historically been highly cyclical.

Figure 5: DoD Budget, FY 1948 to FY 2016, Adjusted for Inflation



Source: Center for Strategic & International Studies

Since the end of World War II, there have been four major cycles of defense spending driven by military conflicts and peacetime competition. In the most recent budget cycle, the overall defense budget grew from its low point in FY 1998 to a post-World War II high in FY 2010. Since then, however, the budget has declined by 25 percent, adjusting for inflation, through FY 2015. Much of this decline was due to a reduction in operations in Iraq and Afghanistan. If war-related funding is excluded, the “base” defense budget declines by only 12 percent. In FY 2016, the base defense budget began to grow again, marking what could be an end to this downturn.

Due to these considerations, the average spending between 2011 and 2015 is used for estimating the impacts DoD spending in Maryland throughout this report.⁴⁴ Figure 6 outlines

⁴⁴ RESI also conducted forecasts assuming a 10 percent decrease and a 10 percent increase in average DoD spending in Maryland. However, these numbers are not reported as the hypothetical increase shows a 9.971 percent average increase in employment over ten years, and the hypothetical decrease shows a 9.973 percent average decrease in employment over ten years. This shows that the model predicts diminishing returns, as there is a slightly larger gain to employment from moving from the 10 percent decrease to the status quo than there is from moving from the status quo to the 10 percent increase, but is otherwise unremarkable. Section 7 of "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape" presents detailed policy change analyses based on specific policy changes determined to be likely through the SWOT analysis.

the amount of DoD funding that the State of Maryland received per year from 2011–2015 at both the state and regional level. In regards to the latter, RESI analyzed five Maryland regions in this report. These regions (and the counties comprising these regions) are in alphabetical order as follows:

1. Capital region – Frederick, Montgomery, and Prince George’s Counties
2. Central region – Anne Arundel, Baltimore, Carroll, Harford, Howard Counties and Baltimore City
3. Eastern Shore – Cecil, Caroline, Dorchester, Kent, Queen Anne’s, Somerset, Talbot, Wicomico, and Worcester Counties
4. Southern Maryland – Calvert, Charles, and St. Mary’s Counties
5. Western Maryland – Allegany, Garrett, and Washington Counties

The DoD funding allocated to each region can be found below in Figure 6. The table with greater detail for this data can be found in Appendix A.

Figure 6: Annual DoD Funding Obligations by Region (Spending in \$Millions)

Region	2011	2012	2013	2014	2015	Average Spending (\$Millions)
Capital Region	\$8,675.2	\$8,450.2	\$7,357.1	\$7,316.2	\$6,626.9	\$7,685.1
Central Region	\$8,069.7	\$8,528.3	\$7,472.3	\$8,158.5	\$8,182.4	\$8,082.2
Eastern Shore	\$195.6	\$140.9	\$108.5	\$119.5	\$277.7	\$168.5
Southern Maryland	\$1,991.4	\$2,095.6	\$1,795.2	\$1,890.6	\$1,948.7	\$1,944.3
Western Maryland	\$75.3	\$91.9	\$81.1	\$58.2	\$101.3	\$81.6
Maryland Total	\$19,007.2	\$19,306.8	\$16,814.3	\$17,543.0	\$17,137.0	\$17,961.7

Sources: RESI, USA Spending

Taking the information in Figure 6 at the regional level in Maryland (depicting the state-wide trends as a whole), and viewing it alongside the national trends illustrated in Figure 5, a similar situation has been occurring across at the national and state levels. Regionally there has been some variation, with spending on the Eastern Shore first declining and then increasing. This type of variability is expected because at more disaggregate levels variation can be more easily effected by relatively few relatively large contracts. This is particularly noticeable in the post-2013 period with the winding down of war funding as well as the impact of sequestration. The data used to construct Figure 6 can be found in Appendix A.1.3.

2.3 Report Overview

This report will continue as follows. Section 3 provides an overview of the methodologies used in the cluster analysis as well as the definitions used to define the clusters. The methodology subsection focuses on outlining the data used in the cluster analysis. The data sources are described in detail, including an explanation of why these sources were chosen and the sources' individual strengths and weaknesses. This subsection also includes an overview of the methods used by Tertius Analytics to conduct the social network analysis (SNA). The definitions subsection highlights how RESI organized the industry clusters in the state.

Section 4 and Section 5 are closely related. Section 4 focuses on reviewing the findings from the RESI cluster analysis at the state level, while Section 5 focuses on reviewing the findings from the RESI cluster analysis at the five-region level. These two sections comprise the core analysis of industry clusters in the report. Both sections provide the following information: an overview of the employment and wages of each cluster in the state/region; the distribution of DoD funding (from 2011-2015) to each cluster in the state/region; a discussion of the current economic impact of this DoD funding on the clusters; and a forecast of the economic impact of this DoD funding under different conditions over a ten-year period.

Section 6 details the SNA performed by Tertius Analytics, RESI's subcontractor. Tertius Analytics' SNA highlights innovation clusters in the state and the dynamic interaction between military, government, academia, and private industry in Maryland. Their analysis found that universities are a large asset to Maryland in terms of fostering innovation.

Taking the results from Sections 4, 5, and 6, Section 7 presents a combination of the cluster analysis and the social analysis, where the results of the two are used to present a more complete overall picture of innovation in Maryland. This section is important as the preceding sections (4 and 5) focus on the agglomeration of companies providing similar products and services that comprise the industry clusters as well as how these companies interact (Section 6), if at all, within clusters and between clusters. However, sections 4, 5, and 6 do not highlight the collaboration occurring within the clusters, which Section 7 highlights.

The final section of the report, Section 8, presents a summary of the main findings of the report broken out for the state and its component regions. Using these findings, RESI suggests recommendations for the diversification of clusters in Maryland focusing on clusters with a high level of DoD funding, as well as clusters with a high level of employment reliant on DoD funding. It should be noted that RESI also created several appendices where additional information on the methodology, definitions, and analysis can be found.

3.0 Methodology

RESI used both primary and secondary data based in Maryland to complete the cluster analysis found in this report. This data includes information from the strengths, weaknesses, opportunities, threats (SWOT) analysis, the survey, the SNA, and secondary data sources to ascertain more specific cluster definitions and to allow for a better understanding of how potential policy changes will affect Maryland.⁴⁵

This section will review these primary and secondary datasets explaining why they were used. In addition, this section will also outline how the clusters were defined for both the clusters defined by North American Industry Classification System (NAICS) codes as well as the customized clusters. A more robust review of the methods used and the analytical approach adopted can be found in Appendix A and Appendix D.

3.1 Collection of Primary Data: The Maryland Defense Network Survey

To support the cluster analysis as well as the larger OEA project, RESI collected primary data in the form of business surveys. The aim of the survey was two-fold. First, the survey was developed to identify companies that received DoD funding but were further down the DoD supply chain, beyond the prime and first-tier contractors, not reported in USA Spending. Second, once these companies self-identified as being a part of the supply chain, the aim was to determine their level of dependency on DoD funding as a percent of their annual revenue. To meet these objectives, the survey questions, a supplier-list upload website, an introduction, and a reminder were created by RESI and disseminated by Commerce via email between April 2016 and December 2016. In addition, RESI contracted with the Schaefer Center for Public Policy at the University of Baltimore to conduct the survey via phone from September 2016 to December 2016. While the survey collected data until December 2016, for the purposes of this report, the data collected from April 2016 to October 2016 was used. During this period, the survey collected 591 responses. An overview of the survey collection and analysis is outlined in Appendix A.2.1.

3.2 Review of Secondary Data & Analysis

To conduct a defense-related industry cluster analysis RESI utilized data from multiple sources, including:

- U.S. Census County Business Pattern (CBP) dataset,
- U.S. Census Quarterly Workforce Indicators from the Longitudinal Employer-Household Dynamics (LEHD),
- Bureau of Labor Statistics (BLS) Occupational Employment Statistics (OES),
- BLS Local Area Unemployment Statistics (LAUS),

⁴⁵ As a separate part of this overall project, RESI also conducted a SWOT analysis of the defense industry in Maryland to better understand DoD spending impacts on Maryland.

- BLS Quarterly Census of Employment and Wage (QCEW),
- InfoUSA,
- O*Net (the Occupational Information Network), and
- USA Spending.

RESI used a combination of the aforementioned secondary datasets to complete the cluster analysis. The CBP data was used to develop a detailed summary of labor and employment characteristics for both the State of Maryland and for each of the five regions selected. The CBP data set provides estimates for employment by six-digit NAICS code.⁴⁶ NAICS are two- to six-digit codes for classifying businesses by the industry they are in, with two-digit codes being more generic, and six-digit codes being more specific. For example, the two-digit NAICS code “11” is the classification for Agriculture, Forestry, Fishing and Hunting, and the code “111110” is the code for Soybean Farming.⁴⁷ Using data from the 2014 CBP dataset for each cluster in the state, RESI estimates the number of jobs each cluster supports in the state. CBP data is used instead of QCEW data because CBP data provides size ranges for employers and provides a means for estimating employment in industries with data that was suppressed to maintain privacy.⁴⁸ The 2014 CBP data was the most recently available data by that source and was used in lieu of more recent 2015 QCEW data due to data suppression issues in the latter source. CBP data provides categorical firm size data, which allows for an estimate on the level of employment in many, but not all, suppressed industries such as those in the Aerospace and Defense Cluster.

The LEHD data was used alongside the CBP data to provide information on labor transitions between industries at the state level, and is collected under the Local Employment Dynamics partnership. This data provides an understanding of the quantity and type of labor that is transitioning between industries. Additionally, the BLS LAUS data provides an overview of employment trends for the state and each region in Maryland.

Similar to the CBP and the LEHD data being used together, using the BLS OES and QCEW data in conjunction with O*Net data sets allows for estimation of occupational wage and employment levels for Maryland. This method is used for estimating wages because it allows for approximations of earnings in industries with annual payroll data, which is suppressed by the CBP data. It should be noted that throughout the report the 2015 wage data was used with the 2014 occupation data to allow for the most up-to-date estimations, providing an accurate account of current conditions.

⁴⁶ "County Business Patterns: 2014," U.S. Census Bureau, accessed September 27, 2016, <http://www.census.gov/data/datasets/2014/econ/cbp/2014-cbp.html>.

⁴⁷ "North American Industry Classification System: Concordances," U.S. Census Bureau, accessed October 4, 2016, <https://www.census.gov/eos/www/naics/concordances/concordances.html>.

⁴⁸ "County Business Patterns," U.S. Census Bureau, accessed January 5, 2017, <https://www.census.gov/econ/overview/mu0800.html>.

The InfoUSA dataset contains information on many verified businesses in the United States, and was developed by InfoUSA by utilizing publicly available data such as record notices, county courthouse business filings, and phone directories.⁴⁹ To verify and update the business data, InfoUSA representatives call companies on a regular basis. As a result, the dataset is kept current and provides a timely and detailed understanding of business activity at the national level. For the purposes of this report, InfoUSA data for Maryland was used to supplement the information companies reported in the survey (outlined in Section 3.2). Specifically, the companies responding to the survey were matched against those in the InfoUSA data set. This allowed RESI to match respondents to six-digit NAICS codes to be mapped to the Delgado, Porter, and Stern cluster definitions.⁵⁰

RESI used USA Spending data to quantify the impacts of the defense industry on Maryland's economy using the REMI PI+ model.^{51,52} The data provided by USA Spending shows the actual contracts awarded to companies conducting business with the DoD from around the country. The federal government requires that the prime and the first-tier companies within the defense industry supply chain report their DoD contracting activity – dollars awarded, revenue, point of contact – through USA Spending which also provides a basis for understanding the collaboration among firms in the defense industry.⁵³ Appendix A provides more details on the data outlined above as well as how this data was analyzed.

3.3 Social Network Analysis

Social network analysis (SNA) consists of analyzing three main components: nodes, ties, and networks. The nodes are the actors within the system; for this report, they are individuals, business, and organizations. Ties are the linkages between the nodes in the system. For example, if a company acts as a subcontractor to another firm, there is a linkage between the two nodes representing those companies. Networks are groupings of nodes and ties, and can contain other groupings of nodes and linkages, creating subnetworks. By analyzing these networks at different levels of granularity, economic developers can get a better sense of how companies and other organizations interact in the innovation process.

⁴⁹ "How We Gather Data," InfoUSA, accessed December 31, 2016, https://lp.infousa.com/infousa_g?bas_phone=800.868.5249&bas_offer=16109445366&gclid=CNToj-2_mtECFQZLDQodjjwD1w&gclsrc=aw.ds.

⁵⁰ Delgado, Porter, and Stern, "Defining Clusters of Related Industries," 23-30.

⁵¹ "Download Center," USA Spending.

⁵² See Appendix D for a detailed explanation of this process.

⁵³ A prime contractor is defined as the recipient of DoD funding who is contracted to provide a product or service. First-tier refers to the first level of subcontractor(s) that the prime contractor hires to complete the project. Contractors further down the supply chain can exist with second-tier and third-tier contractors; however, prime and first-tier contractors do not need to report these second-tier and third-tier contractors to USA Spending.

SNA requires specialized skills and data to perform for an accurate analysis. As such, RESI contracted with Tertius Analytics, which has developed a proprietary data set to conduct this type of research. Tertius Analytics' dataset utilizes information from multiple sources, including:

- U.S. Patent and Trademark Office data on patent grants and patent applications,
- National Institutes of Health (NIH) research grants,
- National Science Foundation (NSF) research grants,
- Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants, and
- USA Spending.

Unless otherwise noted, the dataset for the SNA is comprised of grant contracts and patent application documents dated from January 1, 2010 through August 31, 2016. In general, grant contract start dates and patent application dates were used to determine if a document was included in the analysis. An explanation of the data preparation and analysis can be found in Appendix A.

3.4 Developing the Clusters

To conduct the cluster analysis in Maryland, RESI used cluster definitions developed by a team of researchers from Harvard, Massachusetts Institute of Technology (MIT), and Temple, funded by the U.S. Department of Commerce's Economic Development Administration.⁵⁴ Delgado, Porter, and Stern, three researchers from the aforementioned institutions, describe this approach in a 2015 paper.⁵⁵ Their approach, outlined in U.S. Cluster Mapping, utilizes geographical considerations, national co-location patterns, occupational data, and industry input-output tables to define their clusters.^{56,57} Beyond this approach, RESI created customized, specific cluster definitions for Information Technology and Cyber Security and for Research and Development (R&D) at the state level. RESI focused on these three specific clusters based on findings from the SWOT report and social network analysis. The SWOT indicated that from a policy perspective that R&D was potentially vulnerable and that Information Technology/Cyber Security was likely to have gains in funding levels.⁵⁸

3.4.1 Creating the Clusters with NAICS codes

Using CBP data (outlined above in Section 3.1) to estimate employment at the six-digit NAICS code level, RESI mapped the Delgado, Porter, and Stern industry clusters to create both state and regional profiles. This process allowed RESI to map 978 six-digit NAICS codes to 67 industry

⁵⁴ "About the Project," U.S. Cluster Mapping.

⁵⁵ Delgado, Porter, and Stern, "Defining Clusters of Related Industries," 23-30.

⁵⁶ Ibid.

⁵⁷ Ibid, 3.

⁵⁸ Regional Economic Studies Institute of Towson University, "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape."

clusters.⁵⁹ RESI constructed wage estimates for each cluster using OES average wage data by occupation. RESI produced industry-wide estimates at the six-digit NAICS code level using occupational profile data. This approach was necessary due to data suppression by both QCEW and CBP.

An example of organizing the 978 six-digit NAICS codes into 67 clusters can be found with the Local Real Estate, Construction, and Development cluster. Within this one cluster, 52 NAICS codes are present including: Masonry Contractors (NAICS code 238140), Roofing Contractors (NAICS code 238160), and Plumbing, Heating, and Air-Conditioning Contractors (NAICS code 238220). Another example would be the Business Services clusters, representing the activity among 33 NAICS codes including: Payroll Services (NAICS code 541214), Engineering Services (NAICS code 541330), and Passenger Car Leasing (NAICS code 532112). Industry sectors were grouped into the Business Services cluster to provide a more detailed analysis. Appendix B contains additional details for spending by NAICS code for the largest clusters by spending.

The advantage of using the Delgado, Porter, and Stern approach is that through its utilization of employment patterns, the methodology allows for distinction between traded and local clusters. Traded clusters generally provide services that support interests external to the region, and local clusters commonly provide more services for those that live in the area.⁶⁰ Traded clusters produce 96.5 percent of the patents in the United States, and overall pay higher wages than local clusters.⁶¹ As will be seen in Section 4, overall DoD spending in Maryland supports jobs that pay an average wage higher than that of the state. This is largely because the majority of DoD spending in Maryland goes to traded clusters. This analysis, presents both traded and local clusters due to the large amounts of funding that Maryland based businesses receive in both. As mentioned above, traded clusters arguably have a disproportionate impact on the economy. However, due to Maryland's competitive advantage with proximity to Washington, D.C. and federal installations such as military bases and research institutes, Maryland effectively exports services that are traditionally thought to be local in nature. Examples of this would include the large amount of spending that occurs on real estate and construction services in the state. Since these buildings and forts provide service to the Federal Government, they are effectively providing services to the rest of the nation too.

One potential limitation of the Delgado, Porter, and Stern approach is that it utilizes national-level data and has the potential to overlook details that are pertinent to the regional

⁵⁹ "Cluster Mapping Methodology," U.S. Cluster Mapping, accessed December 21, 2016, <http://www.clustermapping.us/content/cluster-mapping-methodology>.

⁶⁰ Mercedes Delgado, Richard Bryden, and Samantha Zyontz, "Categorization of Traded and Local Industries in the US Economy," 1, accessed September 29, 2016, <http://clustermapping.us/sites/default/files/files/page/Categorization%20of%20Traded%20and%20Local%20Industries%20in%20the%20US%20Economy.pdf>.

⁶¹ "Clusters," U.S. Cluster Mapping, accessed February 1, 2017, <https://www.clustermapping.us/cluster>.

differences that exist for Maryland. To overcome this limitation, RESI integrated the SWOT analysis findings relevant to the clusters in the state. For example, the SWOT analysis found that that R&D spending was especially vulnerable to DoD funding fluctuations and that Information Technology/Cyber Security was likely to be a growth industry. These two spending categories cross the comprehensive industry definitions primarily used in this report. As such, custom categories were adopted to better understand how these spending categories affect Maryland. To capture R&D and Information Technology/Cyber Security, RESI created customized cluster definitions to capture the employment impacts of this spending, outlined in the following section.

3.4.2 *Creating a Customized Cluster*

In order to conduct a more thorough economic impact analysis for Maryland, RESI developed custom definitions of spending-specific clusters based on observed DoD spending. This was done using USA Spending data, categorized by Product or Service Code (PSC) category. These definitions allowed RESI to better assess cluster activity and associated economic impacts for Maryland. While the activities that the government identifies as R&D or Information Technology/Cyber Security may seem wide-ranging and subject to interpretation, they reflect the official observed classification of the activities funded by the U.S. Government that occur in these clusters. One important observation that comes from this approach is just how many industries that would not be traditionally thought of as being included in R&D or Information Technology/Cyber Security receive funding in these two categories. For example, the DoD reports that the Administrative Management and General Management Consulting Services sector (NAICS code 541611) received over \$63 million in spending annually on average between 2011 and 2015 that was classified as R&D spending. Examples, of the type of services classified as being in R&D spending here includes: AD26: Services (Management/Support), AN95: R&D-Medical: Other (Operational Systems Development), and AJ56: R&D- General Science/Technology: Life Sciences(Management/Support).⁶² Further, if the analysis were limited to only spending lining up on industries more traditionally thought of as being associated with R&D spending, such as the Education and Knowledge Creation cluster, Engineering Services (NAICS code 541330) would not be included as it is included the Business Services cluster. USA Spending reports nearly \$659 million yearly on average between 2011 and 2015 being classified as being spent on Engineering Services.

To identify the clusters for R&D and Information Technology/Cyber Security, RESI used USA Spending data to identify six-digit NAICS codes that received, on average, at least one percent of all DoD obligated dollars from 2011 to 2015 in the relevant PSC category. One percent was an appropriate cut-off for presentation purposes, and limited the analysis to only the NAICS

⁶² "Download Center," USA Spending.

categories where the largest amounts of spending occurred.⁶³ As more NAICS codes are included the overall definition of the cluster becomes less precise, and also includes smaller amounts of DoD spending. As such, a balance between precision and inclusiveness of additional NAICS codes is crucial. For the R&D cluster, RESI used a minimum funding value of approximately \$30 million, and approximately \$19 million for the Information Technology/Cyber Security cluster. All NAICS codes and spending for these categories can be seen in Appendix B.

The R&D spending PSC category receives more than \$2.9 billion per year in obligated DoD funding, or approximately 16 percent of total DoD spending in Maryland.^{64,65} As detailed in Figure 7, the Maryland R&D cluster, based on the one percent cutoff described above, contains nine different sectors receiving a minimum of \$30 million in DoD funding. The sectors are ranked according to share of all DoD funding obligated for the cluster, totaling nearly \$2.7 billion annually. Two industries within this cluster received more than 50 percent of total DoD spending obligated to the R&D cluster:

- The Research and Development in the Physical, Engineering, and Life Sciences (Except Biotechnology) sector, which received more than \$960 million, or approximately 33 percent of all R&D cluster funding; and
- The Engineering Services sector, which received nearly \$660 million, or 22.5 percent of total DoD funding within the R&D cluster.

⁶³ In Economic Impact Analysis presented in the SWOT all spending was used to create the estimates. However, for the primary analysis in this document a 1 percent cut off is used to focus the presentation of spending and occupations to a manageable level of information. All of the spending by NAICS code is presented in Appendix B.

⁶⁴ "Download Center," USA Spending.

⁶⁵ As can be found in Appendix B, total spending on this category was approximately \$2.9 billion, however the NAICS codes that are associated with the additional spending each receive relatively little of the spending.

Figure 7: Maryland R&D Cluster—NAICS Codes and Average DoD Spending

NAICS Code	NAICS Description	Dollars Obligated, 2011-2015	Percent of Total MD DoD R&D Spending
541712	Research and Development in the Physical, Engineering, and Life Sciences (Except Biotechnology)	\$963,035,465	32.9%
541330	Engineering Services	\$658,933,947	22.5%
541711	Research and Development in the Physical, Engineering, And Life Sciences	\$371,771,391	12.7%
334220	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing	\$349,547,710	12.0%
541511	Custom Computer Programming Services	\$182,525,609	6.2%
541611	Administrative Management and General Management Consulting Services	\$63,417,304	2.2%
541512	Computer Systems Design Services	\$40,178,099	1.4%
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	\$33,781,385	1.2%
541711	Research and Development in Biotechnology	\$30,629,588	1.0%
Total		\$2,693,820,498.00	92.1%

Sources: RESI, U.S. Census NAICS, USA Spending

The Information Technology/Cyber Security PSC category received an average of nearly \$1.9 billion per year, or approximately 10 percent of the total DoD spending in Maryland.⁶⁶ Figure 8 shows the Maryland Information Technology/Cyber Defense cluster consists of 11 different sectors receiving a minimum of \$19 million in DoD funding. The sectors are ranked according to share of all DoD funding obligated for the cluster, totaling nearly \$1.8 billion annually. Three industries within this cluster collectively received more than 50 percent of the average obligated dollars between 2011 and 2015:

- The Wired Telecommunications Carriers sector, which received more than \$341 million, or 18.2 percent of all Information Technology/Cyber Security cluster funding;
- The Other Computer Related Services sector, which received over \$311 million in funding, or 16.6 percent of cluster funding; and

⁶⁶ “Download Center,” USA Spending.

- The Computer Systems Design Services sector, which received more than \$294 million, or 15.7 percent of the cluster's total DoD funding.

Figure 8: Maryland Information Technology and Cyber Security Cluster—NAICS Codes and Average DoD Spending

NAICS Code	NAICS Description	Dollars Obligated, 2011-2015	Percent of Total MD IT/Cyber Spending
517110	Wired Telecommunications Carriers	\$341,192,864	18.2%
541519	Other Computer Related Services	\$311,110,209	16.6%
541512	Computer Systems Design Services	\$294,235,699	15.7%
541511	Custom Computer Programming Services	\$196,606,658	10.5%
541330	Engineering Services	\$180,302,559	9.6%
541513	Computer Facilities Management Services	\$164,822,830	8.8%
541712	Research and Development in the Physical, Engineering, and Life Sciences (Except Biotechnology)	\$99,691,836	5.3%
517410	Satellite Telecommunications	\$99,451,891	5.3%
518210	Data Processing, Hosting, and Related Services	\$34,341,776	1.8%
517919	All Other Telecommunications	\$26,049,985	1.4%
443142	Computer and Software Stores	\$19,746,285	1.1%
Total		\$1,767,552,592	94%

Sources: RESI, U.S. Census NAICS, USA Spending

The Information Technology and Analytical Instruments cluster differs from the Information Technology/Cyber Security cluster as the former is a product of the Delgado, Porter, and Stern approach.⁶⁷ Their definition mostly (20 out of 23) consists of six-digit NAICS codes that fit into the three-digit NAICS code category of Computer and Electronic Product Manufacturing category.⁶⁸ The remaining three digit NAICS codes by their definition are the Semiconductor Machinery Manufacturing (NAICS code 333242), Photographic and Photocopying Equipment Manufacturing (NAICS code 33316), and Software Publishers (NAICS code 511210). As shown in Figure 8, none of these match the NAICS codes receiving more than one percent of DoD spending in this category.

⁶⁷ Delgado, Porter, and Stern, "Defining Clusters of Related Industries," 23-30.

⁶⁸ NAICS codes are read from left to right, with the first two digits referring to the top-level industry definition, and each digit to the right becoming more specific. As such, all six-digit NAICS codes that fit the pattern 334XXX (with X representing a digit between 0 and 9) belong to the three-digit NAICS code of 334 which is the Computer and Electronic Product Manufacturing NAICS code.

The datasets and techniques described in this chapter allowed RESI to describe Maryland's economy, the employment impacts of DoD spending, and how Maryland's defense contractors interact to innovate. The next few sections present the results at the state and regional levels of these methods. These results provide the information necessary to help direct economic development efforts.

4.0 Analyzing Maryland's Defense-Related Clusters

On average, more than \$18 billion in DoD spending occurs in Maryland every year. This spending varies both by region and by industry across the state. Drawing on the cluster definitions, DoD spending data, and cluster analysis approaches outlined in the previous sections of this report, this section will provide an analysis of the industry clusters in Maryland that are impacted by DoD funding at the state level. This analysis will highlight the impact of the 2011-2015 DoD funding to Maryland as well as which industry cluster types receive the highest amounts of DoD funding in the state. Given the overarching aim of this project—to determine the impact of potential future fluctuations in DoD funding—RESI also forecasted the economic impacts of these industry clusters under different scenarios in this section.

This section will continue as follows. Section 4.1 provides an overview of the cluster analysis for the state. Specifically, this section presents overall employment by clusters, labor descriptions, and DoD obligated spending by industry cluster. The rest of this section consists of:

- Section 4.1.1 presents the top statewide industry cluster descriptions and corresponding employment characteristics,
- Section 4.1.2 shows details of the cluster analysis for the top clusters receiving DoD funding in the state,
- Section 4.1.3 shows the potential impacts of DoD spending cuts in Maryland's highest-funded clusters,
- Section 4.1.4 details the R&D and Information Technology/Cyber Security clusters that were customized by RESI,
- Section 4.1.5 presents related cluster-level results from the industry survey that RESI conducted as part of a defense industry mapping project, and
- Section 4.1.6 presents the long-term forecast for the impact of DoD spending on the state's economy.

4.1 State Cluster Overview

As of 2014, Maryland's employment base amounts to roughly 2.46 million in-state jobs, with average annual wages as of 2015 amounting to \$52,402.⁶⁹ In terms of absolute employment, Maryland's largest industry clusters are Local Health Services with 346,000 employees, Business

⁶⁹ RESI estimated state-level average annual wages using CBP employment estimates and OES wage data from CBP county-level data. See Appendix A for more details.

Services with 315,000 employees, and Local Hospitality Establishments with 245,000 employees. Collectively, these three clusters employ more than 907,000 individuals, and comprise approximately 37 percent of total jobs in Maryland.

4.1.1 Maryland Economy Overall Top Clusters

It is necessary to understand Maryland's overall economic profile to fully understand DoD spending impacts on Maryland. As mentioned in Section 3, RESI used CBP data to determine industry cluster employment as defined by Delgado, Porter, and Stern, to provide background data and information on Maryland's economy.⁷⁰ In addition to defining clusters, their methodology makes a distinction between traded clusters, which provide services that are generally for those living outside the area, and local clusters, which generally provide services to those living in the area.⁷¹ This report analyzes both local and traded clusters, as DoD spending is significant in both types. Further, due to Maryland's proximity to Washington, D.C., and federal installations such as military bases and research institutions, Maryland effectively exports services to the rest of the country that are traditionally thought of as being local in nature—in part by providing services to the federal government. This section will review the top clusters in Maryland—by number of employees, by wages, and by location quotient—prior to taking the impact of DoD funding on state clusters into account in the next section.

Using 2014 data from the CBP and 2015 data from OES, RESI calculated the top clusters by total employment in Maryland, and their corresponding wages. Local Health Services is the largest overall cluster, employing approximately 346,000 workers and paying an average wage of \$54,876. The Business Services cluster employs over 315,000 and pays an average salary of \$76,688 per year. The high number of employees and the high wages in the Business Services cluster can be attributed to the following sectors—which collectively employ over 212,000 people in Maryland—being included in this cluster definition:

- Corporate, Subsidiary, and Regional Managing Offices (NAICS code 551114);
- Engineering Services (NAICS code 541330);
- Computer Systems Design Services (NAICS code 541152); and
- Custom Computer Programming Services (NAICS code 541511).

Despite having very different wages, the third-largest cluster is the Local Hospitality Establishments cluster, employing over 245,000 workers and providing an average wage of \$24,730. Collectively, the three top clusters employ more than 907,000 individuals, and comprise approximately 37 percent of total jobs in Maryland.⁷² The Local Real Estate,

⁷⁰ Delgado, Porter, and Stern, "Defining Clusters of Related Industries," 23-30.

⁷¹ Delgado, Bryden, and Zyontz, "Categorization of Traded and Local Industries in the US Economy," 1.

⁷² Number of employees is estimated using U.S. Census CBP data from 2014, the most recent data available, while the average wage data is estimated using the Bureau of Labor Statistics OES data from 2015. The most recent data available was used for this analysis, in order to make the overall estimates as comparable as possible to current conditions.

Construction and Development; Local Commercial Services; Local Food and Beverage Processing and Distributions; Local Retailing of Clothing and General Merchandise; Distribution and Electronic Commerce; Local Community and Civic Organizations; and Local Motor Vehicle Products and Services clusters comprise the remaining clusters in the top ten clusters by employment. The commensurate employment and wage information for each of these clusters can be found in Appendix E.

Using 2014 data from the CBP and 2015 data from OES, RESI also calculated the top ten industry clusters in Maryland by wage. The top industry cluster by wage is the Information Technology and Analytical Instruments cluster, with an estimated employment of approximately 12,500 employees and an average wage of \$94,160. The Aerospace Vehicles and Defense cluster is second, with employment of nearly 11,000 workers who are paid an average wage of \$85,290. Third is the Financial Services cluster, which has over 45,500 employees, and paid an average wage of over \$82,323. The remaining seven-highest average wage clusters in descending order are: Business Services; Electric Power Generation and Transmission; Education and Knowledge Creation; Biopharmaceuticals; Communications Equipment and Services; Oil and Gas Production and Transportation; and Marketing, Design, and Publishing. The commensurate employment and wage information for each of these clusters can be found in Appendix E.

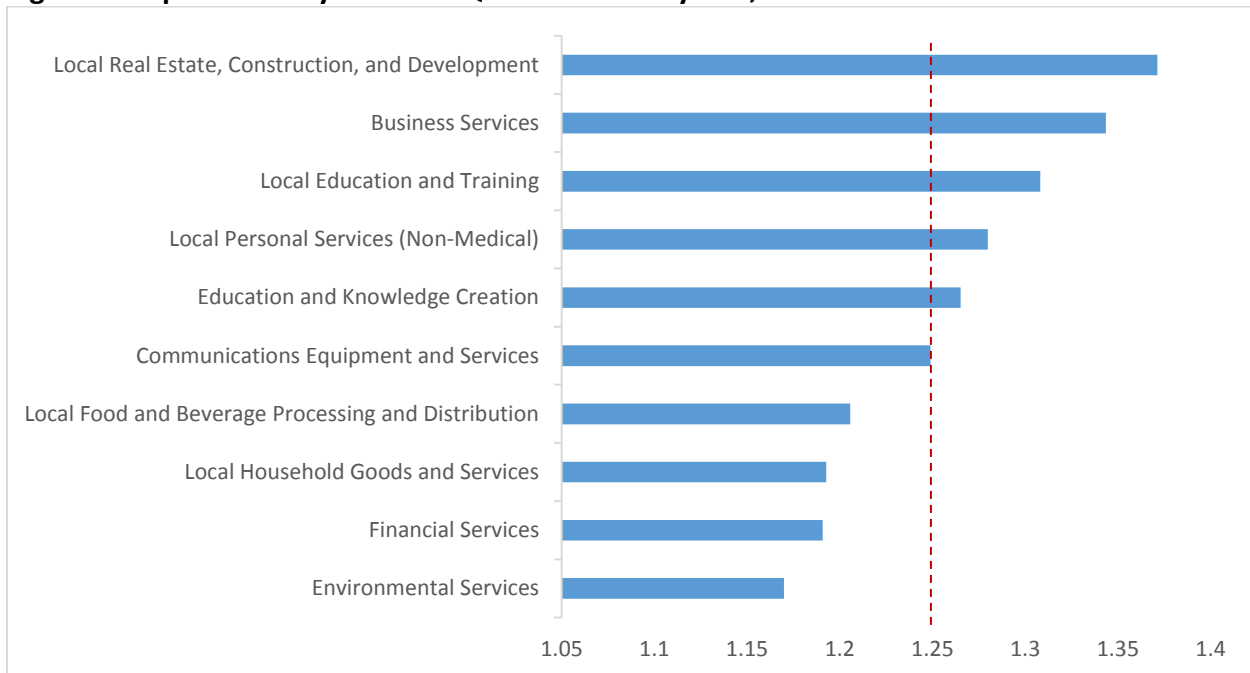
The employment and wage information is important to understand for the current economic activity among the industry clusters identified in this report. Even without understanding the distribution of DoD funding to these industry clusters (which will be reviewed later in this section), the impact of employment and wages in these clusters is pertinent to the overall picture for how diversification will proceed. This background information can contribute to targeting specific industry clusters for proactive diversification planning in future.

Location quotients are a tool to identify industry concentrations within a geographic location. By definition, a location quotient of 1.0 means that the same ratio or industry employment occurs at the local and national level, which is used as a baseline value. If a region were to produce and consume the same basket of goods, in the same proportion as the nation, this area would also have a location quotient of 1.0. However, we know that trade occurs across regions, and that different areas specialize in production of different goods and services. This specialization is reflected in employment, and hence location quotients. Location quotients over 1.0 indicate that the labor in that sector produces more goods than are being consumed in the region. In general, an industry with a location quotient higher than 1.25 is expected to be an export industry.⁷³

⁷³ William Shuffstall, "Using Location Quotients to Identify Local Strengths, Opportunities, and Industry Clusters," 1.

Maryland is home to five industry clusters with a location quotient greater than 1.25, as shown in Figure 9. Location quotients under 1.0 indicate that commodities are being imported into the region.⁷⁴ For example, in Maryland the Business Services sector has a location quotient of 1.34, indicating that this sector employs 1.34 people to all those employed in Maryland, for everyone person employed in this sector to all of those employed nationally. However, the Metal Mining industry has a location quotient of .002 in Maryland. This is not surprising, as Maryland does not have an abundance of these natural resources, compared to the rest of the country. This example shows how location quotients can be used to identify the comparative advantages that one region may possess.

Figure 9: Top Clusters by Location Quotients—Maryland, 2014



Sources: Delgado, Porter, and Stern; RESI, U.S. Census

Figure 9 shows the top industry clusters by location quotient for the State of Maryland, using 2014 employment estimates from CBP. The five industry clusters with a location quotient greater than 1.25 are: Local Real Estate, Construction, and Development; Business Services; Local Education and Training; Local Personal Services (Non-Medical); and Education and Knowledge Creation.⁷⁵ Given their high location quotients, these industries would be primed for

⁷⁴ William Shuffstall, "Using Location Quotients to Identify Local Strengths, Opportunities, and Industry Clusters," 1.

⁷⁵ As mentioned at the beginning of this section, both local and traded clusters are considered in this analysis because of significant DoD spending to both types of clusters. Local Real Estate, Construction and, Development really demonstrates this point. As will be seen in the next section, the cluster received nearly \$1.5 billion in DoD

export activity. Communications Equipment and Services is just below the threshold at 1.24. The remaining clusters in the top ten by location quotient for Maryland are Local Food and Beverage Processing and Distribution, Local Household Goods and Services, Financial Services, and Environmental Services.

As will be seen in the next section, there is significant overlap with the top clusters by location quotient and by DoD funding. With five of the six top clusters by location quotient, Local Real Estate, Construction, and Development, Business Services, Local Education and Training, Education and Knowledge Creation, and the Communications Equipment and Services cluster all receiving over \$1.1 billion in funding annually on average, between 2011 and 2015. This spending directly added over 37,500 jobs across these clusters in Maryland, which directly increases the location quotient in these clusters. For example, in Appendix H RESI estimates that there were 19,927 jobs directly being supported in Maryland, in the Business Services cluster from DoD funding on average annually. These jobs account for 6.3 percent of all of the jobs in this cluster in Maryland, and without them the cluster would still be an exporting cluster, but just barely as it would have a location quotient of approximately 1.26. Further, the spending in this cluster creates additional 15,519 indirect and induced jobs employing additional workers in Maryland.

4.1.2 DoD Spending in Maryland by Top Clusters

RESI's analysis of USA Spending data found that the DoD spends an average of over \$18 billion annually on contracts awarded to Maryland-based vendors, or for work performed in the state. Overall, DoD spending is diverse in terms of economic sectors impacted, and has at least an indirect effect on all aspects of Maryland's economy. Using the Delgado, Porter, and Stern cluster approach to analyze the 978 six-digit NAICS codes which received funding from DoD, RESI found 63 clusters that were impacted by DoD funding in the State of Maryland from 2011-2015. In an average year in Maryland (during this analysis period), DoD spending impacts 63 of the 67 clusters in Maryland with direct funding obligations. The 11 clusters in Figure 10 receive the most direct funding obligations from the DoD, with each having an annual DoD obligation exceeding \$300 million. The full list of the allocation of DoD funds to clusters in Maryland can be found in Appendix F.

funding on average annually between 2011 and 2015. Maryland is effectively exporting these services to the rest of the country.

Figure 10: Estimated Jobs, Average Annual Wages Funding, and Impact by Cluster—
Maryland^{76,77,78}

Cluster Name	Statewide Job Estimate, 2014	Average Wages, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Funding
Business Services	315,659	\$76,688	\$7,299,282,121	35,446
Education and Knowledge Creation	78,237	\$75,859	\$1,864,276,683	9,152
Local Real Estate, Construction, and Development	233,818	\$49,519	\$1,487,297,165	11,185
Aerospace Vehicles and Defense	10,881	\$85,290	\$1,240,767,978	5,418
Communications Equipment and Services	10,725	\$73,561	\$1,103,423,851	5,586
Water Transportation	4,469	\$60,708	\$871,676,614	5,347
Local Utilities	29,055	\$67,836	\$659,778,570	3,622
Local Health Services	346,345	\$54,877	\$500,422,212	3,396
Information Technology and Analytical Instruments	12,456	\$94,160	\$438,013,070	1,732
Local Commercial Services	178,526	\$47,021	\$396,081,575	3,137
Transportation and Logistics	17,892	\$51,069	\$322,011,737	2,348
Subtotal	1,238,062	\$60,713	\$16,183,031,576	86,369
State Total	2,460,086	\$52,546	\$17,968,243,321	101,263

Sources: BLS OES; Delgado, Porter, and Stern; REMI, RESI; USA Spending; U.S. Census

⁷⁶ This analysis does not account for the customized clusters including Information Technology/Cyber Security or R&D as outlined in Section 3. These clusters were not accounted for in this section because they use different definitions, are not comprehensive, and are not mutually exclusive in terms of the NAICS codes represented.

⁷⁷ The subtotal row contains the total estimated employment and overall average wage for the clusters presented in the chart.

⁷⁸ This estimated employment supported by DoD funding by cluster (in the fifth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for more a detailed methodology.

Moving from left to right in the columns of Figure 10, the industry clusters are listed with their order based on the average annual funding from the DoD. These clusters were defined using NAICS codes at the six-digit level with RESI assuming that the DoD funding was used entirely within the cluster. The next column shows the estimated number of jobs available in each cluster, supported by both DoD and non-DoD funding, followed by the average wage of individuals working in the cluster, the DoD funding per cluster, and then its impact on the total number of jobs (not exclusive to the respective cluster).⁷⁹ Focusing briefly on the rows in Figure 10, the subtotal row shows that the top 11 clusters received the majority of Maryland's DoD obligated funding, over \$16 billion dollars of the state's total of approximately \$18 billion. The subtotal row also shows that about half of Maryland's workers are employed in the clusters receiving the greatest amounts of DoD funding.

Figure 10 highlights the two largest clusters based on absolute employment levels: Local Health Services and Business Services. Considering that the Business Services cluster received over \$7 billion in average annual obligated funding—roughly 40.6 percent of the state's total DoD funding from 2011 to 2015—the high number of individuals employed in this cluster is expected. However, the Local Health Services cluster, which received \$500 million, or 6.9 percent of the average funding that the Business Services cluster received from the DoD per year, employed more individuals within the state. This indicates that the Local Health Services cluster in Maryland is less dependent on DoD funding and therefore better insulated against potential future funding fluctuations than the other clusters.

Using USA Spending data categorized by industry sector, RESI calculated the overall economic impacts of DoD spending in Maryland. To estimate cluster level impacts, RESI multiplied the salary-weighted DoD funding for each category by the estimated overall employment impacts.⁸⁰ This estimate allows for detailed impacts based on spending at the cluster level to be estimated, and can be used to better understand how potential policy changes relating to spending allocations will effect Maryland. DoD spending on the top 11 clusters provide approximately 85 percent of the estimated employment impact in Maryland, supporting over 86,000 total jobs, which includes direct, indirect, and induced jobs.⁸¹

⁷⁹ The column titled "DoD Spending Jobs Impact" reflects the total number of jobs (direct, indirect, and induced) supported from obligated DoD funding, not the number of jobs created exclusively within the cluster.

⁸⁰ These figures were calculated by using the spending levels divided by the average wages in each cluster, divided by the total spending levels, divided by the average wages summed for all clusters. This methodology is outlined in more detail, including equations, in Appendix C.4.

⁸¹ The REMI model separates direct effects (jobs supported and dollars spent as a direct result of DoD contracts) from indirect and induced effects (jobs and output supported by direct employees' and businesses' purchases either for business or from personal salaries).

In terms of earnings, it is important to note that most of the top 11 clusters are high-wage clusters, exceeding the state's 2015 average annual wage of \$52,402.⁸² The Business Services cluster, for instance, captured 40.6 percent of total DoD funding in Maryland and boasts an average annual wage of more than \$76,500. However, this is not the case for three clusters: Local Real Estate, Construction, and Development; Local Commercial Services; and Transportation and Logistics. The 2015 wage data was used alongside the 2014 occupational data because it allowed for the most up-to-date information available from both data sources to be used. Combining these data sources enables RESI to get the most comparable estimates of the conditions today.

Figure 10 highlights two important points to consider for diversification measures in future. First, the obligated DoD spending is one of many sources of funding to the industry clusters in the state. Due to variations in DoD funding obligations between 2011 and 2015 and differing cluster dependence on this funding, the impacts to the individual clusters resulting from fluctuations in defense spending vary. Second, this figure makes clear that the impacts of this DoD spending are not limited to traditionally-defined defense contractors. While expected clusters such as Aerospace and Defense do appear, unlikely clusters such as Local Health Services are also present. This contrast highlights the non-traditional aspects of DoD funding in Maryland.

4.1.3 Impact of DoD Spending on Top Cluster Occupations and Companies in Maryland

To further refine the information provided in Figure 10 to the occupational level, RESI focused additional analysis on the three clusters receiving the highest levels of DoD funding from 2011–2015:

- The Business Services cluster;
- The Education and Knowledge Creation cluster; and
- The Local Real Estate, Construction and Development cluster.

The occupational data presented in Figure 11, Figure 12, and Figure 13 also allow for an estimation of which occupations will be directly impacted by funding cuts in the respective clusters. Figure 10 presents the total impact of jobs at the cluster level. The total jobs impact includes direct, indirect, and induced jobs. Using the direct job impacts and occupational information, presented in Appendix H, RESI is able to estimate the specific occupational level impacts of spending, and the lost wages that will come from these losses. For each of the three clusters presented, the overall occupational information is presented first, followed by an analysis of how a cut in defense spending would specifically impact cluster occupations.

⁸² RESI estimated state-level average annual wages using CBP employment estimates and OES wage data from CBP county-level data. See Appendix A for a detailed methodology.

Figure 11 shows employment and average wages by occupational category for the Business Services cluster. The average wage for this industry cluster is \$76,688, which is higher than that of the state (\$52,402).⁸³ The largest occupational category for the Business Services cluster in Maryland is Computer and Mathematical Occupations, which employs over 90,000 workers. Some occupational categories have higher annual wages within this cluster, such as Management Occupations, compared to the total for this occupational category in the state. Other occupational categories, such as Transportation and Material Moving, are lower for individuals within the Business Services cluster compared to all Transportation Material Moving employment in the state.

⁸³ RESI estimated state-level average annual wages using CBP employment estimates and OES wage data from CBP county-level data. See Appendix A for more details.

Figure 11: Employment Data by Occupational Category for the Business Services Cluster—Maryland

SOC	Occupational Category	Estimated Employment, 2014	Annual Average Wage, 2015
15-0000	Computer and Mathematical Occupations	90,609	\$88,778
43-0000	Office and Administrative Support Occupations	47,339	\$39,173
13-0000	Business and Financial Operations Occupations	44,141	\$80,459
17-0000	Architecture and Engineering Occupations	33,352	\$80,499
11-0000	Management Occupations	31,262	\$144,063
41-0000	Sales and Related Occupations	12,604	\$71,982
53-0000	Transportation and Material Moving Occupations	10,021	\$28,828
19-0000	Life, Physical, and Social Science Occupations	9,544	\$68,674
49-0000	Installation, Maintenance, and Repair Occupations	4,814	\$48,141
37-0000	Building and Grounds Cleaning and Maintenance Occupations	4,783	\$25,233
33-0000	Protective Service Occupations	4,466	\$35,599
51-0000	Production Occupations	4,115	\$32,751
29-0000	Healthcare Practitioners and Technical Occupations	4,059	\$64,635
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	3,992	\$64,685
47-0000	Construction and Extraction Occupations	3,585	\$50,350
23-0000	Legal Occupations	1,516	\$127,167
31-0000	Healthcare Support Occupations	1,303	\$28,944
35-0000	Food Preparation and Serving Related Occupations	1,221	\$26,630
25-0000	Education, Training, and Library Occupations	1,010	\$40,773
39-0000	Personal Care and Service Occupations	961	\$25,095
21-0000	Community and Social Service Occupations	916	\$43,826
45-0000	Farming, Fishing, and Forestry Occupations	46	\$29,759
Total		315,659	\$76,688

Sources: BLS OES; Delgado, Porter, and Stern; RESI; U.S. Census

Combining the DoD spending impacts in Figure 10 with the occupation data in Figure 11, RESI forecasted how a reduction in DoD funding to the Business Services cluster would impact employment in the state. DoD funding for the Business Services cluster supports 35,446 jobs. Therefore, a 10 percent cut in DoD funding to the cluster, would result in approximately 3,534

fewer total jobs (direct, indirect, and induced) in the state, with 1,987 of these jobs being direct jobs in the cluster.⁸⁴ Computer and Mathematical Occupations would be especially hit hard in this scenario, as these professions account for 28.7 percent of the total jobs in the cluster for the state.⁸⁵ RESI estimates that as a result of a 10 percent cut in DoD funding, approximately 570 jobs would be lost in Computer and Mathematical Occupations in the Business Services cluster, which would result in a loss of \$50.6 million in wages. Office and Administrative Occupations comprise 15 percent of the occupations in this cluster at the state level and would be the second-most impacted occupation, losing an estimated 298 jobs. These lost jobs would result in \$11.7 million lost wages in the state. The third-most impacted occupational category would be Business and Financial Operations Occupations, which comprise 14 percent of the occupations in this cluster in the state. A ten percent cut in funding to this cluster would be expected to create a loss of approximately 278 jobs, resulting in \$22.4 million in lost wages. Appendix H provides more details on the direct job impacts per cluster.

The Education and Knowledge Creation cluster is the second largest in the state for average annual DoD funding, and pays an average wage of \$75,859—higher than the state average of \$52,402.⁸⁶

Figure 12 shows the estimated employment within the cluster by occupational category and the associated annual average wage. The highest salaries for this cluster are found in the Legal and Management occupations, while the lowest salaries are found in the Food Preparation and Serving Related, and Building and Grounds Cleaning and Maintenance occupations. The largest occupational category for the Education and Knowledge Creation cluster is the Life, Physical, and Social Science category, with an estimated employment of 15,256.

Figure 12: Employment Data by Occupational Category for the Education and Knowledge Creation Cluster—Maryland

SOC	Occupational Category	Estimated Employment, 2014	Annual Average Wage, 2015
19-0000	Life, Physical, and Social Science Occupations	15,256	\$80,325
25-0000	Education, Training, and Library Occupations	14,628	\$68,185

⁸⁴ A decrease of 10 percent in the overall DoD budget will result in an approximate decrease of 9.971 percent, reflecting diminishing returns. This number is used to estimate the impacts.

⁸⁵ Note that occupational compositions vary at the six-digit NAICS. Since there are differing mixes of industries at the six-digit NAICS code level at the state and regional levels, there are different occupational proportions in different regions.

⁸⁶ RESI estimated state-level average annual wages using CBP employment estimates and OES wage data from CBP county-level data. See Appendix A for more details.

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SOC	Occupational Category	Estimated Employment, 2014	Annual Average Wage, 2015
43-0000	Office and Administrative Support Occupations	9,507	\$40,945
13-0000	Business and Financial Operations Occupations	7,649	\$72,539
11-0000	Management Occupations	7,358	\$135,075
15-0000	Computer and Mathematical Occupations	7,286	\$92,595
17-0000	Architecture and Engineering Occupations	5,100	\$97,941
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	1,905	\$56,985
29-0000	Healthcare Practitioners and Technical Occupations	1,738	\$71,451
37-0000	Building and Grounds Cleaning and Maintenance Occupations	1,268	\$30,238
49-0000	Installation, Maintenance, and Repair Occupations	1,101	\$46,921
21-0000	Community and Social Service Occupations	1,073	\$50,096
41-0000	Sales and Related Occupations	899	\$71,019
33-0000	Protective Service Occupations	835	\$39,010
39-0000	Personal Care and Service Occupations	718	\$30,079
35-0000	Food Preparation and Serving Related Occupations	363	\$27,870
31-0000	Healthcare Support Occupations	343	\$35,321
53-0000	Transportation and Material Moving Occupations	311	\$41,015
47-0000	Construction and Extraction Occupations	300	\$56,133
51-0000	Production Occupations	299	\$51,558
23-0000	Legal Occupations	277	\$137,420
45-0000	Farming, Fishing, and Forestry Occupations	23	\$33,079
Total		78,236	\$75,859

Sources: BLS OES; Delgado, Porter, and Stern; RESI; U.S. Census

Combining the occupation data from Figure 12 with the DoD spending impacts from Figure 10, RESI estimates that a 10 percent cut in DoD funding to the Education and Knowledge Creation

cluster would cause a loss of about 912 total jobs in the state, 513 of which will be lost in the cluster directly.⁸⁷ The largest effect at the occupational level would occur in the Life, Physical, and Social Science Occupations category, which makes up 19.5 percent of the employment for the cluster. This occupational category would see an estimated loss of 100 jobs, which would have paid approximately \$8 million in total wages. The Education, Training, and Library Occupations would see the next largest reduction in employment, as these occupations comprise 18.7 percent of the total jobs in the cluster. These occupations would lose an estimated 96 jobs, paying a total over \$6.5 million in wages. The third-highest losses would occur in Office and Administrative Support Occupations, which employs 12.2 percent of workers in the Education and Knowledge Creation cluster. This occupational category would see a loss of 62 positions and a total loss of approximately \$2.6 million in wages.

Figure 13 shows that the average annual wage in the Local Real Estate, Construction, and Development cluster is \$49,519, lower than the state average of \$52,402.⁸⁸ However, several occupations do pay more than the state average, including Legal; Management; Architecture and Engineering; Computer and Mathematical; Business and Financial Operations; Healthcare Practitioners and Technical Occupations; Life, Physical, and Social Science; and Education, Training, and Library Occupations.⁸⁹ The largest occupational category for this group is Construction and Extraction Occupations, with over 104,000 estimated employees in these professions.

⁸⁷ See Appendix H for more details.

⁸⁸ RESI estimated state-level average annual wages using CBP employment estimates and OES wage data from CBP county-level data. See Appendix A for more details.

⁸⁹ Ibid.

Figure 13: Employment Data by Occupational Category for the Local Real Estate, Construction, and Development Cluster—Maryland

SOC	Occupational Category	Estimated Employment, 2014	Annual Average Wage, 2015
47-0000	Construction and Extraction Occupations	104,851	\$47,173
43-0000	Office and Administrative Support Occupations	30,741	\$35,744
41-0000	Sales and Related Occupations	24,683	\$43,233
49-0000	Installation, Maintenance, and Repair Occupations	21,334	\$42,807
11-0000	Management Occupations	17,610	\$100,274
13-0000	Business and Financial Operations Occupations	10,545	\$65,879
53-0000	Transportation and Material Moving Occupations	8,447	\$36,071
37-0000	Building and Grounds Cleaning and Maintenance Occupations	4,904	\$28,556
17-0000	Architecture and Engineering Occupations	2,770	\$73,389
51-0000	Production Occupations	2,340	\$38,771
23-0000	Legal Occupations	1,658	\$103,073
15-0000	Computer and Mathematical Occupations	1,124	\$70,933
33-0000	Protective Service Occupations	1,017	\$33,520
39-0000	Personal Care and Service Occupations	591	\$30,065
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	463	\$45,663
35-0000	Food Preparation and Serving Related Occupations	384	\$23,758
29-0000	Healthcare Practitioners and Technical Occupations	152	\$64,480
19-0000	Life, Physical, and Social Science Occupations	131	\$63,176
21-0000	Community and Social Service Occupations	51	\$42,960
25-0000	Education, Training, and Library Occupations	10	\$54,795
45-0000	Farming, Fishing, and Forestry Occupations	9	\$30,838
31-0000	Healthcare Support Occupations	2	\$27,905
Total		233,817	\$49,519

Sources: BLS OES; Delgado, Porter, and Stern; RESI; U.S. Census

A 10 percent cut in the DoD funding for the Local Real Estate, Construction, and Development cluster would result in a total statewide loss of approximately 1,115 total jobs, 627 of which would be within the cluster. Construction and Extraction Occupations, which comprise 44.8 percent of the jobs in this cluster, would incur the largest losses. This category would lose approximately 281 jobs, resulting in a statewide loss of approximately \$13.3 million in wages.

Office and Administrative Support Occupations contain 13.2 percent of the workers in this cluster. This occupational category would lose approximately 82 positions resulting in the loss of approximately \$3 million in statewide wages. Sales and Related Occupations would have the third-largest losses due to a DoD cut, as they comprise approximately 10.6 percent of the employment in this cluster. This occupational category would lose approximately 66 positions, resulting in a loss of approximately \$2.9 million in total wages in the state. Appendix H provides more details on the direct job impacts per cluster.

Taking into account the concept of “similarities” between companies or skillsets within an industry (outlined by Delgado, Porter and Stern), as well as the aim of this study in preparing for future fluctuations in DoD funding, understanding the occupations that may be impacted by DoD funding changes is of the utmost importance for retaining a high-skilled workforce. A reduction in high-skill and high-wage occupations, including many of those listed in the preceding three figures, can have an indirect and negative economic impact in the short-term, with less disposable income in the economy. In the long term, the impact can be more severe if migration of a high-skilled workforce occurs. To further highlight the importance of this issue, Figure 14 below demonstrates the types of companies that perform work in these clusters, providing further context on the type of businesses that operate in these groups.

Figure 14: Highest-Funded Company per Top-Funded Clusters

Cluster	Company Name	Dollars Obligated, 2011- 2015
Water Transportation	Lockheed Martin Corporation	\$820,918,132
Education and Knowledge Creation	The Johns Hopkins University Applied Physics Laboratory LLC	\$715,023,269
Business Services	BAE Systems Technology Solutions & Services Inc.	\$600,429,936
Aerospace Vehicles and Defense	AAI Corporation	\$486,257,908
Insurance Services	Johns Hopkins Medical Services Corporation	\$367,505,000
Communications Equipment and Services	Lockheed Martin Corporation	\$346,379,176
Business Services	Mantech Sensor Technologies, Inc.	\$317,955,839
Local Hospitality Establishments	Sodexo Management Inc.	\$239,268,456
Local Health Services	Johns Hopkins Medical Services Corporation	\$233,027,453
Local Real Estate, Construction, and Development	Walsh/Gilbane JV	\$206,445,000

Sources: RESI, USA Spending

Figure 14 shows the top company for each cluster based on DoD funding to individual vendors at the cluster level, ranked by funding amount.⁹⁰ Lockheed Martin Corporation received the largest amount of average annual funding for two of the top ten clusters: Water Transportation, and Communications Equipment and Services, at approximately \$821 million and \$346 million, respectively. The Johns Hopkins University Applied Physics Laboratory is the second-largest recipient of funding at the cluster level, receiving an average of over \$715 million annually for work in the Education and Knowledge Creation cluster. BAE Systems is the third-largest recipient at the cluster level, receiving an average of more than \$600 million annually for work in the Business Services cluster. For all of the top vendors by cluster based on DoD awards, see Appendix F.

4.1.4 Additional Custom Clusters Analyzed

The SWOT analysis determined through interviews, focus groups, and surveys that STEM-related fields to need to be explored in more detail.⁹¹ As such, RESI focused on spending in R&D and the Information Technology/Cyber Security areas to better analyze defense spending and clusters that may be present there. To determine clusters that are present in these categories, RESI analyzed spending by six-digit NAICS codes relating to both R&D and Information Technology/Cyber Security.⁹² All NAICS codes and spending for this category can be found in Appendix D.⁹³

Figure 15 shows that almost a billion dollars has been spent annually on Research and Development in the Physical, Engineering, and Life Sciences (Except Biotechnology) NAICS sector in Maryland between 2011 and 2015.⁹⁴ These funds are part of the approximate \$18 billion spent in Maryland on average annually, and constitutes nearly one-third of total DoD spending in the R&D cluster.⁹⁵ Engineering Services was the second-largest category for spending in the R&D cluster, with average annual spending of nearly \$660 million. As detailed in Figure 15, these two categories constitute over 55 percent of spending in R&D. Collectively, the top nine NAICS categories included in Figure 15 receive over 92 percent of the total DoD spending in the R&D cluster in Maryland.

⁹⁰ For display purposes, only the top ten clusters are shown here. See Appendix F for the top vendor in each cluster by DoD funding obligations.

⁹¹ Regional Economic Studies Institute of Towson University, "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape."

⁹² Note that these clusters are not defined to be mutually exclusive from each other.

⁹³ As mentioned above, the NAICS codes in the R&D and Information Technology/Cyber Security clusters are not mutually exclusive to the other cluster definitions presented. However, they allow for a better analysis of potential policy changes and were created for this purpose.

⁹⁴ The NAICS code is listed as "Life Sciences (Except Biotechnology)" as set forth in the NAICS definitions outlined here: <http://www.census.gov/eos/www/naics/>.

⁹⁵ "Download Center," USA Spending.

Figure 15: Average DoD Spending by NAICS Code in the Maryland R&D Cluster

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total DoD R&D Spending
541712	Research and Development in the Physical, Engineering, and Life Sciences (Except Biotechnology)	\$963,035,465	32.9%
541330	Engineering Services	\$658,933,947	22.5%
541711	Research and Development in the Physical, Engineering, And Life Sciences	\$371,771,391	12.7%
334220	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing	\$349,547,710	12.0%
541511	Custom Computer Programming Services	\$182,525,609	6.2%
541611	Administrative Management and General Management Consulting Services	\$63,417,304	2.2%
541512	Computer Systems Design Services	\$40,178,099	1.4%
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	\$33,781,385	1.2%
541711	Research and Development in Biotechnology	\$30,629,588	1.0%
Total		\$2,693,820,498	92.1%

Sources: RESI, U.S. Census NAICS, USA Spending

In comparison to the other clusters outlined in Figure 10, the total amount of DoD funding allocated to the R&D cluster in Maryland would rank second, after the Business Services cluster which received \$7 billion per year from the DoD from 2011 to 2015. Similar to other clusters in Figure 10 the R&D cluster receives a high level of funding, serves as an employer for a larger number of individuals, and supports a range of occupational categories. These occupations are outlined in Figure 16 below.

Figure 16: Employment and Wage Data by Occupational Category for the Maryland R&D Cluster

SOC	Occupational Category	Estimated Employment, 2014	Annual Average Wage, 2015
11-0000	Management Occupations	18,289	\$149,592
13-0000	Business and Financial Operations Occupations	21,933	\$84,846
15-0000	Computer and Mathematical Occupations	65,072	\$90,882
17-0000	Architecture and Engineering Occupations	34,831	\$82,386
19-0000	Life, Physical, and Social Science Occupations	18,024	\$77,091
21-0000	Community and Social Service Occupations	205	\$53,360
23-0000	Legal Occupations	477	\$140,784
25-0000	Education, Training, and Library Occupations	328	\$68,421
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	2,324	\$69,413
29-0000	Healthcare Practitioners and Technical Occupations	1,247	\$68,624
31-0000	Healthcare Support Occupations	188	\$34,684
33-0000	Protective Service Occupations	453	\$49,225
35-0000	Food Preparation and Serving Related Occupations	63	\$31,341
37-0000	Building and Grounds Cleaning and Maintenance Occupations	544	\$30,386
39-0000	Personal Care and Service Occupations	69	\$31,255
41-0000	Sales and Related Occupations	6,213	\$83,849
43-0000	Office and Administrative Support Occupations	18,065	\$42,755
45-0000	Farming, Fishing, and Forestry Occupations	29	\$32,824
47-0000	Construction and Extraction Occupations	1,809	\$57,994
49-0000	Installation, Maintenance, and Repair Occupations	1,927	\$52,227
51-0000	Production Occupations	2,236	\$42,083
53-0000	Transportation and Material Moving Occupations	976	\$37,007
Total		195,302	\$86,003

Sources: BLS OES, RESI, USA Spending, U.S. Census, CBA

As shown in Figure 16, RESI estimates that the R&D cluster employs over 195,000 workers both through DoD and non-DoD funding, and has an average annual wage of \$86,003. The largest occupational category for this cluster is Computer and Mathematical Occupations, which is estimated to employ over 65,000 individuals at an average annual wage of \$90,882. The types of skills and qualifications for individuals in this occupational category are comparable to other

industry clusters, including the Business Services, Education and Knowledge Creation, and Local Commercial Services clusters.⁹⁶

The R&D cluster was one of two customized clusters created by RESI based on the feedback provided in the SWOT report. The Information Technology/Cyber Security cluster, the second customized by RESI, is detailed below in Figure 17. This cluster received over \$1.7 billion dollars in annual DoD funding from 2011 to 2015, ranking it fourth in comparison to the clusters in Figure 10 (including the custom R&D cluster).

Figure 17 also highlights the distribution of DoD funding across the NAICS codes used to define the cluster. For example, an average of over \$300 million dollars was spent annually in the Wired Telecommunications Carriers and Other Computer Related Services sectors. All NAICS codes and spending for this category can be seen in Appendix D.

Figure 17: Average DoD Spending by NAICS Code in the Maryland Information Technology/Cyber Security Cluster

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total IT/Cyber Spending
517110	Wired Telecommunications Carriers	\$341,192,864	18.2%
541519	Other Computer Related Services	\$311,110,209	16.6%
541512	Computer Systems Design Services	\$294,235,699	15.7%
541511	Custom Computer Programming Services	\$196,606,658	10.5%
541330	Engineering Services	\$180,302,559	9.6%
541513	Computer Facilities Management Services	\$164,822,830	8.8%
541712	Research and Development in the Physical, Engineering, and Life Sciences (Except Biotechnology)	\$99,691,836	5.3%
517410	Satellite Telecommunications	\$99,451,891	5.3%
518210	Data Processing, Hosting, and Related Services	\$34,341,776	1.8%
517919	All Other Telecommunications	\$26,049,985	1.4%
443142	Computer and Software Stores	\$19,746,285	1.1%
Total		\$1,767,552,592	94%

Sources: RESI, USA Spending

⁹⁶ Appendix H contains additional details for the occupational profiles.

Figure 18 shows that the Information Technology/Cyber Security cluster is estimated to employ over 200,000 individuals, including both DoD and non-DoD funded positions. Further, this cluster pays significantly higher wage than the average for Maryland with an estimated average wage of \$83,277. The largest occupation types in this category are the Computer and Mathematical Occupations, with nearly 81,000 individuals employed.

Figure 18: Employment and Wage Data by Occupational Category for the Maryland Information Technology/Cyber Security Cluster

SOC	Occupational Category	Estimated Employment, 2014	Annual Average Wage, 2015
11-0000	Management Occupations	16,529	\$149,291
13-0000	Business and Financial Operations Occupations	15,580	\$83,324
15-0000	Computer and Mathematical Occupations	80,866	\$89,632
17-0000	Architecture and Engineering Occupations	31,285	\$81,491
19-0000	Life, Physical, and Social Science Occupations	12,223	\$75,579
21-0000	Community and Social Service Occupations	101	\$53,200
23-0000	Legal Occupations	429	\$145,977
25-0000	Education, Training, and Library Occupations	242	\$67,544
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	2,070	\$69,153
29-0000	Healthcare Practitioners and Technical Occupations	649	\$68,617
31-0000	Healthcare Support Occupations	112	\$34,862
33-0000	Protective Service Occupations	380	\$45,452
35-0000	Food Preparation and Serving Related Occupations	32	\$29,617
37-0000	Building and Grounds Cleaning and Maintenance Occupations	444	\$30,094
39-0000	Personal Care and Service Occupations	33	\$30,867
41-0000	Sales and Related Occupations	12,668	\$61,425
43-0000	Office and Administrative Support Occupations	19,162	\$42,146
45-0000	Farming, Fishing, and Forestry Occupations	14	\$33,679
47-0000	Construction and Extraction Occupations	1,649	\$58,137
49-0000	Installation, Maintenance, and Repair Occupations	7,513	\$54,907
51-0000	Production Occupations	977	\$45,466
53-0000	Transportation and Material Moving Occupations	694	\$35,661
Total		203,653	\$83,277

Sources: BLS OES, RESI, USA Spending, U.S. Census, CBA

In regards to this specific cluster, it should be noted that the employment and wage information derived from CBP and OES data is for the private industry and does not account for

most government employees. This is particularly pertinent given the advanced research that is being carried out in the field of cyber security across Maryland at educational institutions such as the University of Maryland, College Park (UMCP); University of Maryland, Baltimore County (UMBC); and Johns Hopkins University (JHU).⁹⁷ Additionally, Maryland has federal institutions conducting advanced research in cyber security, including the National Security Agency (NSA), the National Institute of Standards and Technology (NIST), and the Intelligence Advanced Research Projects Activity (IARPA).⁹⁸ In response to the need for workers with advanced skillsets, academic institutions including JHU, UMCP, and UMBC have developed programs to produce graduates with the skills and qualifications these federal agencies demand.⁹⁹ With cutting-edge research being conducted at these academic institutions and a pipeline of employment into the private industry outlined above by occupational category or into the military bases such as Aberdeen Proving Ground and Fort Meade, Maryland is a national leader in cyber security.^{100,101}

4.1.5 Survey Results by Cluster

As part of the overall research project on the defense industry in Maryland, RESI conducted a survey of defense contractors to determine their dependency on DoD funding. An explanation of the survey methodology is outlined in Section 3. While the survey collected data until December 2016, for the purposes of this report, the data collected from April 2016 to October 2016 was used. During this period, the survey collected 591 full and partial responses from businesses in Maryland. Of these responses, 565 were from unique companies.¹⁰² There were 477 fully complete responses, 494 responses where the companies provided dependency ranges, and 71 responses where companies started the survey but stopped responding to the survey before providing a dependency range. The survey responses were matched to InfoUSA to allow for inclusion in this analysis; of the 565 unique company name responses, 290 of them were matched to InfoUSA data.¹⁰³ These 290 companies represented 42 different clusters, with 6 of these clusters having more than 10 companies surveyed. The cluster with the most

⁹⁷ Maryland Department of Business and Economic Development, "CyberMaryland," 12, accessed January 4, 2017, <http://commerce.maryland.gov/Documents/ResearchDocument/CybermarylandReport.pdf>.

⁹⁸ Ibid., 9.

⁹⁹ Ibid., 20.

¹⁰⁰ Regional Economic Studies Institute of Towson University, "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape."

¹⁰¹ "Cybersecurity," Army Alliance, accessed February 6, 2017, <http://armyalliance.org/about-apg/missions-of-apg/cybersecurity/>.

¹⁰² Some companies had more than one respondent. When this occurred, RESI used the most complete, and if they were equally complete the most recently completed response.

¹⁰³ Of the non-matches, 25 indicated having only 1 employee, 106 indicated having between 2 and 10 employees, and 82 indicated having between 11 and 50 employees. Companies of this size are not always present in the InfoUSA dataset in 2015, which requires verification. Further, companies may not have used their legal name in their response on the survey as indicated on their DBA, this could create situations where the name is different enough to inhibit a successful match.

companies surveyed was the Business Services cluster, which had 88 company responses. Other clusters with more than 10 company responses were Local Real Estate, Construction, and Development with 31 responses; Local Commercial Services with 25 responses; Local Entertainment and Media with 21 responses; Education and Knowledge Creation with 14 responses; and Distribution and Electronic Commerce with 13 responses.

Of the 494 companies that provided dependency ranges, 158 identified their dependency on DoD spending as high (above 70 percent of their revenue), 50 identified their dependency as mid-level (between 35 and 69 percent of their revenue), and 286 companies identified their dependency on DoD contracts as low (34 percent or less of their revenue). Of the 290 companies matched to clusters, there were 255 responses containing both cluster information and dependency responses. Figure 19 presents the top clusters in terms of total responses with dependency information provided, these clusters all received at least total responses for this question. The Business Services cluster had the most responses in each category, with 33 respondents indicating they had a low dependency on DoD spending, eight companies with a medium dependency, and 35 with a high dependency. The amount of companies expressing a high dependency on DoD spending fits expectations as the cluster receives over 40 percent of the DoD funding in the state. Appendix C.1 contains all of the survey responses tabulated by cluster.

Figure 19: Dependency on DoD Spending by Maryland Cluster¹⁰⁴

Cluster Name	Low	Medium	High	Total Responses
Business Services	33	8	35	76
Local Real Estate, Construction, and Development	21	2	6	29
Local Commercial Services	13	1	6	20
Local Entertainment and Media	13	0	4	17
Education and Knowledge Creation	10	2	1	13
Distribution and Electronic Commerce	8	0	3	11
Local Industrial Products and Services	6	1	1	8
Information Technology and Analytical Instruments	3	2	1	6
Subtotal	107	16	57	180
Total	145	26	84	255

Sources: Delgado, Porter, and Stern; RESI

Many of the respondents indicated that there were problems with finding qualified employees. Figure 20 shows that the level of difficulty that respondents expressed in finding qualified employees varied by cluster. Of the 65 respondents to the question from the Business Services

¹⁰⁴ Only clusters with a minimum of five responses were included in this figure.

cluster, 45 indicated that it was somewhat difficult or difficult to hire qualified employees. However, in the Local Commercial Services cluster only half, nine, of the respondents indicated that it was difficult or somewhat difficult to hire qualified employees. In Appendix C.1 responses are tabulated for all of the respondents by cluster.

Figure 20: Level of Difficulty in Hiring Qualified Employees by Maryland Cluster

Cluster Name	Very Difficult	Somewhat Difficult	Not Difficult	Total Responses
Business Services	14	31	20	65
Local Real Estate, Construction, and Development	6	13	7	26
Local Commercial Services	4	5	9	18
Local Entertainment and Media	3	8	4	15
Education and Knowledge Creation	4	6	2	12
Distribution and Electronic Commerce	3	2	5	10
Local Industrial Products and Services	1	5	0	6
Information Technology and Analytical Instruments	1	4	1	6
Recreational and Small Electric Goods	1	1	1	3
Local Health Services	0	1	1	2
Plastics	2	1	1	4
Subtotal	39	77	51	167
Total	55	96	67	218

Sources: Delgado, Porter, and Stern; RESI

One theme that emerged in the comments was that skilled workers were in high demand, especially in Information Technology. Further, the respondents indicated that it was especially hard to find workers possessing the necessary skills with security clearances.¹⁰⁵ For example, one respondent noted, “We require Information Technology professionals with Security Clearances [sic]. They are in short supply.” Security clearance at any level is difficult to acquire and maintain unless the employee is consistently engaged in work that requires a security clearance. Additionally, data compromises—including the Office of Personnel Management (OPM) breach in 2015—have impacted public trust and made some potential applicants wary of providing sensitive information required by to obtain security clearance.¹⁰⁶ These difficulties,

¹⁰⁵ Eilene Zimmerman, “Top-Secret Security Clearance is a Ticket to Lots of Job Offers,” *The New York Times* (April 9, 2006): accessed January 4, 2017, <http://www.nytimes.com/2006/04/09/jobs/topsecret-security-clearance-is-a-ticket-to-lots-of-job-offers.html>.

¹⁰⁶ Lindy Kyzer, “Got a Clearance? Getting a Job Just Got Harder,” *Defense One* (October 26, 2015): accessed January 4, 2017, <http://www.defenseone.com/business/2015/10/got-clearance-getting-job-just-got-harder/123136/>.

coupled with delays in processing clearances by the OPM, present barriers for recruiters and agencies seeking to fill defense contracts with qualified personnel.¹⁰⁷

4.1.6 Long-Term Forecast

Using the REMI PI+ model and USA Spending data, RESI forecasted the impact of DoD funding on jobs and wages in industry clusters in Maryland over the next ten years. REMI PI+ is a high-end dynamic modeling tool that helps RESI to build a sophisticated model that is calibrated to the specific demographic features of the state. This model enumerates the economic and fiscal impacts of each dollar earned and spent by the following: employees relating to the economic events, other supporting vendors (business services, retail, etc.), each dollar spent by these vendors on other firms, and each dollar spent by the households of the event's employees, other vendors' employees, and other businesses' employees. The model features the ability to capture price effects, wage changes, and behavioral effects over time. It allows RESI to capture the effects occurring between industries and minimize the potential for double counting in employment, output, and wages. The ability to capture these effects provides a detailed representation of the impact of DoD funding on the economy of Maryland over time. Three scenarios were developed and a forecast was completed for each situation:

- Scenario 1: Assuming that the average DoD funding from 2011-2015 remains constant, what will the economic impact of this funding be on industry clusters in Maryland over the next ten years?
- Scenario 2: Assuming that the average DoD funding from 2011- 2015 is reduced by 10 percent, what will the economic impact of this funding reduction be on industry clusters in Maryland over the next ten years?
- Scenario 3: Assuming that the average DoD funding from 2011- 2015 is increased by 10 percent, what will the economic impact of this funding addition be on industry clusters in Maryland over the next ten years?

Starting with Scenario 1, Figure 21 shows the ten-year forecast for the impacts of the defense industry in Maryland, assuming funding levels stay at their five-year average, and are not adjusted for inflation.

¹⁰⁷ Lindy Kyzer, "Got a Clearance? Getting a Job Just Got Harder."

Figure 21: Forecasted Total Economic Impacts for Maryland for all DoD Spending, 2017-2026

Year	Employment	Output	Wages
2017	115,708	\$15,043,690,976	\$5,475,544,544
2018	117,991	\$15,421,023,822	\$5,673,405,693
2019	115,786	\$15,407,858,658	\$5,742,593,305
2020	111,237	\$15,035,879,503	\$5,724,345,205
2021	105,618	\$14,493,863,934	\$5,654,222,553
2022	99,683	\$13,872,695,438	\$5,553,067,291
2023	94,015	\$13,252,256,471	\$5,451,533,677
2024	88,765	\$12,660,950,181	\$5,357,276,104
2025	84,022	\$12,116,757,711	\$5,276,177,177
2026	79,807	\$11,667,482,185	\$5,218,638,703
Average	101,263.2	\$13,897,245,887.90	\$5,512,680,425.20

Sources: REMI PI+, RESI

The total impact on private non-farm jobs in the region is estimated to peak in 2018 at an employment level of approximately 118,000, and will fall to its lowest level in 2026, nearly 80,000 individuals employed. This pattern occurs because the forecast assumes that current DoD spending is maintained without increases for inflation.¹⁰⁸ Without adjustment for inflation, the same levels of DoD funding will be able to support fewer jobs and outputs, as nominal wages and prices increase with inflation.

Figure 21 shows that total predicted wages remain relatively stable over the ten-year period, with total wages resulting from defense spending in Maryland peaking in 2019 at a level of approximately \$5.7 billion, and the lowest levels estimated at \$5.2 billion in 2026. Output is estimated to peak in 2018 at approximately \$15.4 billion, and be at its lowest level of \$11.7 billion in 2026. Output follows a similar pattern to employment, because over time the same amount of money spent will have a lower purchasing power for inputs, and with wages predicted to remain level, this means that output will fall.

The results from the forecast are similar to the average annual employment impacts calculated by RESI while performing the SWOT analysis, even though there are methodological differences between the analyses.¹⁰⁹ For the SWOT analysis at the state level, RESI found an average annual employment impact of 113,277 for the years 2011 to 2015 using observed annual values of DoD funding.¹¹⁰ Using the average for only the first five years of the ten-year forecast reported in Figure 21, a virtually identical number of jobs supported by DoD funding is obtained (113,268).

¹⁰⁸ More details on the REMI PI+ model and modelling assumptions can be found in Appendix C.

¹⁰⁹ Regional Economic Studies Institute of Towson University, "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape."

¹¹⁰ Ibid.

Further analyzing the impacts of DoD funding on the clusters over the next ten years, RESI forecasted the occupations that will have the most growth in Maryland. Figure 22 presents these occupational categories in order of their estimated total percent increase over the ten-year period.

Figure 22: Maryland Employment Projections by Occupational Category, 2017-2026

SOC	Occupational Category	10 Year Total Growth	Average Annual Growth	Percent Growth
47-0000	Construction and Extraction Occupations	49,219	4,922	43.9%
31-0000	Healthcare Support Occupations	10,474	1,047	14.5%
23-0000	Legal Occupations	3,259	326	13.5%
29-0000	Healthcare Practitioners and Technical Occupations	21,702	2,170	13.2%
37-0000	Building and Grounds Cleaning and Maintenance Occupations	7,110	711	8.4%
21-0000	Community and Social Service Occupations	3,378	338	8.2%
19-0000	Life, Physical, and Social Science Occupations	3,110	311	7.7%
17-0000	Architecture and Engineering Occupations	4,255	426	7.5%
11-0000	Management Occupations	9,957	996	6.8%
15-0000	Computer and Mathematical Occupations	8,095	809	6.7%
39-0000	Personal Care and Service Occupations	4,843	484	6.1%
13-0000	Business and Financial Operations Occupations	9,624	962	5.9%
43-0000	Office and Administrative Support Occupations	23,087	2,309	5.7%
49-0000	Installation, Maintenance, and Repair Occupations	5,350	535	5.3%
35-0000	Food Preparation and Serving Related Occupations	9,844	984	4.6%
25-0000	Education, Training, and Library Occupations	6,662	666	3.9%
33-0000	Protective Service Occupations	2,555	255	3.6%
41-0000	Sales and Related Occupations	5,236	524	2.0%
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	494	49	1.6%
53-0000	Transportation and Material Moving Occupations	1,120	112	0.7%
51-0000	Production Occupations	-2,231	-223	-2.9%
45-0000	Farming, Fishing, and Forestry Occupations	-123	-12	-5.2%
Total		187,020	18,702	7.2%

Sources: REMI PI+, RESI

The top growth category, both by raw numbers and percent growth rates, is Construction and Extraction Occupations. These occupations were especially impacted by the Great Recession, and have shown recovery recently.¹¹¹ Nonetheless, they are still somewhat sensitive to DoD spending. According to the SWOT analysis, this category is the second-largest for DoD dependent occupations by employment, employing an average of nearly 15,000 annually, between 2011 and 2015. The next-largest occupation by growth rate is Healthcare Support Occupations. These occupations, and the Healthcare Practitioners and Technical Occupations, will grow largely due to demographic changes; as a large part of the population ages, the demand for healthcare will also increase. Further, according to the SWOT analysis, DoD spending as it is currently constituted is going to have the most impact on Office and Administrative Support Occupations. This category employed on average 17,041 of 113,227 total jobs over the past five years.¹¹²

Maryland is expected to have significant job growth in important DoD related occupations. Computer and Mathematical Occupations are predicted to grow at a 6.7 percent rate over the next ten years, adding an average of 809 jobs per year. The Architecture and Engineering Occupations, and Life, Physical, and Social Science Occupations are also expected to grow over the next ten years, at rates of 7.5 percent and 7.7 percent per year, respectively. Computer and Mathematical Occupations comprised the third-largest category for DoD-funded jobs, with nearly 10,000 workers. The Architecture and Engineering Occupations category employed nearly 5,000 individuals, and the Life, Physical, and Social Science Occupations employed nearly 2,700. Further, Figure 11, which presents Business Services cluster employment by occupation, shows that over 90,000 workers are employed in Computer and Mathematical Occupations in that cluster, compared to the 120,000 workers in the same occupations in the state. Similarly, the Business Services cluster employed over 33,000 in the Architecture and Engineering occupational category, compared to nearly 57,000 in the state overall, and the Life, Physical, and Social Science occupations category employed 9,500, compared to over 40,500 in the state overall. The survey results also indicated that Information Technology and skilled computer jobs are in demand, and the occupational forecast suggests that this demand will persist over the long term.

Focusing on Scenarios 2 and 3, RESI forecasted the economic impact of DoD spending between 2017 and 2026, assuming a 10 percent decrease and increase, respectively, in average DoD funding. From analyzing both scenarios and comparing the results to the data presented in Scenario 1 in Figure 21, RESI found that a 10 percent increase or decrease in DoD funding had only a marginal impact. For example, Scenario 2 found that with a reduction in funding there was a 9.973 percent average decrease in employment over the next ten years. Similarly,

¹¹¹ Regional Economic Studies Institute of Towson University, "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape."

¹¹² Ibid.

Scenario 3 found that with an increase in funding there was a 9.971 percent average increase in employment over ten years. This indicates that the model predicts diminishing returns, as there is a slightly larger gain to employment from moving from the ten percent decrease to current spending, than there is from moving from current spending to the ten percent increase, but otherwise provides limited insight. Section 7 of "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape" presents detailed analyses that are based on specific policy changes that the SWOT analysis identified.¹¹³

5.0 Analyzing Maryland's Regional Defense-Related Clusters

RESI took the analysis completed at the state level in Section 4 a step further by completing the same analysis at the regional level. Drawing on the cluster definitions, DoD spending data, and cluster analysis approaches outlined in the previous sections of this report, this section will provide an analysis of the industry clusters in Maryland that are impacted by DoD funding at the regional level. This analysis will highlight the impact of the 2011-2015 DoD funding to Maryland noting where the highest amounts of DoD funding go to clusters across the state, as well as which industry cluster types in each region receive the highest amounts of DoD funding in Maryland. Given the overarching aim of this project—to determine the impact of potential future fluctuations in DoD funding—RESI also forecasted the economic impacts of these industry clusters in each region.

For this analysis, the state is broken down into five different regions, including: the Capital, Central, Eastern Shore, Southern Maryland and Western Maryland regions. The counties that comprise these regions are as follows (regions in alphabetical order):

1. Capital region – Frederick, Montgomery, and Prince George's Counties
2. Central region – Anne Arundel, Baltimore, Carroll, Harford, Howard Counties and Baltimore City
3. Eastern Shore – Cecil, Caroline, Dorchester, Kent, Queen Anne's, Somerset, Talbot, Wicomico, and Worcester Counties
4. Southern Maryland – Calvert, Charles, and St. Mary's Counties
5. Western Maryland – Allegany, Garrett, and Washington Counties

Maryland's regions are diverse in terms of rural and urban populations, and this is largely reflected in the number of jobs estimated to be located in each region. The Eastern Shore, Southern Maryland, and Western Maryland regions are the more rural areas of the state, while the Capital and Central regions are more urban. This geographic difference will have an impact on wages and jobs. As a result, it will be explored throughout this section.

¹¹³ Regional Economic Studies Institute of Towson University, "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape."

The same level of analysis carried out at the state level, focusing on the industry clusters, the DoD impact on industry clusters and occupations, and the forecasted DoD impact on industry clusters will be carried out for each of these regions. It should be noted that the impacts of the customized clusters are not reviewed at the regional level as it will be a repeat of the information provided for these clusters at the state level. The spending in the category is captured in the comprehensive cluster definitions, and the SWOT report provides additional details for the policy analysis that the cluster definitions enabled.¹¹⁴

5.1 Capital Region Overview

The Capital region in Maryland is comprised of Frederick, Montgomery, and Prince George's Counties. This region had an estimated 875,000 jobs in 2014 with average annual wages of approximately \$54,200—the highest in the state.¹¹⁵ The region receives 42.8 percent of all DoD funding in Maryland, at an average annual of over \$7.7 billion dollars, which is the second-highest allocation to a specific region in the state. The region's largest employment cluster is the Business Services cluster, which employs over 155,000 individuals at an average wage of over \$80,000 per year.

The next subsections are organized as follows: Section 5.1.1 provides an overview of the top industry clusters present in the region by employment, wages, and location quotients; Section 5.1.2 details the top industry clusters in the region by annual DoD funding; and Section 5.1.3 presents the long-term forecast for the Capital region.

5.1.1 Capital Region—Overall Top Clusters

It is necessary to understand the Capital region's overall economic profile to fully understand DoD spending impacts on the area. Focusing on the employment numbers per cluster, RESI constructed a ranking of industry clusters in the Capital region. The construction of the clusters is based on the Delgado, Porter, and Stern definitions using 2014 CBP data. Wage estimates were made using 2015 OES data.

The Business Services cluster is the top cluster by employment in the region, employing over 155,500 individuals at an average wage of \$80,110. The second-largest cluster in the region is the Local Health Services cluster, which employs approximately 103,800 people, and pays an average wage of \$55,397. This cluster is followed by the Local Real Estate, Construction, and Development cluster, employing nearly 100,900 individuals with an average wage of \$49,865.

¹¹⁴ Regional Economic Studies Institute of Towson University, "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape."

¹¹⁵ 2014 CBP data was used to estimate the overall employment levels, the most recent year available that allowed estimation in all clusters. 2015 data was used for estimating the average wages for this study because it was the most recent data available.

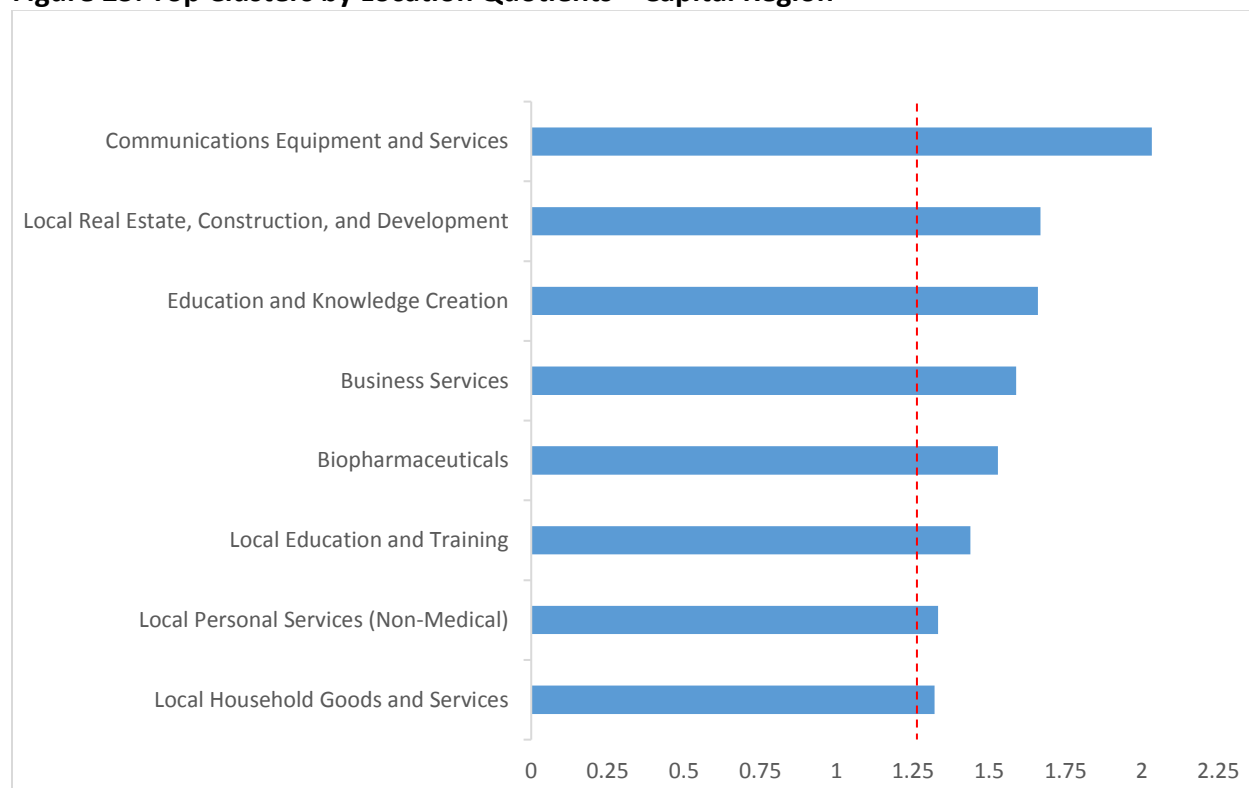
Focusing on wages as the main economic indicator, RESI ranked the clusters by average wage for the Capital region. The Information Technology and Analytical Instruments cluster is the highest-paying cluster in the region, employing over 6,600 individuals at an average wage of \$96,168. The second-highest paying cluster in the region is the Aerospace Vehicles and Defense cluster, employing approximately 1,300 people with an average wage of \$84,977. The Education and Knowledge Creation cluster, which employs almost 44,400 individuals, has the third-highest average wage of \$83,165. Taking into account the estimated employment and the wages in this ranking, there are specialized clusters employing a small number of individuals in the region at a higher wage. This is particularly notable in the Information Technology and Analytical Instruments cluster, as well as the Aerospace Vehicles and Defense cluster, where the skills and education needed to fill the jobs command a higher wage.

For the third and final economic indicator, RESI compared the location quotients of the clusters in the Capital region. Figure 23 shows that within this region in Maryland, there are eight clusters with a location quotient over 1.25 indicating an exporting cluster.^{116, 117}

¹¹⁶ William Shuffstall, "Using Location Quotients to Identify Local Strengths, Opportunities, and Industry Clusters."

¹¹⁷ Location quotients compare the proportion of employment in a specific industry in a region to the proportion of employment in that specific industry at the national level. By definition, a location quotient of 1.0 means that the same ratio of industry employment occurs at the local and national level, while location quotients less than 1.0 indicate an employment concentration lower than the national average. Location quotients over 1.0 indicates that regional labor is producing more goods than are being consumed in the region. Experts typically accept any industries with a value over 1.25 as being exporting industries.

Figure 23: Top Clusters by Location Quotients—Capital Region



Sources: Delgado, Porter, and Stern; RESI; U.S. Census

The Communications Equipment and Services cluster has the highest location quotient for the region at 2.0. Additional clusters with location quotients exceeding 1.25 in the region ranged from 1.3 to 1.7 and include: Local Real Estate, Construction, and Development; Education and Knowledge Creation; Business Services; Biopharmaceuticals; Local Education and Training; Local Personal Services (Non-Medical); Local Households Goods and Services; Local Commercial Services; and Local Food and Beverage Processing and Distribution.

The industries with higher location quotients reflect the competitive advantages of the area. The Capital region enjoys a geographic advantage due to its proximity to Washington, D.C. For example, one reason the region likely has advantages in both the Communications Equipment and Services and Business Services clusters may be that companies prefer to have offices in close vicinity of the U.S. capital. As can be seen in the next section, these two clusters are the top two in terms of funding from the DoD. The proximity to the nation's capital also benefits the area due to the number of government facilities, including research institutions that are located in Washington, D.C. These institutions attract a skilled workforce earning high wages, reflected in an average annual wage for the region that is above the Maryland average. This also contributes to the Local Real Estate, Construction, and Development cluster having a

disproportionate number of jobs. While it is a “Local” cluster, it is effectively exporting its services to the rest of the country while working on DoD and other government contracts.

5.1.2 Capital Region—DoD Spending in Top Clusters

In Maryland’s Capital region, the DoD obligated an average of \$7.7 billion per year for vendors based in or performing work in the region. As seen in Figure 24, in addition to being the largest recipient of DoD funding at the state level, Business Services was also the highest-funded cluster in the Capital region.

Figure 24: Estimated Jobs, Average Wage, and Employment Impacts in the Top Clusters by DoD Spending—Capital Region¹¹⁸

Cluster Name	Regional Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Business Services	155,491	\$80,110	\$3,764,580,776	16,239
Communications Equipment and Services	6,222	\$74,272	\$714,155,402	3,323
Local Real Estate, Construction, and Development	100,882	\$49,865	\$614,306,587	4,257
Education and Knowledge Creation	44,360	\$83,165	\$516,905,370	2,148
Local Health Services	103,770	\$55,397	\$264,504,721	1,650
Local Hospitality Establishments	70,588	\$24,958	\$244,051,349	3,379
Local Commercial Services	72,833	\$45,386	\$237,011,702	1,805
Local Utilities	9,757	\$68,227	\$236,757,638	1,199
Information Technology and Analytical Instruments	6,662	\$96,168	\$230,345,663	828
Aerospace Vehicles and Defense	1,321	\$84,977	\$142,844,325	581
Subtotal	571,886	\$59,229	\$6,965,463,533	35,409
Regional Total	831,966	\$54,547	\$7,685,333,309	40,324

Sources: BLS OES; Delgado, Porter, and Stern; REMI, RESI; U.S. Census CBP

¹¹⁸ This estimated employment supported by DoD funding by cluster (in the fifth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for a more detailed methodology.

RESI estimates that the Business Services cluster, the largest cluster in the state, also had the largest impact on total jobs in the region, contributing over 16,000 total (direct, indirect, and induced) jobs to Maryland's economy due to DoD spending. This cluster had an annual average of \$3.76 billion in obligated funding in the Capital region between 2011 and 2015. The second-largest cluster in the region by funding amount was Communications Equipment and Services, which received an average funding obligation of approximately \$714 million. In 2014, over 6,200 workers were employed in this cluster with an average annual wage of \$74,272. The third-largest cluster for the Capital region was Local Real Estate, Construction, and Development, which had an average funding obligation of \$614 million, estimated employment of approximately 100,900, and an estimated average wage of \$49,865. The subtotal row shows the total numbers for the top ten clusters by DoD spending shown in Figure 24, and the regional total row shows the overall totals for all clusters receiving DoD funding in the Capital region. To see details on the clusters receiving DoD funding see Appendix E.

DoD funding within industry clusters will not impact all occupations or businesses in the region equally. Focusing on the Business Services cluster, Figure 25 provides employment and wage estimates by major occupational category for the Capital region.

Figure 25: Employment and Wage Data by Occupational Category for the Business Services Cluster—Capital Region¹¹⁹

SOC	Occupational Category	Regional Job Estimate, 2014	Average Wage, 2015
15-0000	Computer and Mathematical Occupations	53,596	\$89,042
13-0000	Business and Financial Operations Occupations	22,138	\$81,705
43-0000	Office and Administrative Support Occupations	21,351	\$39,854
11-0000	Management Occupations	15,611	\$145,328
17-0000	Architecture and Engineering Occupations	13,671	\$81,662
41-0000	Sales and Related Occupations	6,408	\$75,939
19-0000	Life, Physical, and Social Science Occupations	4,401	\$70,164
53-0000	Transportation and Material Moving Occupations	2,676	\$31,854
33-0000	Protective Service Occupations	2,512	\$35,756
37-0000	Building and Grounds Cleaning and Maintenance Occupations	2,357	\$25,251
49-0000	Installation, Maintenance, and Repair Occupations	2,246	\$48,628
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	2,047	\$65,070
29-0000	Healthcare Practitioners and Technical Occupations	1,669	\$63,660
47-0000	Construction and Extraction Occupations	1,282	\$53,846
51-0000	Production Occupations	978	\$38,006
23-0000	Legal Occupations	708	\$128,500
35-0000	Food Preparation and Serving Related Occupations	441	\$27,681
21-0000	Community and Social Service Occupations	418	\$43,796
31-0000	Healthcare Support Occupations	415	\$28,317
39-0000	Personal Care and Service Occupations	282	\$25,545
25-0000	Education, Training, and Library Occupations	268	\$50,181
45-0000	Farming, Fishing, and Forestry Occupations	17	\$32,076
Total		155,491	\$80,110

Sources: BLS OES; Delgado, Porter, and Stern; RESI; U.S. Census CBP

In total, RESI estimates that the average annual wage for occupations in the Business Services cluster in the Capital region was approximately \$80,110 in 2015. Computer and Mathematical

¹¹⁹ Major occupational categories represent the highest-level occupational groupings of employees on private non-farm payrolls. The employment data are from 2014 CBP and wage estimates are from 2015 OES.

Occupations within the cluster had the largest number of workers in the region, with nearly 53,600 employed at an estimated average wage of \$89,042. The second-largest occupational category in terms of employment was in Business and Financial Operations Occupations, which employed over 22,100 workers receiving an average annual wage of approximately \$81,705. The Office and Administrative Support Occupations category had the third-largest number of employees, with approximately 21,400 individuals receiving an average annual wage of \$39,854.

Using the information from Figure 24 and Figure 25 informs how a cut in DoD funding to the Business Services cluster would impact employment in the Capital region. A 10 percent reduction in DoD funding to the cluster in the Capital region would have large negative impacts to the region's economy because of the large amount of funding (nearly \$3.8 billion) the cluster receives. This cut would result in a loss of 572 direct jobs from the cluster and 1,619 total jobs in the region. Computer and Mathematical Occupations would be expected to especially be hit hard in this scenario, as these professions account for 34.5 percent of the total jobs in the cluster in this region.¹²⁰ RESI estimates that approximately 372 jobs would be lost in this occupation in this cluster, corresponding to a loss of approximately \$33.1 million in wages in the region. Business and Financial Operations Occupations account for 14.2 percent of the jobs in the cluster, and would lose approximately 154 jobs, resulting in approximately \$12.5 million in lost wages. The third-largest loss of jobs would occur in the Office and Administrative Occupations. This occupational category accounted for 13.7 percent of the jobs in the cluster, and would lose approximately 148 jobs, resulting in nearly \$5.9 million in lost wages in the state. Calculations were made using the direct employment values by occupational category, from Appendix F.

Figure 26 lists the top company for each of the ten highest-funded clusters in the Capital region, based on DoD allocations to individual vendors at the cluster level.¹²¹ BAE Systems Technology Solutions & Services was the largest company by annual DoD funding for the Business Services cluster, receiving approximately \$600 million annually. The second-largest funding commitment by cluster was for Lockheed Martin receiving the greatest funding amounts in the Communication Equipment and Services cluster, at an average of approximately \$290 million and \$86 million annually, respectively. The third-largest funding commitment by cluster is for Local Hospitality Establishments, in which Sodexo Management received an average of over \$239 million annually in the Capital region. For all of the top vendors by cluster based on DoD awards, see Appendix F.

¹²⁰ Note that occupational compositions vary at the six-digit NAICS. Since there are differing mixes of industries at the six-digit NAICS code level at the state and regional levels, there are different occupational proportions in different regions.

¹²¹ Only the top ten are displayed here, see Appendix F for the top vendor in each cluster by DoD funding obligations.

Figure 26: Highest-Funded Company per Top-Funded Clusters—Capital Region

Cluster	Company Name	Annual Average Dollars Obligated, 2011-2015
Business Services	BAE Systems Technology Solutions & Services Inc.	\$600,429,936
Communications Equipment and Services	Lockheed Martin Corporation	\$346,379,176
Local Hospitality Establishments	Sodexo Management Inc.	\$239,268,456
Aerospace Vehicles and Defense	BAE Systems Technology Solutions & Services Inc.	\$91,826,258
Local Utilities	International Business Machines	\$90,744,101
Local Real Estate, Construction, and Development	Manhattan Hunt A Joint Venture	\$74,643,269
Education and Knowledge Creation	URS Federal Services, Inc.	\$50,271,994
Transportation and Logistics	Dyncorp International LLC	\$48,251,775
Information Technology and Analytical Instruments	Hewlett-Packard Company	\$46,772,419
Local Commercial Services	International Business Machines	\$39,869,235

Sources: RESI, USA Spending

Overall, the distribution of DoD funding in the region, which is concentrated in the Business Services cluster, parallels the findings at the state level. Interestingly, significant awards from DoD funds for a contractor in the Capital region have been distributed across different companies in several clusters, highlighting the diverse array of companies in the area and the involvement of multiple clusters in defense activity. For example, Figure 26 shows BAE Systems Technology Solutions & Services and International Business Machines both received the largest awards in two different clusters.

5.1.3 Capital Region—Long-Term Forecast

RESI used the REMI PI+ model to forecast the impacts of DoD funding on the Capital region over the next ten years.¹²²

¹²² RESI also conducted forecasts assuming a 10 percent decrease and a 10 percent increase in average DoD Spending in Maryland, but these are not presented as they are roughly the same results but scaled up and down. Section 7 of "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape" presents detailed policy change analyses that are based on specific policy changes determined as likely through the SWOT analysis.

Figure 27: Forecasted Total Economic Impacts for all Defense Spending—Capital Region, 2017-2026

Year	Employment	Output	Wages
2017	46,718	\$5,878,278,230	\$2,188,248,053
2018	47,070	\$5,970,606,577	\$2,245,369,122
2019	45,815	\$5,928,580,035	\$2,258,195,109
2020	43,919	\$5,777,776,994	\$2,247,614,718
2021	41,708	\$5,572,439,397	\$2,220,924,720
2022	39,472	\$5,347,114,240	\$2,186,419,811
2023	37,365	\$5,124,550,437	\$2,153,169,245
2024	35,426	\$4,913,615,556	\$2,123,188,620
2025	33,675	\$4,718,782,532	\$2,098,135,563
2026	32,073	\$4,553,192,876	\$2,079,765,488

Sources: REMI PI+, RESI

Figure 27 shows that between 2017 and 2016, the total impact on private non-farm jobs in the region will peak in 2018 at an employment level of approximately 47,100, and will fall to its lowest level in 2026, at 32,100 individuals employed. Output will peak in 2018 at approximately \$6.0 billion, and be at its lowest level of \$4.6 billion in 2026. Total wages resulting from defense spending in the Capital region will peak in 2019 at a level of approximately \$2.3 billion, and be at its lowest level of \$2.1 billion in 2026. As spending occurs further in the future, the same amount of money effectively purchases less, as wage rates and prices increase. Notice that predicted wages remain relatively stable, but the number of those employed declines. Output follows a similar pattern to employment, because over time the same amount of money spent will have a lower purchasing power for inputs, and with wages predicted to remain level, this means that output will fall.

5.2 Central Region Overview

The Central region in Maryland is comprised of Anne Arundel, Baltimore, Carroll, Harford, and Howard Counties, and Baltimore City. This region has the largest number of employees in the state—estimated at 1.2 million jobs in the region in 2014—and has the second-highest average wage of more than \$52,600 per year. The Central region’s largest employment cluster is Local Health Services, employing over 187,000 individuals at an average annual wage (for the region) of over \$55,300. The Central region receives the most funding of any region in Maryland with nearly \$8.1 billion worth of obligated DoD funding—45 percent of the total allocated to the state in an average year.

The next subsections are organized as follows: Section 5.2.1 provides an overview of the top industry clusters present in the region by employment, wages, and location quotients; Section 5.2.2 details the top industry clusters in the region by annual DoD funding; and Section 5.2.3 presents the long-term forecast for the Central region.

5.2.1 Central Region—Overall Top Clusters

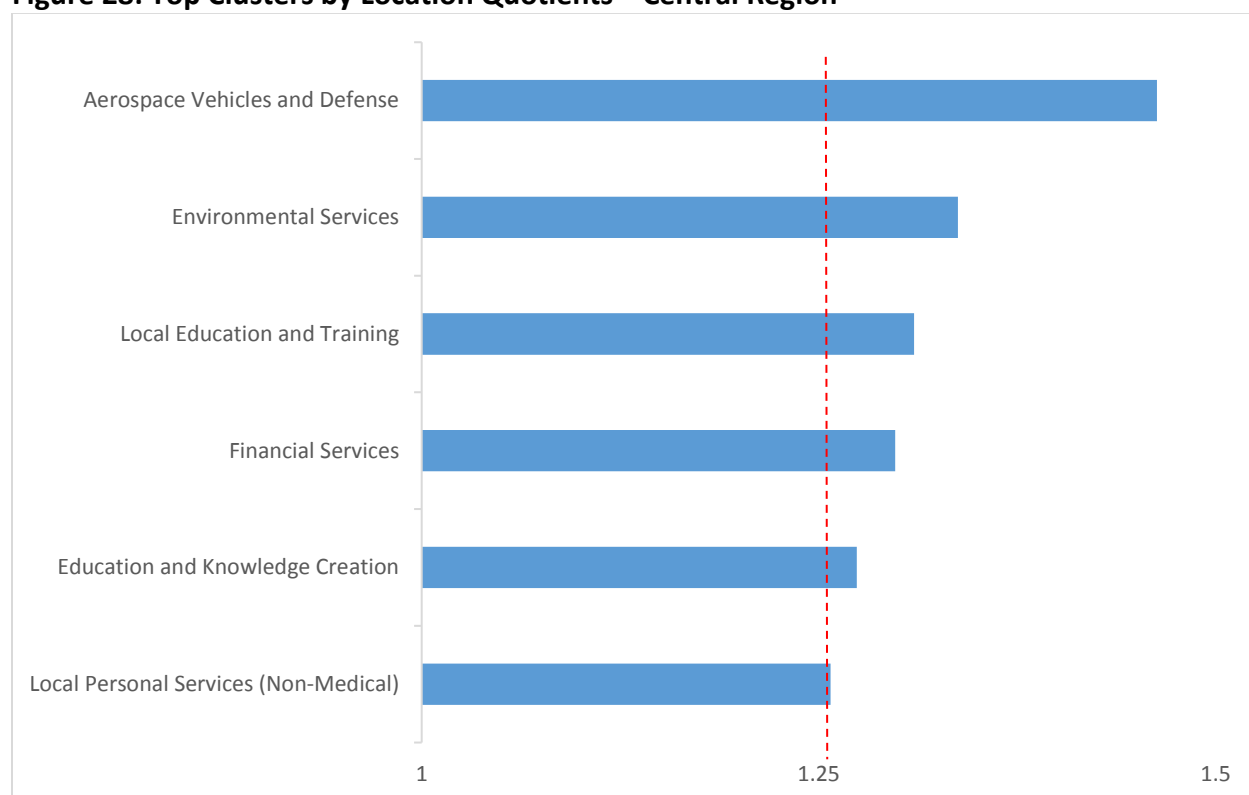
It is necessary to understand the Capital regions' overall economic profile to fully understand DoD spending impacts on the area. Focusing on the employment numbers per cluster, RESI constructed a ranking of industry clusters in the Central region. The construction of the clusters is based on the Delgado, Porter, and Stern definitions using 2014 CBP data. Wage estimates were made using 2015 OES data.

The Local Health Services cluster is the largest overall cluster in the region and employs nearly 187,200 people and pays an average wage of \$55,307. The second-largest cluster in the region is the Business Services cluster, which employs approximately 166,800 people, at an average wage of \$79,025. This third largest cluster by employment, in this region is the Local Hospitality Establishments cluster with over 109,500 employees, at an average wage of \$24,940.

The Information Technology and Analytical Instruments cluster is the highest-paying cluster in the Central region, employing over 6,200 individuals at an average wage of nearly \$95,482. The second-highest paying cluster in the region is the Financial Services cluster, which employs almost 27,000 people, and pays an average wage of \$87,980. The Aerospace Vehicles and Defense cluster, which employs over 7,600 individuals, has the third-highest average wage of \$85,419. Similar to the findings in the Capital region, the Information Technology and Analytical Instruments cluster has a relatively small number of employees receiving a high wage in the region.

Figure 28 shows that the Central region of Maryland has six industry clusters with location quotients for employment over 1.25. The top cluster by location quotient is the Aerospace Vehicles and Defense cluster with a location quotient of 1.46, followed by the Environmental Services cluster at 1.34. The other industry clusters in the region with location quotients above 1.25 are Local Education and Training; Financial Services; Education and Knowledge Creation; and Local Personal Services (Non-Medical).

Figure 28: Top Clusters by Location Quotients—Central Region



Sources: Delgado, Porter, and Stern; RESI; US

The clusters with high location quotients described above demonstrate the strengths of the Central region. The area is home to several large defense contractors including the Lockheed Martin Corporation and the AAI Corporation, both part of the Aerospace Vehicles and Defense cluster. Further, the area has large universities including JHU, Towson University, UMB and UMBC which are part of the Education and Knowledge cluster. In addition to these academic institutions, the Johns Hopkins Applied Physics Laboratory (part of the Education and Knowledge cluster) is also located in the Central region, and is one of the largest recipients of DoD funding in the state.

5.2.2 Central Region—DoD Spending in Top Clusters

The Central region received the highest level of DoD funding, with annual average of \$8.1 billion spent annually for vendors based in or performing work in the region. In addition to being the top recipient of DoD funding for both Maryland and the Capital region, Business Services was also the highest-funded cluster in the Central region with average DoD spending of \$2.15 billion annually. Figure 29 below shows the top ten clusters in the Central region by obligated DoD funding between 2011 and 2015.

Figure 29: Estimated Jobs, Average Wage, and Employment Impacts in the Top Clusters by DoD Spending—Central Region¹²³

Cluster Name	Regional Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Business Services	166,779	\$79,025	\$2,153,631,370	11,657
Education and Knowledge Creation	44,933	\$72,797	\$1,259,500,038	7,401
Aerospace Vehicles and Defense	7,601	\$85,419	\$995,080,987	4,983
Water Transportation	3,263	\$60,955	\$845,277,435	5,932
Local Real Estate, Construction, and Development	105,131	\$49,708	\$778,528,515	6,699
Local Utilities	15,065	\$68,679	\$401,596,981	2,501
Communications Equipment and Services	4,391	\$72,385	\$323,817,737	1,914
Local Health Services	187,184	\$55,307	\$230,706,971	1,784
Information Technology and Analytical Instruments	6,223	\$95,482	\$179,139,792	803
Insurance Services	14,005	\$70,072	\$147,926,423	903
Subtotal	554,575	64,564	\$7,315,206,249.00	44,577
Regional Total	1,188,453	\$52,491	\$8,082,350,494	51,344

Sources: BLS OES, REMI, RESI, U.S. Census CBP

DoD spending in the Business Services cluster is estimated to result in over 11,600 total jobs (direct, indirect, and induced) in the Central region. RESI estimates that this cluster employed approximately 166,800 individuals with an estimated average wage of \$79,025 in 2014. The second-largest cluster by obligated funding was the Education and Knowledge Creation cluster, which had an average funding obligation of approximately \$1.3 billion annually. This cluster employed approximately 44,900 individuals in 2014 at an estimated wage of \$72,797. The third-largest cluster for the Central region was the Aerospace Vehicles and Defense cluster, which had an average funding obligation of \$995 million, estimated employment of approximately

¹²³ This estimated employment supported by DoD funding by cluster (in the fifth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for a more detailed methodology.

7,600, and an estimated annual wage of \$85,419. The subtotal row shows the total numbers for the top ten clusters by DoD spending shown in Figure 29, and the regional total row shows the overall totals for all clusters receiving DoD funding in the Central region. To see details on the clusters receiving DoD funding see Appendix E. DoD funding within industry clusters will not impact all occupations or businesses in the region equally. Focusing on the Business Services cluster—the largest cluster in the Central region—Figure 30 reviews employment and wage estimates by major occupational category for the Central region.

Figure 30: Employment and Wage Data by Occupational Category for the Business Services Cluster—Central Region¹²⁴

SOC	Occupational Category	Regional Job Estimate, 2014	Average Wage, 2015
15-0000	Computer and Mathematical Occupations	52,231	\$88,796
43-0000	Office and Administrative Support Occupations	24,584	\$39,763
13-0000	Business and Financial Operations Occupations	23,772	\$80,336
11-0000	Management Occupations	17,552	\$144,754
17-0000	Architecture and Engineering Occupations	16,882	\$80,942
41-0000	Sales and Related Occupations	6,849	\$73,204
19-0000	Life, Physical, and Social Science Occupations	4,621	\$69,134
53-0000	Transportation and Material Moving Occupations	4,282	\$29,457
49-0000	Installation, Maintenance, and Repair Occupations	2,242	\$48,529
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	2,113	\$65,439
29-0000	Healthcare Practitioners and Technical Occupations	1,933	\$65,573
51-0000	Production Occupations	1,728	\$34,031
37-0000	Building and Grounds Cleaning and Maintenance Occupations	1,646	\$25,615
47-0000	Construction and Extraction Occupations	1,589	\$51,507
33-0000	Protective Service Occupations	1,458	\$36,639
23-0000	Legal Occupations	827	\$130,591
31-0000	Healthcare Support Occupations	594	\$29,095
35-0000	Food Preparation and Serving Related Occupations	507	\$27,557
21-0000	Community and Social Service Occupations	464	\$44,222
39-0000	Personal Care and Service Occupations	443	\$25,382
25-0000	Education, Training, and Library Occupations	442	\$42,354
45-0000	Farming, Fishing, and Forestry Occupations	20	\$30,283
Total		166,779	\$79,025

Sources: BLS OES, RESI, U.S. Census CBP

RESI estimates that the average regional wage for the Business Services cluster in the Central region was approximately \$79,025 in 2014. Computer and Mathematical Occupations had the

¹²⁴ Major occupational categories represent the highest-level occupational groupings of employees on private non-farm payrolls. The employment data is from 2014 CBP and wage estimates are from 2015 OES.

largest number of workers in the region with more than 52,200 individuals employed at an estimated average wage of \$88,796. The second-largest occupational category by employment was in the Office and Administrative Support Occupations, which employed approximately 24,600 individuals receiving an average annual wage of \$39,763. The Business and Financial Operations Occupations category was ranked third in the region by employment level, having approximately 23,800 individuals earning an average annual wage of \$80,336.

Using the information from Figure 29 and Figure 30 informs how a cut in DoD funding to the Business Services cluster would impact employment in the Central region. The Central region would also experience large negative economic impacts from a 10 percent cut in DoD funding to the Business Services cluster. A cut of ten percent would result in approximately 1,162 fewer direct, indirect, and induced jobs in the region. Of the total jobs lost, approximately 572 would be direct jobs in the cluster. Computer and Mathematical Occupations would be especially hit hard in this scenario, as these professions account for 31.3 percent of the total jobs in the cluster in this region.¹²⁵ RESI estimates that approximately 179 jobs would be lost in this occupation in this cluster, resulting in a loss of approximately \$15.9 million in wages in the region. The Office and Administrative Occupations account for 14.7 percent of the jobs in the cluster, and would lose approximately 84 jobs, resulting in approximately \$3.3 million in lost wages. The third-largest loss of jobs would occur in the Business and Financial Operations Occupations. This occupation category accounted for 14.3 percent of the jobs in the cluster, and would lose approximately 81 jobs, resulting in approximately \$6.5 million in lost wages in the state. For these calculations, RESI used the direct employment values by occupational category, from Appendix H.

While understanding how the cluster and occupations are impacted by DoD funding is important, it is also important to understand how this funding is allocated to specific firms in the Central region. Figure 31 shows the top company for each of the ten highest-funded clusters based on DoD allocations to individual vendors at the cluster level.

¹²⁵ Note that occupational compositions vary at the six-digit NAICS. Since there are differing mixes of industries at the six-digit NAICS code level at the state and regional levels, there are different occupational proportions in different regions.

Figure 31: Highest-Funded Company per Top-Funded Clusters—Central Region

Cluster	Company Name	Annual Average Dollars Obligated, 2011-2015
Water Transportation	Lockheed Martin Corporation	\$820,918,132
Education and Knowledge Creation	The Johns Hopkins University Applied Physics Laboratory LLS	\$715,023,269
Aerospace Vehicles and Defense	AAI Corporation	\$486,257,908
Insurance Services	Johns Hopkins Medical Services Corp	\$367,505,000
Business Services	Mantech Sensor Technologies, Inc.	\$317,955,839
Local Health Services	Johns Hopkins Medical Services Corp	\$233,027,453
Local Real Estate, Construction, and Development	Walsh/Gilbane JV	\$206,445,000
Local Utilities	Lockheed Martin Corporation	\$181,973,845
Communications Equipment and Services	Telecommunication Systems Incorporated	\$98,419,347
Downstream Metal Products	Lockheed Martin Corporation	\$78,358,575

Sources: RESI, USA Spending

Lockheed Martin Corporation was the largest vendor for three of the highest-funded clusters: Water Transportation, Local Utilities, and Downstream Metal Products, receiving average annual funding obligations of approximately \$821 million, \$182 million, and \$78 million, respectively. The second-largest vendor by awards at the cluster level was The Johns Hopkins Applied Physics Laboratory, which received an average of over \$715 million annually in DoD spending in the Education and Knowledge Creation cluster. While a corporation such as Lockheed Martin Corporation may not traditionally be thought of as being in the Local Utilities or Downstream Metal Products clusters, based on USA Spending data, they have performed work categorized as such by the DoD. For all of the top vendors by cluster based on DoD awards, see Appendix F.

5.2.3 Central Region—Long-Term Forecast

Using the REMI PI+ mode, RESI forecasted the impact of DoD funding in the Central region over a ten-year period. Figure 32 shows the output from the forecast in the Central region. This forecast assumes funding levels stay at their five-year average, and are not increased for inflation.¹²⁶

¹²⁶ RESI also conducted forecasts assuming a 10 percent decrease and a 10 percent increase in average DoD Spending in Maryland, but these are not presented as they are roughly the same results but scaled up and down.

Figure 32: Forecasted Total Economic Impacts for All Defense Spending—Central Region, 2017-2026

Year	Employment	Output	Wages
2017	58,688	\$8,015,814,970	\$2,853,860,032
2018	60,126	\$8,248,831,948	\$2,972,730,880
2019	59,181	\$8,260,456,594	\$3,018,042,563
2020	56,804	\$8,051,504,142	\$3,006,209,070
2021	53,813	\$7,743,135,390	\$2,963,121,235
2022	50,599	\$7,384,741,029	\$2,899,951,575
2023	47,524	\$7,027,017,823	\$2,835,922,919
2024	44,679	\$6,686,953,667	\$2,775,872,691
2025	42,119	\$6,376,236,821	\$2,723,600,436
2026	39,906	\$6,127,098,218	\$2,687,572,647

Sources: REMI PI+, RESI

The total impact on private non-farm jobs in the Central region will peak in 2018 at an employment level of approximately 60,100, and will fall to its lowest level in 2026, at 39,900 individuals employed. Output will peak in 2019 at approximately \$8.3 billion, and be at its lowest level of \$6.1 billion in 2026. Total wages resulting from defense spending in Central Maryland will peak in 2019 at a level of approximately \$3.0 billion, and be at its lowest level of \$2.7 billion in 2026. As spending occurs further in the future, the same amount of money effectively purchases less, as wage rates and prices increase. Notice that predicted wages remain relatively stable, but the number of those employed declines. Output follows a similar pattern to employment, because over time the same amount of money spent will have a lower purchasing power for inputs, and with wages predicted to remain level, this means that output will fall.

5.3 Eastern Shore Overview

The Eastern Shore consists of Cecil, Caroline, Dorchester, Kent, Queen Anne's, Somerset, Talbot, Wicomico, and Worcester Counties. It is the third-largest region in the state by the number of employees, having over 146,000 jobs with an average wage of approximately \$45,000 per year. The region's largest employment cluster is the Local Health Services cluster, which has an average wage of over \$54,000 per year and employs nearly 27,000 individuals. The Eastern Shore receives an average of \$173 million in DoD funding annually, significantly below the five-region average of \$3.6 billion.

The next subsections are organized as follows: Section 5.3.1 provides an overview of the top industry clusters present in the region by employment, wages, and location quotients; Section 5.3.2 details the top industry clusters in the region by annual DoD funding; and Section 5.3.3 presents the long-term forecast for the Eastern Shore region.

5.3.1 Eastern Shore—Overall Top Clusters

To fully understand DoD spending impacts on the Eastern Shore's economy, it is necessary to understand the Eastern Shore's overall economic profile. Focusing on the employment numbers per cluster, RESI constructed a ranking of industry clusters on the Eastern Shore. The construction of the clusters is based on the Delgado, Porter, and Stern definitions using 2014 CBP data. Wage estimates were made using 2015 OES data.

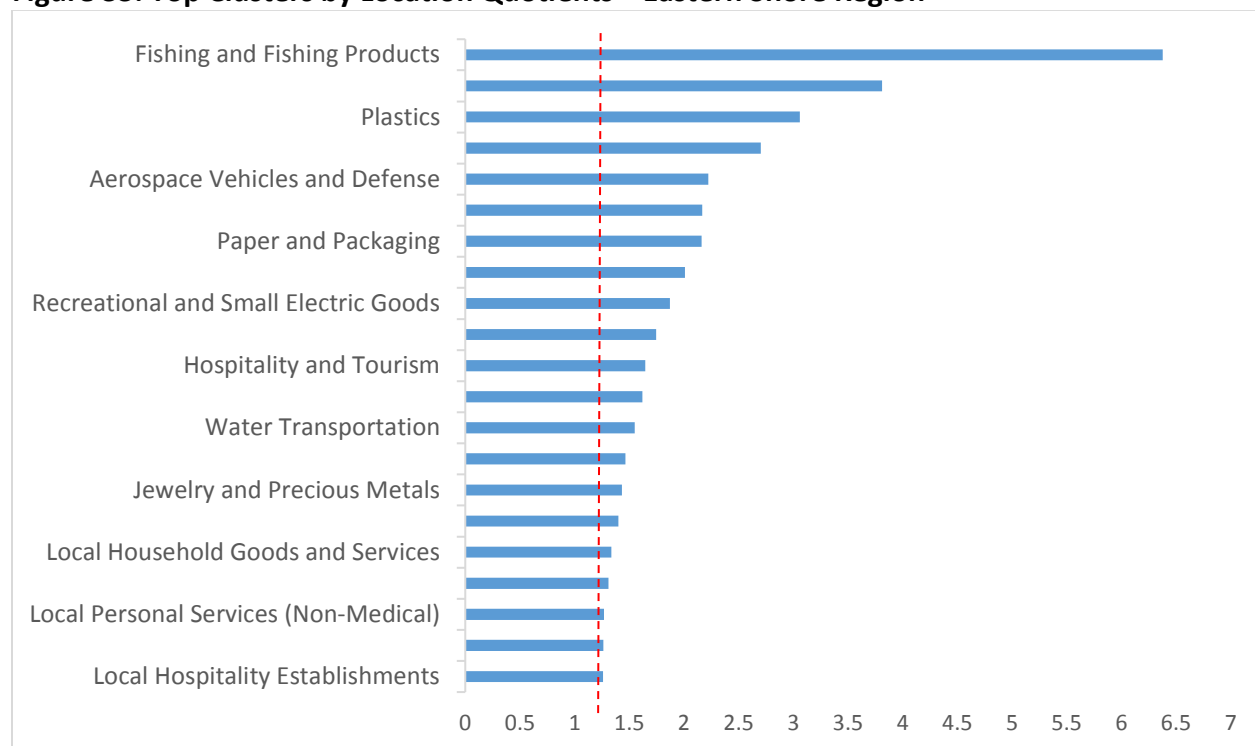
The Local Health Services cluster is the largest cluster in the region, employing nearly 27,000 individuals, and paying an average wage of \$54,052. The second-largest cluster in the region is the Local Hospitality Establishments cluster, which employs over 17,300 people at an average wage of \$24,374. The third largest cluster by employment is the Local Real Estate, Construction, and Development cluster, which employs more than 12,900 individuals, and pays an average wage of \$48,931.

Aerospace Vehicles and Defense is the highest paying cluster in the region, employing approximately 1,400 at an average wage of over \$84,929. The second-highest paying cluster in the region is the Information Technology and Analytical Instruments cluster, which employs nearly 600 people and pays an average wage of approximately \$83,467. The Financial Services cluster has the third-highest average wage for the region, employing 1,045 individuals with average earnings exceeding \$77,561.

Of the three regions analyzed thus far, this region is the first to identify the Aerospace Vehicles and Defense cluster as having the highest average wage in the region. While there are considerably less employment opportunities in the Eastern Shore region than in the Central and Capital regions, and the wages are slightly less in comparison, the wages are higher on the Eastern Shore than the other more rural regions of the state.

Figure 33 shows the top clusters by location quotient for the Eastern Shore. The region has 21 clusters with location quotients over 1.25, indicating that much of the economic output of the Eastern Shore is exported to other locations.

Figure 33: Top Clusters by Location Quotients—Eastern Shore Region



Sources: Delgado, Porter, and Stern; RESI; U.S. Census

The industries with high location quotients in the region demonstrate the comparative advantages of the Eastern Shore, notably, access to natural resources. Fish and agricultural commodities are produced in the area and sent to other regions, and comprise the top two clusters by location quotient. The top industry by location quotient is the Fishing and Fishing Products industry at 6.38, which demonstrates the importance of this cluster to the area and the high intensity of labor associated with this industry. Natural resources also benefit the region through tourism, which plausibly contributes to the strong retail, jewelry, and service industries in the area. It could be argued that the large number of clusters with location quotients exceeding 1.25 indicate that the region lacks diversity in employment options. Analysis of this region indicates that DoD spending is not a strong predictor of regional employment patterns on the Eastern Shore, as there is such low funding allocated to this region, compared to the five-region average.

5.3.2 Eastern Shore—DoD Spending in Top Clusters

The DoD spent an average of approximately \$174 million per year in the Eastern Shore region between 2011 and 2015 for vendors based in or performing work in the region. At the regional level, DoD funding for the Eastern Shore is considerably less than the spending obligated to the Central and Capital regions. The allocation of these funds across clusters in the Eastern Shore region is displayed below in Figure 34.

Figure 34: Estimated Jobs, Average Wage, and Employment Impacts in the Top Clusters by DoD Spending—Eastern Shore Region^{127,128}

Cluster Name	Regional Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Education and Knowledge Creation	1,980	\$62,875	\$24,841,118	153
Production Technology and Heavy Machinery	623	\$55,179	\$21,036,679	147
Construction Products and Services	586	\$53,561	\$19,690,751	142
Aerospace Vehicles and Defense	1,398	\$84,929	\$14,769,258	67
Downstream Metal Products	175	\$53,263	\$14,756,795	107
Distribution and Electronic Commerce	5,130	\$50,880	\$12,003,283	91
Medical Devices	652	\$61,649	\$11,728,084	74
Business Services	5,914	\$71,651	\$9,053,887	49
Information Technology and Analytical Instruments	564	\$83,467	\$8,515,272	39
Local Food and Beverage Processing and Distribution	6,254	\$32,779	\$5,673,377	67
Subtotal	23,276	\$55,651	\$142,068,504.00	936
Regional Total	132,464	\$44,751	\$173,764,748	1,195

Sources: BLS OES, REMI, RESI, U.S. Census CBP

As seen in Figure 34, Education and Knowledge Creation was the top cluster for the Eastern Shore, which had an average of \$25 million in annual funding and created an estimated 153 total jobs (direct, indirect, and induced) in the region between 2011 and 2015. RESI estimates that this cluster employed approximately 2,000 individuals with an average wage of \$62,875.

¹²⁷ Spending figures from 2011-2015, employment and wage figures from 2014.

¹²⁸ This estimated employment supported by DoD funding by cluster (in the fifth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for a more detailed methodology.

The second-largest cluster according to annual funding was Production Technology and Heavy Machinery. With an average funding obligation of more than \$21 million annually, this cluster supported an estimated 600 jobs in 2014 with an average wage of \$55,179. Construction Products and Services was the third-largest cluster for the Eastern Shore region, having an average funding obligation of \$19 million. In 2014, this cluster supported an approximately 600 employees with an estimated annual wage of \$53,600. The subtotal row shows the total numbers for the top ten clusters by DoD spending shown in Figure 34, and the regional total row shows the overall totals for all clusters receiving DoD funding in the Eastern Shore region. To see details on the clusters receiving DoD funding see Appendix E.

Focusing on the top cluster by average DoD allocations in the Eastern Shore region, Figure 35 provides employment and wage estimates by major occupational category for the Education and Knowledge Creation cluster.

Figure 35: Employment and Wage Data by Occupational Category for the Education and Knowledge Creation Cluster—Eastern Shore Region

SOC	Occupational Category	Regional Job Estimate, 2014	Average Wage, 2015
11-0000	Management Occupations	148	\$109,950
13-0000	Business and Financial Operations Occupations	127	\$64,837
15-0000	Computer and Mathematical Occupations	111	\$73,373
17-0000	Architecture and Engineering Occupations	28	\$87,204
19-0000	Life, Physical, and Social Science Occupations	155	\$65,258
21-0000	Community and Social Service Occupations	43	\$49,508
23-0000	Legal Occupations	3	\$124,839
25-0000	Education, Training, and Library Occupations	766	\$67,654
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	75	\$45,810
29-0000	Healthcare Practitioners and Technical Occupations	52	\$73,180
31-0000	Healthcare Support Occupations	9	\$36,186
33-0000	Protective Service Occupations	23	\$40,391
35-0000	Food Preparation and Serving Related Occupations	15	\$27,810
37-0000	Building and Grounds Cleaning and Maintenance Occupations	46	\$30,395
39-0000	Personal Care and Service Occupations	31	\$31,317
41-0000	Sales and Related Occupations	19	\$54,433
43-0000	Office and Administrative Support Occupations	284	\$37,682
45-0000	Farming, Fishing, and Forestry Occupations	0	\$34,080
47-0000	Construction and Extraction Occupations	10	\$53,005
49-0000	Installation, Maintenance, and Repair Occupations	26	\$45,601
51-0000	Production Occupations	3	\$49,828
53-0000	Transportation and Material Moving Occupations	8	\$35,206
Total		1,980	\$62,875

Sources: BLS OES, RESI, U.S. Census CBP

In total, RESI estimates that the average regional wage for all occupational categories in this cluster was approximately \$62,875. The Education, Training, and Library Occupations category had the largest number of workers employed in the region, with an estimated 800 individuals employed at an average wage of approximately \$67,654. The second-largest occupational category in terms of employment was in the Office and Administrative Support Occupations. This category of occupations employed approximately 300 individuals receiving an average annual wage of approximately \$37,682. The Life, Physical, and Social Science Occupations category is the second-highest in the cluster according to employment, with an estimated 155 workers employed at an average annual wage of \$65,258.

The leading cluster by DoD spending on the Eastern Shore helps to show that the area is not as dependent on DoD funding as other parts of the state. Using the information from Figure 34 and Figure 35 informs how a cut in DoD funding to the Education and Knowledge Creation cluster would impact employment on the Eastern Shore. A 10 percent cut in DoD funding to the cluster, would result in approximately 15 fewer direct, indirect, and induced jobs in the region. Of these 15 total jobs, approximately three would be direct jobs lost in the cluster. For the eastern shore, these reductions would result in no or only partial jobs being lost in the occupational categories, with the exception of Education, Training, and Library Occupations. In this occupational category, RESI estimates that a 10 percent decrease in funding would result in a loss of 1.23 jobs, and \$83,493 in lost wages. While reductions in DoD funding will likely result in some job losses in the region, they will likely be dispersed and compared to other parts of the state, they will be relatively few both in the region.

Figure 36 shows the top company for each cluster based on DoD funding to individual vendors at the cluster level. Two vendors, Federal Resources Supply Company and Alliant Techsystems Operations, received the largest funding obligations for seven of the top ten clusters. Federal Resource Supply Company received the largest amount of funding for five clusters:

- Aerospace Vehicles and Defense,
- Distribution and Electronic Commerce,
- Medical Devices,
- Furniture, and
- Information Technology and Analytical Instruments.

Average annual funding to this company for these five clusters amounts to approximately \$54.5 million. Assuming that the advantage for this vendor to be located in the Eastern Shore is access to a wider supply chain in the region, as it supplies products from multiple clusters, it could be argued that this firm is pivotal to the economic growth of the region, even if that growth is lead through diversification. Alliant Techsystems Operations received the most obligated funding for both the Education and Knowledge Creation and Downstream Metal Products clusters, at an average of approximately \$17.8 million and \$12.3 million annually, respectively. For all of the top vendors by cluster based on DoD awards, see Appendix F.

Figure 36: Highest-Funded Company per Top-Funded Clusters —Eastern Shore Region

Cluster	Company Name	Annual Average Dollars Obligated, 2011-2015
Construction Products and Services	Sealaska Constructors, LLC	\$18,900,000
Education and Knowledge Creation	Alliant Techsystems Operations LLC	\$17,791,861
Production Technology and Heavy Machinery	Global Strategies Group (North America) Inc.	\$15,606,091
Aerospace Vehicles and Defense	Federal Resources Supply Company	\$13,222,947
Downstream Metal Products	Alliant Techsystems Operations LLC	\$12,259,745
Distribution and Electronic Commerce	Federal Resources Supply Company	\$11,479,651
Medical Devices	Federal Resources Supply Company	\$11,427,692
Furniture	Federal Resources Supply Company	\$10,939,173
Information Technology and Analytical Instruments	Federal Resources Supply Company	\$7,498,863
Business Services	Global Strategies Group (North America) Inc.	\$6,939,537

Sources: RESI, USA Spending

5.3.3 Eastern Shore—Long-Term Forecasts

Figure 37 shows the ten-year forecast of the regional economic impact of DoD funding for the region conducted by RESI using the REMI PI+ model. The analysis assumes funding levels stay at their five-year average, and are not adjusted for inflation.¹²⁹

¹²⁹ RESI also conducted forecasts assuming a 10 percent decrease and a 10 percent increase in average DoD Spending in Maryland, but these are not presented as they are roughly the same results but scaled up and down. Section 7 of "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape" presents detailed policy change analyses that are based on specific policy changes determined as likely through the SWOT analysis.

Figure 37: Forecasted Total Economic Impacts for All Defense Spending—Eastern Shore Region, 2017-2026

Year	Employment	Output	Wages
2017	1,339	\$144,970,347	\$37,333,767
2018	1,428	\$154,577,137	\$40,520,495
2019	1,423	\$156,673,910	\$41,755,639
2020	1,358	\$152,249,986	\$41,429,539
2021	1,277	\$145,754,245	\$40,597,161
2022	1,186	\$137,878,487	\$39,304,016
2023	1,098	\$129,886,665	\$37,933,124
2024	1,016	\$122,279,902	\$36,610,276
2025	944	\$115,462,734	\$35,460,278
2026	883	\$110,018,693	\$34,648,248

Sources: REMI PI+, RESI

The total impact on private non-farm jobs in the Eastern Shore region will peak in 2018 at an employment level of approximately 1,400, and will fall to its lowest level in 2026, with less than 900 individuals employed. Output will peak in 2019 at approximately \$157 million, and be at its lowest level of \$110 million in 2026. Total wages resulting from defense spending on the Eastern Shore will peak in 2019 at a level of approximately \$41 million, and be at its lowest level of \$35 million in 2026. As spending occurs further in the future, the same amount of money effectively purchases less, as wage rates and prices increase. Notice that predicted wages remain relatively stable, but the number of those employed declines. Output follows a similar pattern to employment, because over time the same amount of money spent will have a lower purchasing power for inputs, and with wages predicted to remain level, this means that output will fall.

5.4 Southern Maryland Overview

Southern Maryland is composed of Calvert, Charles, and St. Mary's Counties. It is the second-smallest region by workforce based on the CBP data, with an estimated 89,000 jobs in 2014 and an annual wage of over \$49,000. The region's largest employment cluster is Business Services, which employs approximately 15,000 individuals and pays an average wage in the region of over \$78,000 per year. The region benefits from an annual average of more than \$1.9 billion in DoD funding. Within the state, this region is known as being heavily dependent on DoD funding.¹³⁰

¹³⁰ C. Scott Dempwolf et al., "St. Mary's County, Maryland Comprehensive Economic Development Study and Proposed Strategy (CEDS)," University of Maryland, College Park, U.S. Economic Development Administration (Revised May 2016): 10, accessed January 19, 2017, <http://www.co.saint-marys.md.us/docs/UMD%20Recommended%20CEDS.pdf>.

The next subsections are organized as follows: Section 5.4.1 provides an overview of the top industry clusters present in the region by employment, wages, and location quotients; Section 5.4.2 details the top industry clusters in the region by annual DoD funding; and Section 5.4.3 presents the long-term forecast for the Southern Maryland region.

5.4.1 Southern Maryland—Overall Top Clusters

This section provides an overview of the industry clusters for Southern Maryland, utilizing the cluster definitions given by Delgado, Porter, and Stern, to provide the proper context to understand DoD spending impacts in the region. The construction of the clusters is based on the Delgado, Porter, and Stern definitions using 2014 CBP data. Wage estimates were made using 2015 OES data.

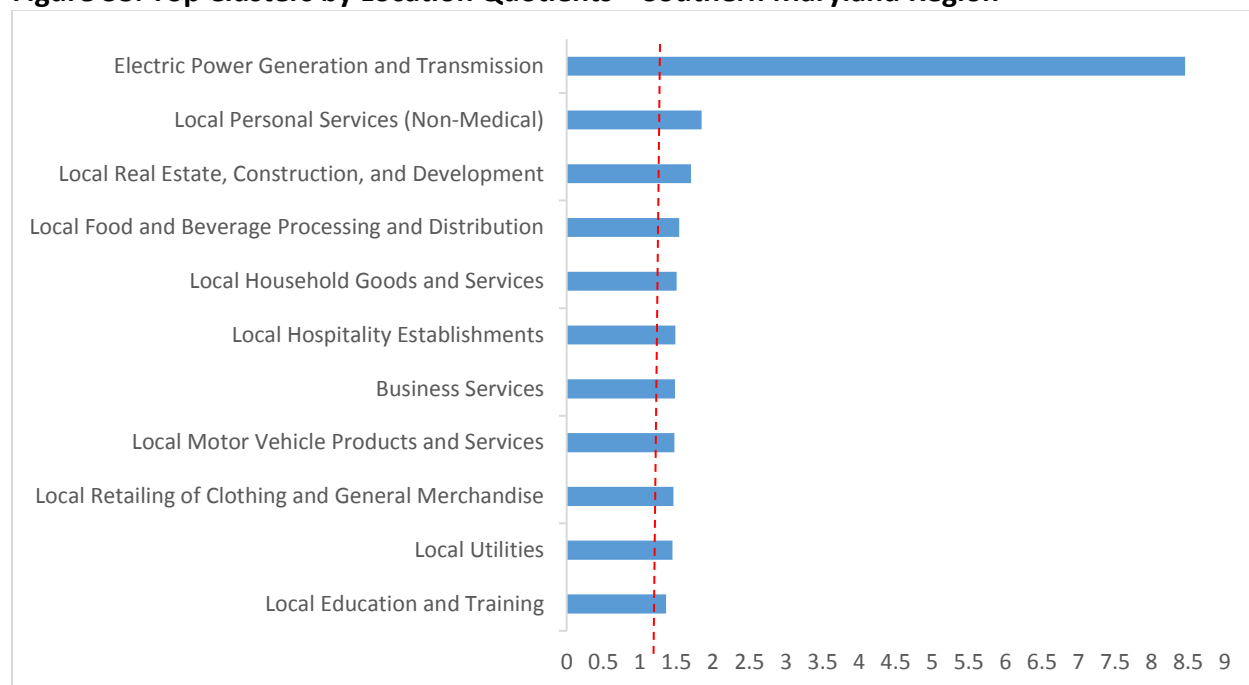
The Business Services cluster is the largest cluster by employment in Southern Maryland and employs approximately 15,100 individuals at an average wage of \$78,107. The second-largest cluster in the region is Local Health Services which employs approximately 13,000 people, and pays an average wage of \$56,049. The third-largest cluster, is the Local Hospitality Establishments cluster, which employs approximately 11,800 individuals at an average wage of \$24,072.

The Aerospace Vehicles and Defense cluster is the highest-paying cluster in the region, employing an estimated 107 individuals at an average wage of \$85,309. The second-highest paying cluster in the region is Education and Knowledge Creation, which employs an estimated 1,419 people, and pays an average wage of approximately \$81,056. The Business Services cluster employs approximately 15,089 Marylanders at an average wage of \$78,107, ranking it as the third-highest cluster by earnings in the region.

Figure 38 shows that Southern Maryland has 11 industry clusters with location quotients over 1.25. The Electric Power Generation and Transmission cluster has the highest location quotient for the region with a value of 8.46. The magnitude of this location quotient can be explained by the presence of Calvert Cliffs Nuclear Power Plant, which accounted for 40 percent of Maryland's electricity generation in 2015.¹³¹

¹³¹ "Maryland State Profile and Energy Estimates," U.S. Energy Information Administration, accessed October 17, 2016, <http://www.eia.gov/state/?sid=MD>.

Figure 38: Top Clusters by Location Quotients—Southern Maryland Region



Sources: Delgado, Porter, and Stern; RESI; U.S. Census

Southern Maryland benefits greatly from military spending. Besides the DoD funding levels that are analyzed in this report, the region benefits from U.S. Navy military bases.¹³² One likely reason for the strength in the local clusters in the region is due to the number of government employees who are employed in the area in relation to the relatively small number of the overall workforce. As a result, the local clusters are larger than would otherwise be supported, because the local industries are effectively exporting these services to the rest of the country through the disproportionate number of government employees.

5.4.2 Southern Maryland—DoD Spending in Top Clusters

The DoD spent an average of \$1.94 billion per year between 2011 and 2015 for vendors based in or performing work in the Southern Maryland region. The allocation of DoD spending across the top-funded clusters in the region can be found in Figure 39.

¹³² C. Scott Dempwolf et al., “St. Mary’s County, Maryland Comprehensive Economic Development Study and Proposed Strategy (CEDS),” 21-22.

Figure 39: Estimated Jobs, Average Wage, and Employment Impacts in the Top Clusters by DoD Spending— Southern Maryland Region¹³³

Cluster Name	Regional Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Business Services	15,089	\$78,107	\$1,352,852,319	4,824
Transportation and Logistics	413	\$49,046	\$171,556,232	974
Local Real Estate, Construction, and Development	10,733	\$49,757	\$89,871,809	503
Aerospace Vehicles and Defense	107	\$85,309	\$79,666,649	260
Communications Equipment and Services	189	\$71,246	\$65,191,487	255
Education and Knowledge Creation	1,419	\$81,056	\$51,880,144	178
Local Utilities	1,492	\$65,550	\$21,252,455	90
Information Technology and Analytical Instruments	16	\$86,074	\$18,567,286	60
Local Commercial Services	2,922	\$51,765	\$13,957,844	75
Local Household Goods and Services	1,641	\$33,738	\$13,748,242	113
Subtotal	34,021	\$76,820	\$1,878,544,467.00	7,332
Regional Total	86,273	\$48,508	\$1,942,834,383	7,664

Sources: BLS OES, REMI, RESI, U.S. Census CBP

¹³³ This estimated employment supported by DoD funding by cluster (in the fifth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for a more detailed methodology.

As shown in Figure 39, Business Services was the largest cluster by both estimated employment and funding for the Southern Maryland region, having an average of \$1.35 billion in annual DoD spending between 2011 and 2015. RESI estimates that this funding resulted in approximately 4,800 total jobs (direct, indirect, and induced) in Southern Maryland. Further, RESI estimates that this cluster employed approximately 15,100 individuals with an estimated average wage of \$78,107. The second-largest cluster by obligating funding was Transportation and Logistics, which had average annual DoD spending of approximately \$171 million. This cluster had an estimated 400 workers earning an annual average wage of \$49,046. The Local Real Estate, Construction, and Development cluster was third-largest cluster for Southern Maryland, with an average DoD funding of \$89 million annually. RESI estimates that the cluster employed approximately 10,700 individuals at an average wage of \$49,757. The subtotal row shows the total numbers for the top ten clusters by DoD spending shown in Figure 39, and the regional total row shows the overall totals for all clusters receiving DoD funding in the Southern Maryland region. Details on the clusters receiving DoD funding can be found in Appendix E.

Focusing on the top cluster by average DoD allocations in the Southern Maryland region, Figure 40 provides employment and wage estimates by major occupational category for the Business Services cluster. RESI estimates that the average wage for all occupational categories within this cluster was \$78,107 in 2015.

Figure 40: Employment and Wage Data by Occupational Category for the Business Services Cluster—Southern Maryland Region

SOC	Occupational Category	Regional Job Estimate, 2014	Average Wage, 2015
11-0000	Management Occupations	1,302	\$143,490
13-0000	Business and Financial Operations Occupations	1,724	\$82,532
15-0000	Computer and Mathematical Occupations	4,023	\$89,643
17-0000	Architecture and Engineering Occupations	3,191	\$78,613
19-0000	Life, Physical, and Social Science Occupations	721	\$64,852
21-0000	Community and Social Service Occupations	37	\$41,903
23-0000	Legal Occupations	34	\$129,748
25-0000	Education, Training, and Library Occupations	21	\$53,926
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	177	\$67,079
29-0000	Healthcare Practitioners and Technical Occupations	86	\$61,396
31-0000	Healthcare Support Occupations	10	\$30,993
33-0000	Protective Service Occupations	393	\$35,476
35-0000	Food Preparation and Serving Related Occupations	52	\$26,372
37-0000	Building and Grounds Cleaning and Maintenance Occupations	423	\$25,145
39-0000	Personal Care and Service Occupations	5	\$28,069
41-0000	Sales and Related Occupations	436	\$80,914
43-0000	Office and Administrative Support Occupations	1,632	\$40,851
45-0000	Farming, Fishing, and Forestry Occupations	2	\$32,531
47-0000	Construction and Extraction Occupations	238	\$56,314
49-0000	Installation, Maintenance, and Repair Occupations	280	\$49,210
51-0000	Production Occupations	118	\$42,717
53-0000	Transportation and Material Moving Occupations	184	\$34,228
Total		15,089	\$78,107

Sources: BLS OES, RESI, U.S. Census CBP

The Computer and Mathematical Occupations category had the largest number of workers employed in the Southern Maryland region, with over 4,000 individuals employed at an average wage of \$89,643. The second-largest occupational category by employment was in Architecture and Engineering Occupations, which employed approximately 3,200 workers receiving an average annual wage of over \$78,613. Business and Financial Operations Occupations had the third-highest employment by occupational category, employing approximately 1,700 workers earning an average annual wage of \$82,532.

Using the information from Figure 39 and Figure 40 informs how a cut in DoD funding to the Business Services cluster would impact employment in Southern Maryland. A 10 percent cut in DoD funding to the cluster, would result in approximately 481 fewer direct, indirect, and induced jobs in the region. Of the total jobs lost, approximately 275 would be direct jobs in the Business Services cluster. For these calculations, RESI used the direct employment values by occupational category, from Appendix H. Computer and Mathematical Occupations would be expected to especially be hit hard in this scenario, as these professions account for 26.7 percent of the total jobs in the cluster in this region.¹³⁴ RESI estimates that approximately 73 jobs would be lost in this occupation in this cluster, which would result in a loss of approximately \$6.6 million in wages in the region. The Architecture and Engineering Occupations account for 21.2 percent of the jobs in the cluster, and would lose approximately 58 jobs, resulting in approximately \$4.6 million in lost wages. The third-largest loss of jobs would occur in the Business and Financial Operations Occupations. This occupational category accounted for 11.4 percent of the jobs in the cluster, and would lose approximately 31 jobs, resulting in approximately \$2.6 million in lost wages in the state. Interestingly, the Southern Maryland Business Services cluster employs more architecture and engineering occupations than the other regions of Maryland.

Figure 41 shows the top company for each of the ten highest-funded clusters, based on DoD awards to individual vendors. Adams Communication & Engineering Technology was the largest vendor by DoD spending at the cluster level in Southern Maryland, with nearly \$113 million in annual average DoD funding obligations for the Business Services cluster. Dyncorp International was ranked second, receiving over \$95 million in funding from contracts classified under the Transportation and Logistics cluster. Neany, Inc. received the third- and fourth-highest funding obligations in Southern Maryland. This company received nearly \$70 million in average annual funding obligations for the Communications Equipment and Services cluster and over \$31 million for the Local Household Goods and Services cluster. For all of the top vendors by cluster based on DoD awards, see Appendix F.

¹³⁴ Note that occupational compositions vary at the six-digit NAICS. Since there are differing mixes of industries at the six-digit NAICS code level at the state and regional levels, there are different occupational proportions in different regions.

Figure 41: Highest-Funded Company per Top-Funded Clusters —Southern Maryland Region

Cluster	Company Name	Annual Average Dollars Obligated, 2011-2015
Business Services	Adams Communication & Engineering Technology, Inc.	\$112,753,173
Transportation and Logistics	Dyncorp International LLC	\$95,311,156
Communications Equipment and Services	Neany, Inc	\$69,791,072
Local Household Goods and Services	Neany, Inc	\$31,088,426
Marketing, Design, and Publishing	Engility Corporation	\$26,195,279
Aerospace Vehicles and Defense	The Boeing Company	\$22,262,918
Local Real Estate, Construction, and Development	Sheffield Korte Joint Venture	\$21,427,802
Oil and Gas Production and Transportation	Airtec, Inc.	\$17,430,278
Education and Knowledge Creation	Pae Applied Technologies LLC	\$13,267,918
Local Utilities	General Dynamics Information Technology, Inc.	\$11,544,091

Sources: RESI, USA Spending

Southern Maryland is more dependent on DoD spending than the other regions in the state, as the \$1.9 billion of DoD funding produces the largest amount of jobs compared to the total in the region. The area is particularly dependent on the DoD spending in the Business Services cluster; more than the Central and Capital regions, which also had Business Services as the highest-funded regional cluster. Approximately 69.6 percent of DoD spending in the region is allocated to the Business Services cluster, versus 26.6 percent and 48.9 percent for the Central and Capital regions, respectively.

5.4.3 Southern Maryland—Long-Term Forecast

Using REMI PI+, Figure 42 shows the ten-year forecast for the impacts of the defense industry for Southern Maryland. The analysis assumes funding levels stay at their five-year average, and are not adjusted for inflation.¹³⁵ The total impact on private non-farm jobs in the region will peak in 2019 at an employment level of approximately 8,500, and will fall to its lowest level in 2026, at 6,400 individuals employed. Output will peak in 2019 at approximately \$976 million,

¹³⁵ RESI also conducted forecasts assuming a 10 percent decrease and a 10 percent increase in average DoD Spending in Maryland, but these are not presented as they are roughly the same results but scaled up and down. Section 7 of "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape" presents detailed policy change analyses that are based on specific policy changes determined as likely through the SWOT analysis.

and be at its lowest level of \$816 million in 2026. Total wages resulting from defense spending in Southern Maryland will peak in 2021 at a level of approximately \$404 million, and be at its lowest level of \$373 million in 2017. As spending occurs further in the future, the same amount of money effectively purchases less, as wage rates increase. Notice that predicted wages remain relatively stable, but the number of those employed declines. Output follows a similar pattern to employment, because over time the same amount of money spent will have a lower purchasing power for inputs, and with wages predicted to remain level, this means that output will fall.

Figure 42: Forecasted Total Economic Impacts for All Defense Spending—Southern Maryland Region, 2017-2026

Year	Employment	Output	Wages
2017	8,138	\$923,442,341	\$372,537,159
2018	8,508	\$961,552,104	\$389,599,611
2019	8,514	\$975,722,601	\$398,718,756
2020	8,335	\$970,035,416	\$403,272,918
2021	8,042	\$951,675,915	\$404,207,423
2022	7,696	\$926,377,068	\$402,755,485
2023	7,344	\$898,563,379	\$400,651,940
2024	7,004	\$870,038,528	\$398,509,915
2025	6,684	\$842,108,313	\$396,595,379
2026	6,378	\$816,214,338	\$394,798,480

Sources: REMI PI+, RESI

5.5 Western Maryland Overview

Western Maryland is composed of Allegany, Garrett, and Washington Counties. This region has an estimated 102,000 jobs and an estimated annual wage of \$47,662. Western Maryland's largest employment cluster is Local Health Services, which employs 17,000 individuals and has an average wage of nearly \$54,000 per year in the region. The region receives the lowest amount of defense spending in the state, averaging approximately \$77.4 million annually.

The next subsections are organized as follows: Section 5.5.1 provides an overview of the top industry clusters present in the region by employment, wages, and location quotients; Section 5.5.2 details the top industry clusters in the region by annual DoD funding; and Section 5.5.3 presents the long-term forecast for the Western Maryland region.

5.5.1 Western Maryland—Overall Top Clusters

This section provides an overview of the industry clusters for Western Maryland, utilizing the cluster definitions given by Delgado, Porter, and Stern. Focusing on the employment numbers per cluster, RESI constructed a ranking of industry clusters in the Western Maryland region. The

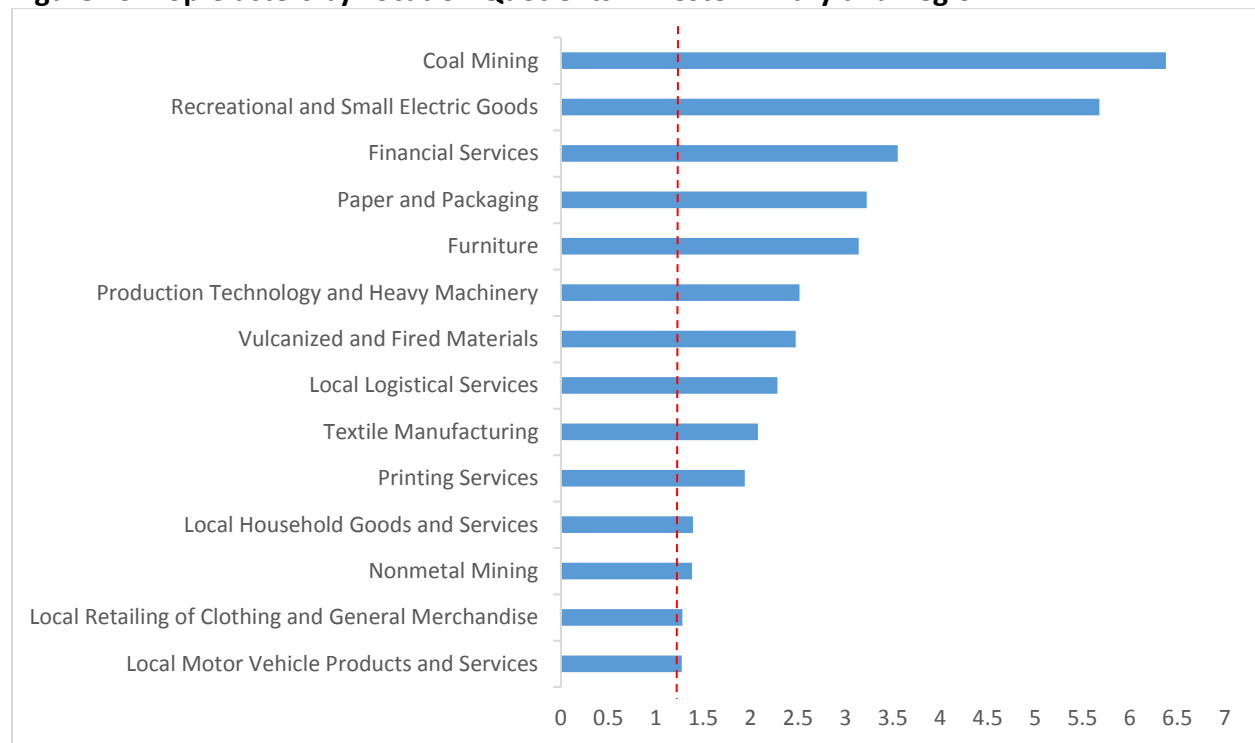
construction of the clusters is based on the Delgado, Porter, and Stern definitions using 2014 CBP data. Wage estimates were made using 2015 OES data.

Local Health Services is the top cluster, by employment, in the region and employs an estimated 17,007 people at an average wage of \$53,938. The second-largest cluster in the region is Local Hospitality Establishments, which employs nearly 9,600 people at an average wage of \$24,271. This cluster is followed by the Local Real Estate, Construction, and Development cluster, at an estimated employment of 7,400 individuals with an average wage of \$48,512.

The Information Technology and Analytical Instruments cluster is the highest-paying cluster in the region, employing nearly 800 individuals at an average wage of approximately \$95,013. The second-highest paying cluster in Western Maryland is the Business Services cluster, which employs over 5,300 people and pays an estimated average wage of \$78,478. The Communications Equipment and Services cluster employs an estimated 182 individuals at an average wage of \$72,230, making it the third-highest cluster by earnings in the region.

In addition to ranking clusters by estimated employment and average wage, RESI evaluated the export potential of clusters in the region using location quotients. Figure 43 shows that Western Maryland has 14 industry clusters with location quotients over 1.25.

Figure 43: Top Clusters by Location Quotients—Western Maryland Region



Sources: Delgado, Porter, and Stern; RESI, U.S. Census

The Coal Mining cluster is most concentrated industry in the Western Maryland region, having the highest location quotient of 6.38. This highlights the comparative advantage the region has from an abundance of natural resources in the coal and non-metal mining industries. While RESI estimates that coal mining employed only 468 people in the region in 2014, this represents a significantly higher proportion than the national average. The coal industry is declining on the national level, yet as of 2014, it was still a significant economic contributor in the Western Maryland region. The area has clusters that are manufacturing-focused, including Textile Manufacturing and Furniture, and tend to be low-wage positions. The evidence indicates that DoD spending is not a strong indicator for regional employment patterns in Western Maryland.

5.5.2 Western Maryland—DoD Spending in Top Clusters

The DoD spends an average of \$77 million per year for vendors based in or performing work in Western Maryland. Of the five Maryland regions, Western Maryland received the lowest average DoD funding between 2011 to 2015. Similar to the DoD funding allocated to the Eastern Shore region, this relatively low amount of funding can be an advantage to the region by forcing other sources of spending to diversify the regions' funding portfolio, making the region more resistant to potential economic shocks such as a reduction in DoD funding. The allocation of DoD spending across the top-funded clusters in the Western Maryland can be found in Figure 44.

Figure 44: Estimated Jobs, Average Wage, and Employment Impacts in the Top Clusters by DoD Spending—Western Maryland Region^{136,137}

Cluster Name	Regional Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Local Commercial Services	5,668	\$52,743	\$25,187,985	262
Business Services	5,340	\$78,478	\$18,801,435	131
Education and Knowledge Creation	193	\$67,707	\$13,499,036	109
Recreational and Small Electric Goods	501	\$43,850	\$4,068,317	51
Apparel	88	\$41,253	\$4,022,570	53
Downstream Metal Products	289	\$53,582	\$2,850,041	29
Local Real Estate, Construction, and Development	7,401	\$48,512	\$1,124,574	13
Distribution and Electronic Commerce	4,396	\$46,827	\$969,943	11
Local Household Goods and Services	1,840	\$32,579	\$862,574	15
Local Industrial Products and Services	350	\$45,409	\$848,057	10
Subtotal	26,066	\$54,205	\$72,234,532.00	684
Regional Total	67,860	\$44,270	\$77,359,941	736

Sources: BLS OES, REMI, RESI, U.S. Census CBP

As shown above, Local Commercial Services was the largest cluster by funding for the Western Maryland region, having an average of \$25 million in annual DoD spending between 2011 and 2015. RESI estimates that this funding resulted in approximately 262 total jobs (direct, indirect, and induced) in Western Maryland. RESI estimates that this cluster employed an average of approximately 5,700 individuals with an estimated wage of \$52,743. The second-largest cluster by obligating funding was Business Services, which had average annual DoD spending of approximately \$18 million. This cluster had an estimated 5,300 workers earning an annual

¹³⁶ Spending figures for 2011-2015, employment and wage figures from 2014.

¹³⁷ This estimated employment supported by DoD funding by cluster (in the fifth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for a more detailed methodology.

average wage of \$78,478. Education and Knowledge Creation was the third-largest cluster for Western Maryland, having an average funding obligation of \$13 million between 2011 and 2015. RESI estimates that this cluster employed approximately 200 individuals at an average wage of \$67,707. The subtotal row shows the total numbers for the top ten clusters by DoD spending shown in Figure 44, and the regional total row shows the overall totals for all clusters receiving DoD funding in the Southern Maryland region. Details on the clusters receiving DoD funding can be found in Appendix E.

Focusing on the top cluster by average DoD allocations in the Western Maryland region, Figure 45 provides employment and wage estimates by major occupational category for the Local Commercial Services cluster. RESI estimates that the average wage for all occupational categories within this cluster was \$52,743 between 2011 and 2015.

The Office and Administrative Support Occupations category had the largest number of workers employed in the Western Maryland region with approximately 1,500 individuals employed at an average wage of approximately \$36,718. The second-largest occupational category by employment was Installation, Maintenance, and Repair Occupation, which employed approximately 700 individuals receiving an annual wage of approximately \$46,344. Business and Financial Operations Occupations was the third-highest occupational category by employment, with approximately 600 workers in Western Maryland earning an average annual wage of approximately \$72,484 between 2011 and 2015.

Figure 45: Employment and Wage Data by Occupational Category for the Local Commercial Services Cluster—Western Maryland Region

SOC	Occupational Category	Regional Job Estimate, 2014	Average Wage, 2015
11-0000	Management Occupations	390	\$122,679
13-0000	Business and Financial Operations Occupations	634	\$72,484
15-0000	Computer and Mathematical Occupations	253	\$78,813
17-0000	Architecture and Engineering Occupations	114	\$80,662
19-0000	Life, Physical, and Social Science Occupations	20	\$61,593
21-0000	Community and Social Service Occupations	2	\$47,011
23-0000	Legal Occupations	235	\$106,048
25-0000	Education, Training, and Library Occupations	15	\$35,434
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	27	\$56,535
29-0000	Healthcare Practitioners and Technical Occupations	77	\$59,945
31-0000	Healthcare Support Occupations	26	\$31,494
33-0000	Protective Service Occupations	266	\$27,943
35-0000	Food Preparation and Serving Related Occupations	14	\$23,388
37-0000	Building and Grounds Cleaning and Maintenance Occupations	456	\$26,466
39-0000	Personal Care and Service Occupations	12	\$24,061
41-0000	Sales and Related Occupations	390	\$41,249
43-0000	Office and Administrative Support Occupations	1,465	\$36,718
45-0000	Farming, Fishing, and Forestry Occupations	1	\$27,686
47-0000	Construction and Extraction Occupations	82	\$46,306
49-0000	Installation, Maintenance, and Repair Occupations	733	\$46,344
51-0000	Production Occupations	214	\$34,306
53-0000	Transportation and Material Moving Occupations	242	\$29,363
All Occupations		5,668	\$52,743

Sources: BLS OES, RESI, U.S. Census CBP

Figure 44 shows Western Maryland's dependence on DoD funding is relatively small, and similar to the Eastern Shore. Using information from Figure 45 in conjunction with information from Figure 44, RESI estimates a ten percent cut to the Local Commercial Services in the region would result in approximately 26 fewer direct, indirect, and induced jobs in the region. Of the total jobs lost, approximately seven would be direct jobs in the Local Commercial Services cluster. Office and Administrative Support Occupations employs approximately 25.8 percent of the total jobs in the cluster in this region, and would be expected to lose approximately two jobs in this occupation in this cluster, resulting in a loss of approximately \$69,064 in wages in the region. The Installation, Maintenance, and Repair Occupations account for 12.9 percent of

the jobs in the cluster, and would lose approximately one job, resulting in approximately \$43,610 in lost wages. The third-largest loss of jobs would occur in the Business and Financial Operations Occupations. This occupation category accounted for 11.2 percent of the jobs in the cluster, and would lose approximately one job, resulting in approximately \$59,011 in lost wages in Western Maryland. For these calculations, RESI used the direct employment values by occupational category, from Appendix F.

Figure 46 shows the top company for each cluster based on DoD funding to individual vendors at the cluster level.¹³⁸ Aaski Technology was the largest vendor by awards at the cluster level for Western Maryland, receiving approximately \$47.5 million in annual average DoD funding obligations. Quantell had the second-highest level of funding for an individual vendor, receiving nearly \$22 million in annual average DoD funding obligations for the Local Commercial Services cluster. Netconn Solutions was ranked third, receiving over \$17 million in annual average DoD funding obligations for the Education and Knowledge Creation cluster. Garrett Container Systems was the largest vendor for five of the top ten clusters: Recreational and Small Electric Goods, Apparel, Downstream Metal Products, Medical Devices, and Local Industrial Products and Services. For all of the top vendors by cluster based on DoD awards, see Appendix F.

¹³⁸ For display purposes, only the top ten are displayed here. See Appendix F for the top vendor in each cluster by DoD funding obligations.

Figure 46: Highest-Funded Company per Top-Funded Clusters —Western Maryland Region

Cluster	Company Name	Annual Average Dollars Obligated, 2011-2015
Business Services	Aaski Technology Inc	\$47,533,000
Local Commercial Services	Quantell, Inc.	\$21,981,115
Education and Knowledge Creation	Netconn Solutions	\$17,485,221
Aerospace Vehicles and Defense	Sierra Nevada Corporation	\$14,258,590
Recreational and Small Electric Goods	Garrett Container Systems, Inc.	\$4,043,413
Apparel	Garrett Container Systems, Inc.	\$3,985,997
Distribution and Electronic Commerce	Epic Aviation, LLC	\$3,505,187
Downstream Metal Products	Garrett Container Systems, Inc.	\$2,528,681
Medical Devices	Garrett Container Systems, Inc.	\$1,272,538
Local Industrial Products and Services	Garrett Container Systems, Inc.	\$961,622

Sources: RESI, USA Spending

It was asserted earlier in this section that receiving less DoD funding than other regions in the state may be an advantage to funding portfolio diversification. While there is less funding coming into this region, as shown in the data provided in Figure 46, certain vendors such as Garrett Container Systems Inc. are reliant on this funding. The vendor's impact spans several clusters, highlighting that this vendor would be a prime target for diversification outreach efforts. The vendor is engaged in a number of clusters across the region. Assuming a local supply chain, the vendor is embedded within the region albeit with a steady stream of funding from the DoD over time. Developing creative, non-DoD uses or funding solutions for the products created by this vendor could be pivotal in preparing this region for fluctuations in DoD funding.

5.5.3 Western Maryland—Long-Term Forecast

Using the REMI PI+ model, RESI forecasted the impacts of DoD funding on Western Maryland over the next ten years. Figure 47 shows the results of the ten-year forecast focusing on the impact on jobs, output, and wages. These calculations assume funding levels stay at their five-year average, and are not adjusted for inflation.¹³⁹

¹³⁹ RESI also conducted forecasts assuming a 10 percent decrease and a 10 percent increase in average DoD Spending in Maryland, but these are not presented as they are roughly the same results but scaled up and down. Section 7 of "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape" presents detailed policy change analyses that are based on specific policy changes determined as likely through the SWOT analysis.

Figure 47: Forecasted Total Economic Impacts for all Defense Spending—Western Maryland Region, 2017-2026

Year	Employment	Output	Wages
2017	824	\$81,185,087	\$23,565,532
2018	859	\$85,456,056	\$25,185,586
2019	852	\$86,425,518	\$25,881,237
2020	821	\$84,312,964	\$25,818,960
2021	778	\$80,858,988	\$25,372,013
2022	731	\$76,584,614	\$24,636,404
2023	684	\$72,238,166	\$23,856,449
2024	641	\$68,062,528	\$23,094,602
2025	601	\$64,167,311	\$22,385,521
2026	566	\$60,958,060	\$21,853,841

Sources: REMI PI+, RESI

The total impact on private non-farm jobs in the Western Maryland region will peak in 2018 at an employment level of approximately 900, and will fall to its lowest level in 2026, with less than 600 individuals employed. Output will peak in 2019 at approximately \$86 million, and be at its lowest level of \$60 million in 2026. Total wages resulting from defense spending in Western Maryland will peak in 2019 at a level of approximately \$26 million, and be at its lowest level of \$22 million in 2026. As spending occurs further in the future, the same amount of money effectively purchases less, as wage rates increase. Notice that predicted wages remain relatively stable, but the number of those employed declines. Output follows a similar pattern to employment, because over time the same amount of money spent will have a lower purchasing power for inputs, and with wages predicted to remain level, this means that output will fall.

5.6 Regional Summary

As noted in the introduction to this section, Maryland's regional economies are diverse in terms of rural and urban populations, and this is largely reflected in the number of jobs estimated to be located in each region. The Eastern Shore, Southern Maryland, and Western Maryland regions are the more rural areas of the state, while the Capital and Central regions are more urban. Figure 48 shows the large disparity in the number of jobs, which is related to overall population, and population density, between the Capital and Central regions and the rest of the state.

Figure 48: Total Jobs and Average Wages by Region¹⁴⁰

Region	Regional Job Estimate, 2014	Regional Average Wage, 2015
Capital	875,165	\$54,199
Central	1,214,807	\$52,630
Eastern Shore	146,615	\$45,157
Southern Maryland	89,020	\$49,017
Western Maryland	102,308	\$47,662
Total	2,427,915	\$52,402

Sources: RESI, U.S. Census CBP

Collectively, the Capital and Central regions support over 2 million of the overall 2.4 million jobs assigned at the regional level.¹⁴¹ Additionally, the more densely populated Capital and Central regions have the two-highest average wages of \$54,200 and \$52,630, respectively, which increases the average state wage for Maryland.¹⁴² The Eastern Shore and Western Maryland regions are the two-lowest paid areas of the state, with average annual wages of \$45,157 and \$47,662, respectively. In general, this aligns with the pattern that rural areas tend to have a lower cost of living and lower wages than urban areas. The Southern Maryland region has the lowest number of jobs in the state, at an estimated 89,020, and falls between the two extremes in terms of wages, with annual average earnings in the region of \$49,017. Southern Maryland is rural, yet still has a close proximity to Washington, D.C. which gives the area a geographic competitive advantage, resulting in a higher average wage than other rural areas in the state.

Figure 49 shows the distribution of the annual DoD funding obligations from 2011-2015 by region. In addition to having the highest number of jobs and wages in the state, the Central and Capital regions receive the vast majority of Maryland's DoD funding obligations, at an average of over \$15.5 billion annually between 2011 and 2015. During this time, the majority of the remaining funding went to Southern Maryland, which received an annual average of nearly \$2 billion. The Eastern Shore and Western Maryland regions received relatively low amounts of annual DoD Spending, averaging approximately \$174 million and over \$77 million, respectively, between 2011 and 2015.

¹⁴⁰ Note that due to data suppression that occurs at the county level the totals for the regions does not add up to the total for the state, and the state average salary is higher due to inclusion of data for the state that is assigned to the "999" county code for privacy purposes.

¹⁴¹ Note that due to data suppression that occurs at the county level the totals for the regions does not add up to the total for the state, and the state average salary is higher due to inclusion of data for the state that is assigned to the "999" county code for privacy purposes.

¹⁴² RESI estimated state-level average annual wages using CBP employment estimates and OES wage data from CBP county-level data. See Appendix A for more details.

Figure 49: Average Annual DoD Funding Obligations and Overall Employment Impact

Region	Average Annual Dollars Obligated, 2011-2015	Estimated Employment Impact	Percent Jobs DoD Dependent
Capital	\$7,685,333,309	40,324	4.85%
Central	\$8,082,350,494	51,344	4.32%
Eastern Shore	\$173,764,748	1,195	0.90%
Southern Maryland	\$1,942,834,383	7,664	8.88%
Western Maryland	\$77,359,941	736	1.08%
Maryland Total	\$17,961,642,875	101,263	4.39%

Sources: RESI, REMI, USA Spending

To show the relative dependency of each region on DoD funding, RESI calculated the percentage of jobs that are DoD dependent for each region.¹⁴³ This analysis found that Southern Maryland is the most dependent on funding, while the Eastern Shore and Western Maryland are the least dependent. Proportionally, the Southern Maryland region receives the largest share of DoD spending obligations in terms of funding-to-jobs ratio. Due to this reliance on DoD funding to support jobs, the Southern Maryland region would be most affected by a reduction in DoD funding and less likely to rebound from fluctuations in DoD funding.

DoD spending is primarily concentrated in three regions of the state: Capital, Central, and Southern Maryland, as shown above in Figure 49. Figure 50 highlights the top cluster for each region of the state by DoD funding levels. In all of the regions, the top cluster by funding also has an annual wage greater than the average for the entire state (approximately \$52,402 annually in 2015).¹⁴⁴ The Business Services cluster receives the largest level of DoD funding, both in the state and in the three regions receiving the most DoD funding. This cluster receives more than \$3.7 billion in average annual funding in the Capital region and employs over 155,000 people. In the Central region, the Business Services cluster receives over \$2.1 billion in the Central region and employs more than 166,000 people. In Southern Maryland, this cluster receives over \$1.3 billion and employs over 15,000 people. The top cluster for Western Maryland was the Local Commercial Services cluster, which received over \$25 million in funding obligations, and employed an estimated 5,668 individuals. The Eastern Shore's top cluster by funding was Education and Knowledge Creation, which received nearly \$25 million annually in funding obligations, and employed nearly 2,000 people.

¹⁴³ Note that this ratio in this report uses the estimated employment impact from REMI outputs and the total number of jobs in a region as estimated by CBP data, described in the Methodology Section and Appendix A.

¹⁴⁴ RESI estimated state-level average annual wages using CBP employment estimates and OES wage data from CBP county-level data. See Appendix A for more details.

Figure 50: Average Annual Funding by Top Regional Cluster

Region	Cluster Name	Average Annual Dollars Obligated, 2011-2015	Regional Job Estimate, 2014	Estimated Average Wage, 2015
Capital	Business Services	\$3,764,580,776	155,491	\$80,110
Central	Business Services	\$2,153,631,370	166,779	\$79,025
Southern Maryland	Business Services	\$1,352,852,319	15,089	\$78,107
Western Maryland	Local Commercial Services	\$25,187,985	5,668	\$52,743
Eastern Shore	Education and Knowledge Creation	\$24,841,118	1,980	\$62,875

Sources: BLS OES; Delgado, Porter, and Stern; RESI; USA Spending; U.S. Census

RESI's impact analysis (using REMI PI+) indicates that DoD funding in the Capital region is predicted to support approximately 40,000 direct, indirect, and induced jobs annually over the next ten years. This amounts to 4.9 percent of the region's job base of more than 875,000 estimated private non-farm jobs in 2014. DoD funding for the Central region is predicted to support more than 51,000 direct, indirect, and induced jobs annually over the next ten years. This represents roughly 4.32 percent of the region's total employment of 1.2 million in 2014. In Southern Maryland, DoD funding is expected to support 7,600 direct, indirect, and induced jobs annually or approximately 8.88 percent of the region's total private non-farm job base of 89,000 in 2014. Again, these estimates assume current spending levels will be maintained and do not account for inflation.

6.0 Social Network Analysis

There are many connections (ties) between the different entities (nodes) that comprise Maryland's defense industry. Connections may represent patents, contracts, or research grants; entities include people, organizations, and agencies. By analyzing these connections for evidence of cooperation and collaboration, it is possible to understand the intellectual strengths present in the state and how people in these industries work together to innovate. Understanding both the skills of the workforce and the collaborative activity between industries is important when establishing any form of future diversification strategy for the state. In the workforce, individuals' skills may be highly transferrable, meaning that if an external shock occurs—such as a dramatic reduction in DoD funds—then the skills of the individual can be used in a different capacity, potentially in a different industry. It is equally important to understand the industry collaboration for a diversification strategy, as economic developers would then be aware of the linkages between industries. Therefore, if one industry suffers an external economic shock, then it will be clear that other related industries may indirectly

experience that shock due to the innovation linkages—e.g. grant funding, publications, patents—between the two industries.

This section will identify and analyze the social networks occurring in the state that are related to the defense industry. Through this section, the reader will gain insight on the activity occurring within network and industry clusters in Maryland. In this capacity, “activity” could represent patents, journal articles, grant funding, and contracts (i.e. connections) between a variety of institutions such as people, organizations, and agencies (i.e. nodes) for the purposes of innovation. The section will continue as follows:

- Section 6.1 provides guidance on the components used in the images throughout this section. It is imperative to review this section to get an understanding of the graphics depicted here.
- Section 6.2 presents the overall innovation network in Maryland, followed by a more detailed inspection of subnetworks to gain insight on the mechanisms of collaboration.¹⁴⁵
- Section 6.3 presents the research and contracts network, which allows for a better examination of how the innovation networks in Maryland relate to DoD and other government spending.
- Section 6.4 presents the “meta-network.” Here each subnetwork identified is reclassified as a node forming a new meta-network. With this reclassification, a node is no longer representing an individual organization or agency; rather, it is representing a whole network of organizations, agencies, and people.

6.1 Understanding the Innovation Network/Social Network Analysis Images

The networks throughout this section will show ties (i.e. connections) and nodes (i.e. institutions, agencies, companies, and people) in a variety of colors. The network legend is as follows:

- Nodes (Dots)
 - People – White or Transparent
 - Organizations – **Orange**
 - Institutions – **Yellow**
 - Agencies – **Maroon**
 - Places – **Blue**
- Ties (Lines)
 - Patents – **Purple**
 - Research Grants (NIH, NSF, NASA) – **Olive**
 - SBIR/STTR – **Fuchsia**
 - Federal Contracts – **Green**
 - Weak Ties – **Lime Green**

¹⁴⁵ For more on the SNA see Appendix A.3.

- Location Ties – **Blue**

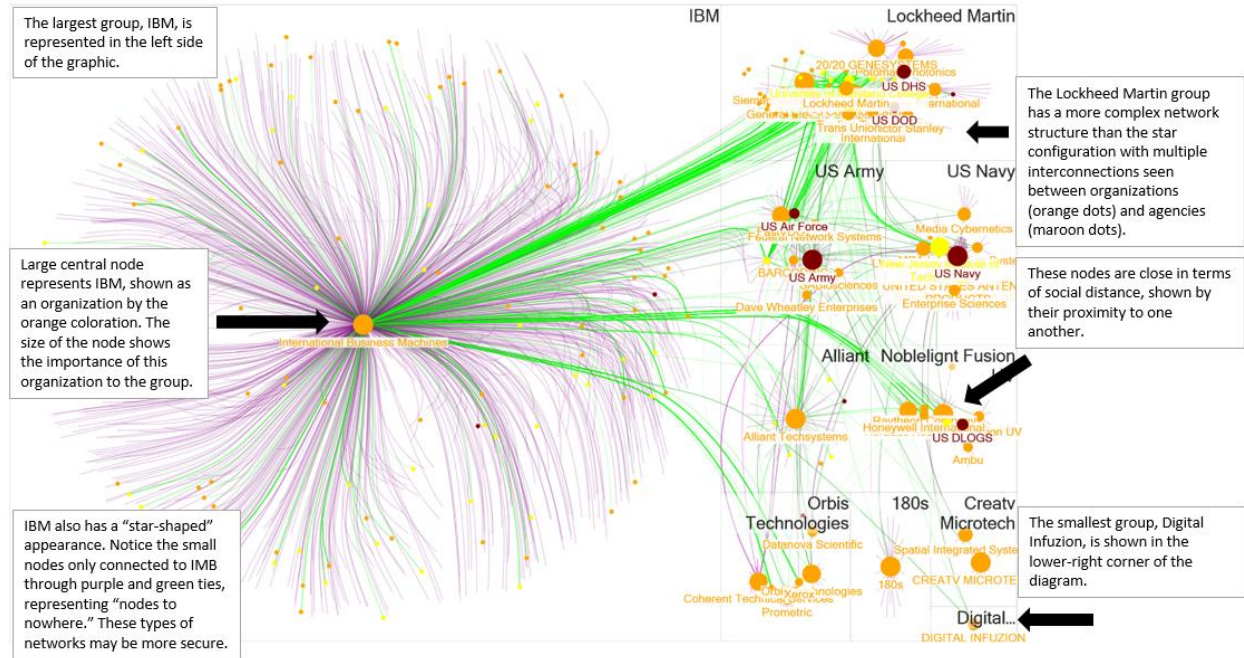
As a general guide to understanding the images in this section, four points will be addressed: the concept of social distance with the nodes, the centrality of the nodes, the arrangement of the nodes, and the layout of the images. In addition to the legend outlined above, reviewing and understanding each of these four points is crucial to comprehending the information provided in the proceeding section. First, nodes are arranged in layouts that reflect the number and types of interactions between them. Thus nodes that appear close to one another are close in terms of social distance. Social distance is often unrelated to spatial distance. For example, most people do not work with their next door neighbors—those closest in terms of spatial distance. In fact, many people work closely with others who live far away. That is, they have short social distances and long spatial distances.

Second, networks typically have a central node with the size of each node scaled to measure centrality. Therefore, the larger the node, the more central it is to the group. Third, some of the network groups are simple “star” networks with one central node surrounded by many other nodes that are connected only to the central node (i.e. nodes to nowhere). Other networks have more complex structures with multiple interconnections. Such networks are denser, meaning that they have a higher percentage of all possible ties. Denser, more connected networks tend to be more collaborative and more resilient since there are multiple paths connecting network nodes. Such characteristics are desirable in many situations. However, with some defense- or intelligence-related situations, other network structures—including star networks—may be more secure.

Fourth, in terms of the network layout in each image, the largest group is shown in the upper left corner, with groups decreasing in size to the smallest group in the lower right corner. Visualizing innovation ecosystems as whole networks in this way tends to reveal three main areas in the graph that correspond in a general way to the so-called “valley of death,” where most innovation ideas die due to lack of resources to move them forward.¹⁴⁶ These three main areas include the research component, the industry component, and the bridge component. The research component is comprised mostly of research institutions and related individuals—typically along the left and top edges of the graph. The industry component is comprised primarily of organizations and people engaged in private sector innovation—typically through the middle of the graph to the right and bottom edges of the graph. Lastly, the bridge component, which may include only a single group with agencies, organizations and people, is visualized along with many inter-group ties throughout the entire graph. As the name suggests, bridges span the valley of death between the research and industry components. To increase clarity, the sample diagram in Figure 51 below highlights some of the image characteristics.

¹⁴⁶ Declan Butler, “Translational Research: Crossing the Valley of Death,” *Nature* 453 (June 11, 2008): accessed November 1, 2016, <http://www.nature.com/news/2008/080611/full/453840a.html>.

Figure 51: Sample Network Diagram



Sources: RESI, Tertius Analytics

6.2 Overall Innovation Network Results for Maryland

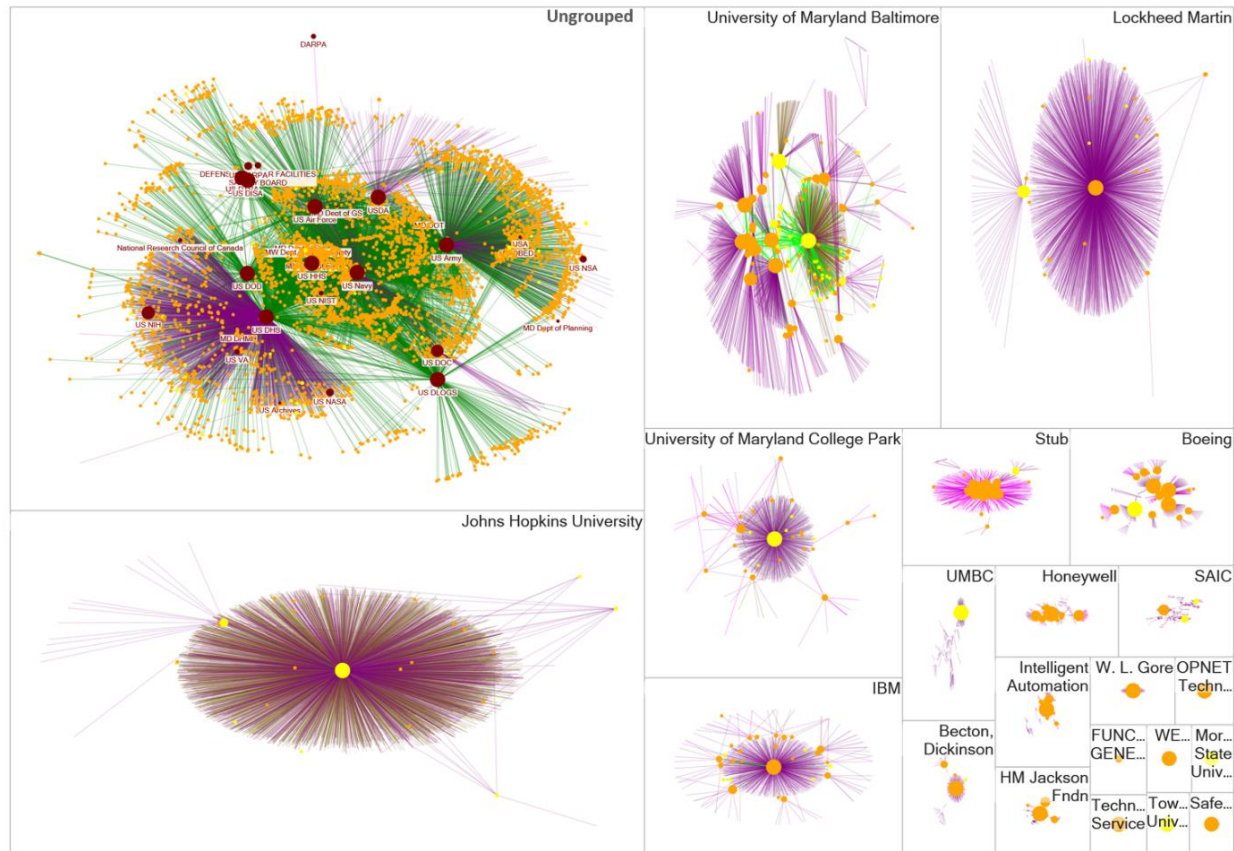
Prior to delving into individual networks focusing on specific types of nodes—such as military agencies or academic institutions—Tertius provides an overview of all of the interaction occurring between all nodes at the state level. Figure 52 and Figure 53 both show the full network of organizations, institutions, agencies, and individuals after grouping algorithms have been applied. Place nodes, nodes that contain information on location, have been excluded from this visualization since the focus here is on functionality rather than spatial relationships. Essentially, these initial figures are highlighting the innovation activity between nodes rather than their proximity to one another. To generate these images, Tertius Analytics used the Clauset-Newman-Moore community-finding (grouping) algorithm.¹⁴⁷

Figure 52 illustrates the network activity of key groups such as Lockheed Martin and Johns Hopkins University (JHU) in Maryland. As this illustration does not include inter-group ties, it focuses on these key actors' connections outside of the group, rather than the connections between the actors in the group. For example, Lockheed Martin and the University of Maryland

¹⁴⁷Aaron Clauset, M.E.J. Newman, and Christopher Moore, "Finding Community Structure in Very Large Networks," *Physical Review E* 70, no. 6 (2004): 1-6, accessed November 4, 2016, <http://eccc-research.unm.edu/ifis/papers/community-moore.pdf>.

Baltimore (UMB) presumably have some innovative collaborative activities, however, Figure 52 does not highlight these inter-group ties. This information will be illustrated in Figure 53.

Figure 52: Overall Network without Inter-Group Ties¹⁴⁸



Source: Tertius Analytics

¹⁴⁸ The network images in this section may include a group labeled "Stub" and/or a node labeled "Stub". The group contains organizations engaged in SBIR grants with one or more federal agencies and the group label should read "SBIR". The "Stub" node does not represent an actual organization, rather it is an error caused inadvertently by placeholder text in one of the data fields.

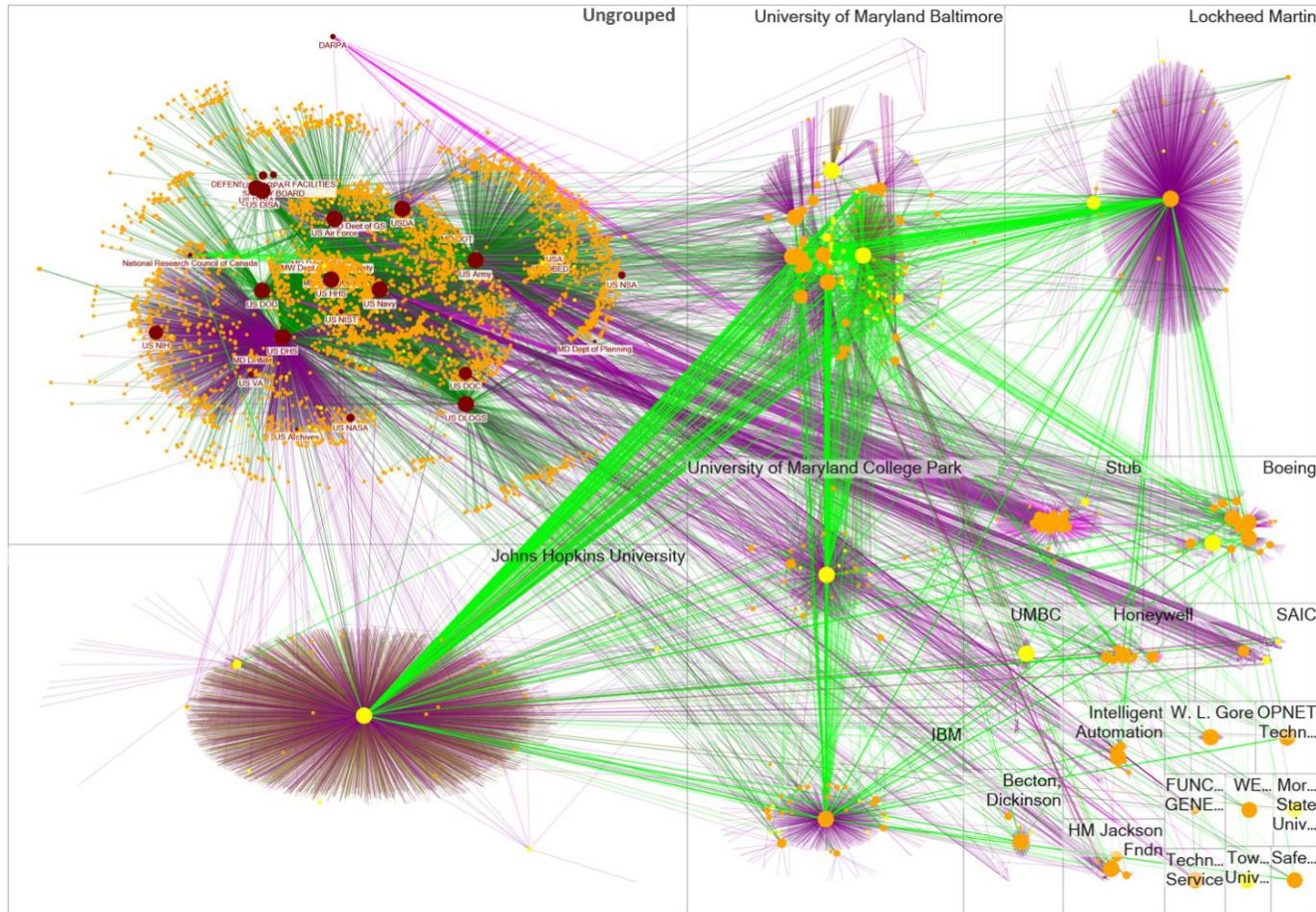
Starting in the upper left hand corner, the box labeled “Ungrouped” includes all the agencies (maroon dots) that were suppressed due to privacy when the grouping algorithm was applied, plus all organizational, institutional, and individual people nodes that connect to—and only to—the agency nodes. Some examples of these agencies include the Department of the Army, the Department of the Navy, the National Security Agency, and the Maryland Department of Planning.

Moving beyond the ungrouped box in Figure 52, groups that are labeled, such as JHU and UMB, are collections of nodes (organizations, institutions, and people) connected by one or more types of ties (including patents, research grants or contracts). As a reminder, these connections do not include inter-group connections in the network which will be outlined in the next figure. The group label corresponds to the most connected or central node in the group. In some cases—such as JHU—this is quite clear. In other cases—for example, UMB—the central node is less obvious and further investigation is often beneficial for understanding the innovation network. When there are several nodes present in the group, this typically means that these subnetworks are more collaborative and more resilient.

From understanding the nodes, the next focal point in this figure is the colored ties emanating from the nodes. From the color legend outlined above, it is clear that the Lockheed Martin group (dominant orange node) has a considerable amount of patent activity (purple ties). In contrast, the university-based groups—such as JHU, UMB, and UMCP—have a combination of ties present representing patents, federal contracts, and research grants.

The second network image, Figure 53, builds on the previous figure by adding the inter-group ties. In addition to illustrating the size and complexity of the overall network, Figure 53 reveals the importance of considering not just the independent groups such as JHU or Boeing, but also the connections between these groups.

Figure 53: Overall Network with Inter-Group Ties



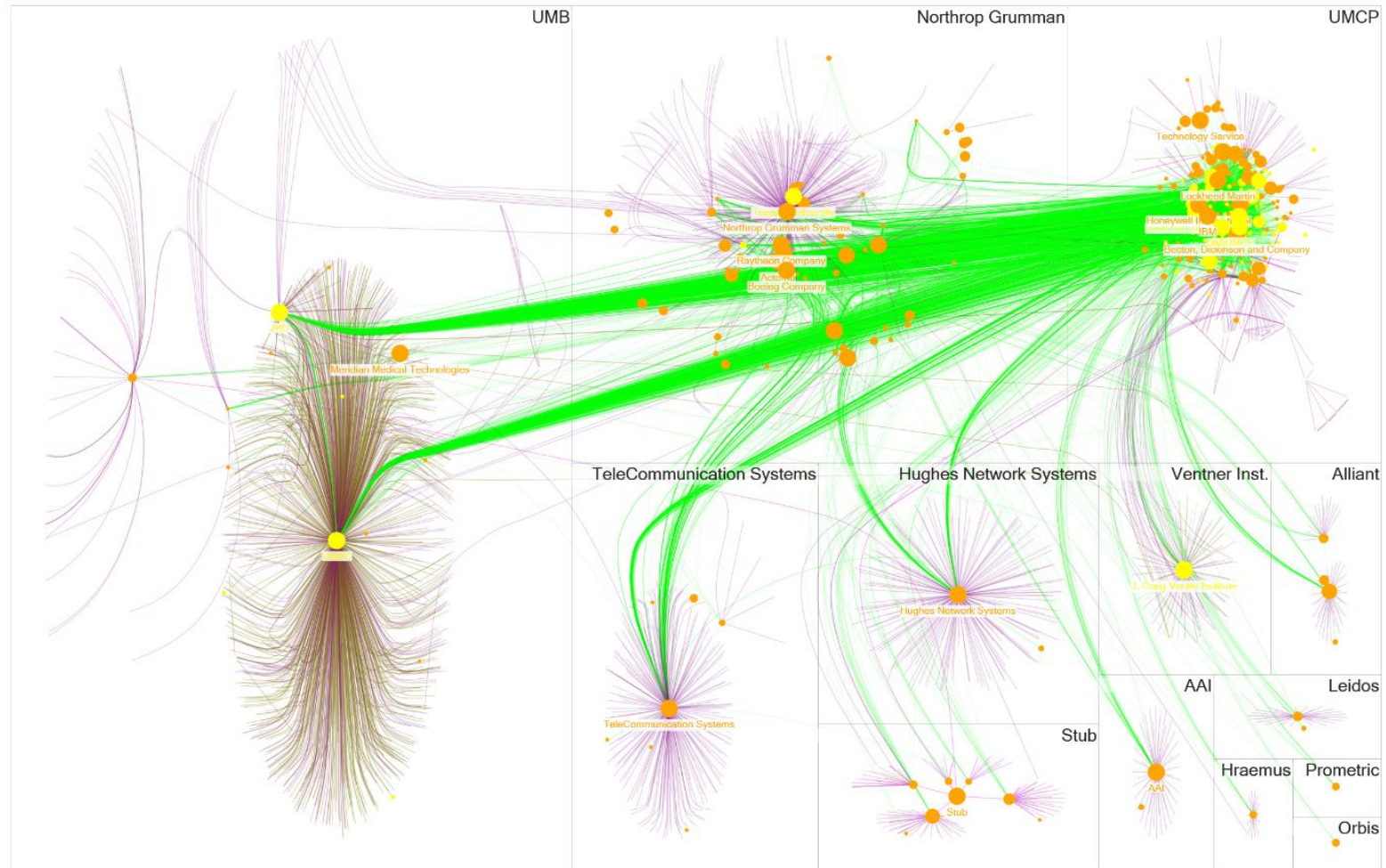
Source: Tertius Analytics

With the addition of the inter-group overlay, the intra-network connections become visible, highlighting that every group in the overall network has at least one tie to another group. These connections are occurring between agencies, universities, and private companies. For example, from reviewing the ties in Figure 53, JHU has patents with the Department of Homeland Security (DHS), NASA, and many other government agencies. JHU also has a considerable amount of weak ties with UMCP, highlighting the competition or potential collaboration between these higher education institutions.¹⁴⁹ Finally, weak ties exist between JHU and companies including, but not limited to, IBM, Becton Dickinson, Honeywell, and Science Applications International Corporation (SAIC).

As noted above, groups in which the central node is not visually clear warrant further exploration. For these groups, their network structures are denser and more complex, indicating that these subnetworks are more collaborative and more resilient. One of the best examples of this phenomenon from Figure 53 is the UMB Group Network. Figure 54 shows this grouped network with the inter-group ties.

¹⁴⁹ Weak ties can depict a potential relationship for future collaboration, competitors, or components parts in a supply chain.

Figure 54: University of Maryland, Baltimore Group Network Detailed Groupings with Inter-Group Ties



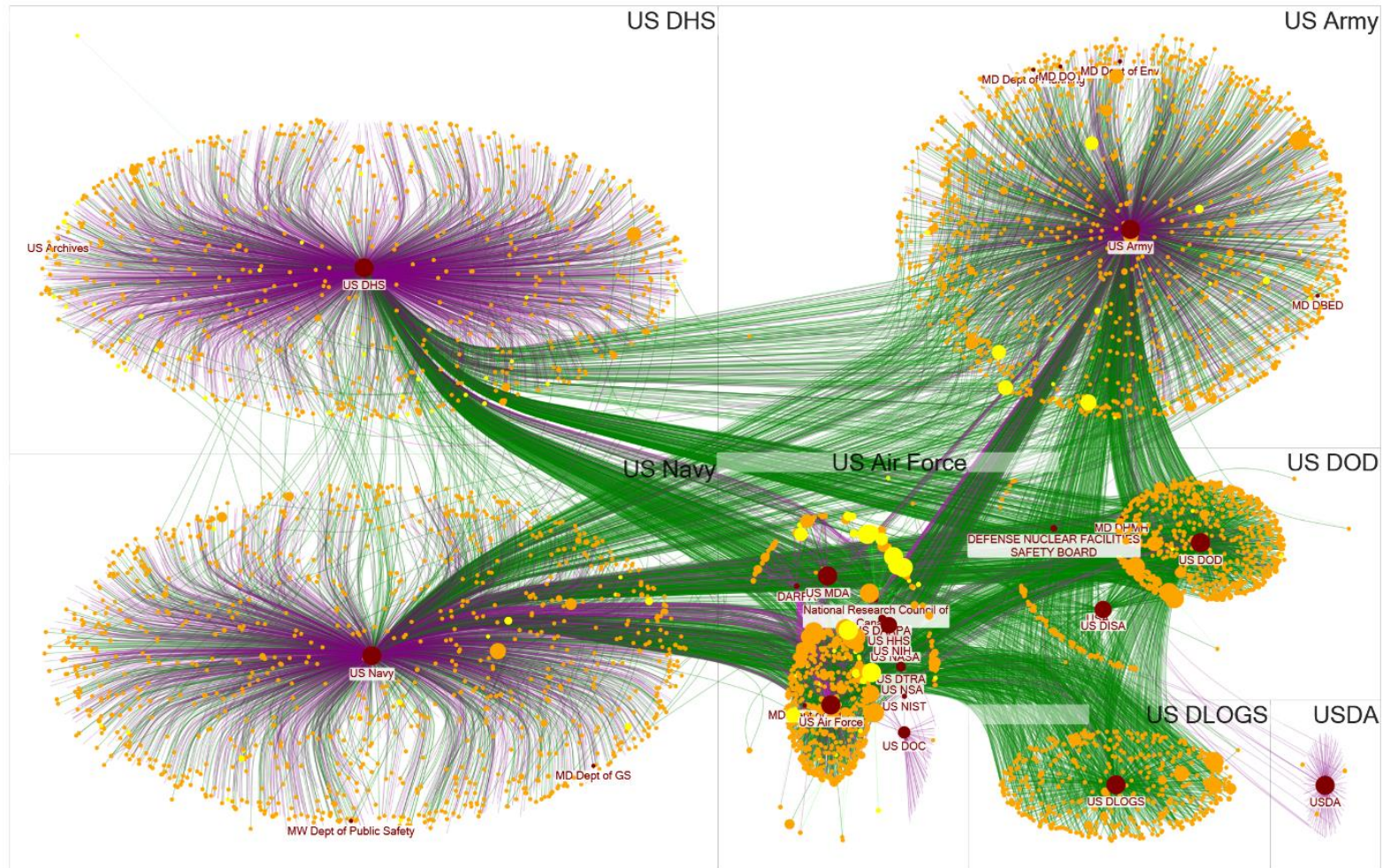
Source: Tertius Analytics

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Focusing on the UMB network containing many nodes, Figure 54 zooms in on the groups to view the ties between the various nodes. This figure illustrates both the ties between the groups, as well as ties with groups external to the UMB network. This highlights the process of drilling down through multiple levels of the network until economic developers are able to identify specific organizations and relationships to be explored further in the context of promoting innovation-based strategies. For example, UMB has a considerable amount of ties external to the network that focus on patent activity and research grants (shown as the purple and olive lines that appear to extend outside of the image). However, UMCP's ties are predominantly inter-group, having at least a weak tie to every group in the network. Beyond the ties, these two groups—UMB and UMCP—also vary considerably regarding the prominence, or lack thereof, of the central node. UMB has a prominent central node, while the UMCP group has a diverse array of nodes with several organizations and institutions comprising the group.

Transitioning from focusing on the academic institutions in the overall network to agencies involved in the overall network, Figure 55 illustrates the intra- and inter-network ties of agencies. The main groups are the DHS; U.S. Army; U.S. Navy; U.S. Air Force; DoD; U.S. Defense Logistics Agency (DLOGS); and the U.S. Department of Agriculture (USDA). The vast majority of organizations depicted in this network are either Maryland-based (i.e. headquartered in Maryland) or have a substantial Maryland presence (one or more establishments in the state) even though they are headquartered elsewhere.

Figure 55: Agency Network with Inter-Group Ties



Source: Tertius Analytics

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The network presented in Figure 55 is dominated by government agencies that are predominantly working collaboratively on federal contracts (dark green ties). This inter-agency activity is anticipated at the federal level. There are also patent ties (purple ties) between some of the agencies, such as those between the Navy and Air Force, DHS and the Air Force, and the Air Force and the Army. Somewhat expectedly, the USDA is represented in this network—as it is a federal agency—however, it does not appear to be as visually connected to the other nodes in the image. This makes sense as the agency's primary objective differs from the defense-related agencies. On closer inspection, the USDA's sole role in this network is as an assignee on several patents (purple ties). Several companies as well as the US Army and US Navy are also assignees on some of those patents.

These groups offer limited information in terms of resilience or economic development. There is no evidence of innovative activity in the public records. This does not mean that the companies are not innovative. However, additional information is needed from the firms involved before economic development or resilience strategies can be developed. An examination of the between-group ties reveals that many of the firms in these groups have contractual ties to multiple federal defense agencies. Firms with ties to multiple agencies are likely to be somewhat more resilient than those with contract ties to one single agency. Ties to non-defense customers and markets would increase firm resilience to shocks in defense procurement, however this information may only be obtained through direct contact with the identified firms.

The US Army, US Navy, and US DHS groups all have similar mixes of patent, contract and SBIR ties to the organizations, people, and institutions in each group's network. As with the DOD and DLOGS groups there is no information concerning non-defense market activity and economic developers on the ground must obtain this information through direct contact. Likewise, many of the organizations (orange nodes) have contract ties with multiple agencies and the analysis in the preceding paragraph applies. However, these networks are more complex with evidence of innovation-driven economic activity including invention, patenting, and commercialization through SBIR.

The US Air Force group is far more complex than any of the other groups with a higher *density* of ties among the nodes in the network. A significant number of nodes have ties to multiple agencies. There is a concentration of research institutions involved in this group along with patent, contract, research and SBIR ties. There is a clear SBIR concentration around DARPA and this suggests potential economic development opportunity to develop non-defense applications for the technologies being developed by and for DARPA. There are also weak ties between several research institutions and firms, suggesting opportunities for tech transfer and commercialization. As with the Army, Navy and DHS groups, this group should be revisited within the cluster analysis context.

In addition to the inter-agency ties, many companies do business with these agencies and appear in this network. The top 20 companies that are present in the Army, Navy, Air Force, and DoD groups can be found in Figure 56. Many of the same companies show up in all four groups in Figure 56: Boeing; Raytheon; Northrop Grumman; Intelligent Automation; Hughes Network Systems; IBM; Telecommunications Systems; Becton, Dickinson and Company; Lockheed Martin; and AAI.

Figure 56: Top 20 Companies for DoD Branches (Based on Node Centrality)¹⁵⁰

U.S. Army	U.S. Navy	U.S. Air Force	U.S. DOD
Boeing Company	Northrop Grumman Systems	Becton, Dickinson and Company	Lockheed Martin
Raytheon Company	Lockheed Martin	Boeing Company	Northrop Grumman Systems
Northrop Grumman Systems	Raytheon Company	Lockheed Martin	Intelligent Automation
Intelligent Automation	Intelligent Automation	Northrop Grumman Systems	Hughes Network Systems
Hughes Network Systems	Hughes Network Systems	Hughes Network Systems	Boeing Company
IBM	IBM	IBM	TeleCommunication Systems
TeleCommunication Systems	W. L. Gore & Associates	TeleCommunication Systems	IBM
Honeywell International	Becton, Dickinson and Company	Raytheon Company	Becton, Dickinson and Company
Becton, Dickinson and Company	TeleCommunication Systems	Intelligent Automation	Raytheon Company
W. L. Gore & Associates	Boeing Company	W. L. Gore & Associates	Henry M. Jackson Foundation for the Advancement of Military Medicine Inc.
Lockheed Martin	Henry M. Jackson Foundation for the Advancement of Military Medicine Inc.	OPNET Technologies	OPNET Technologies

¹⁵⁰ As a reminder, the larger the node, the more central to the group it is, i.e. the higher the centrality the higher the influence this company/person/agency/institution may have on the larger network.

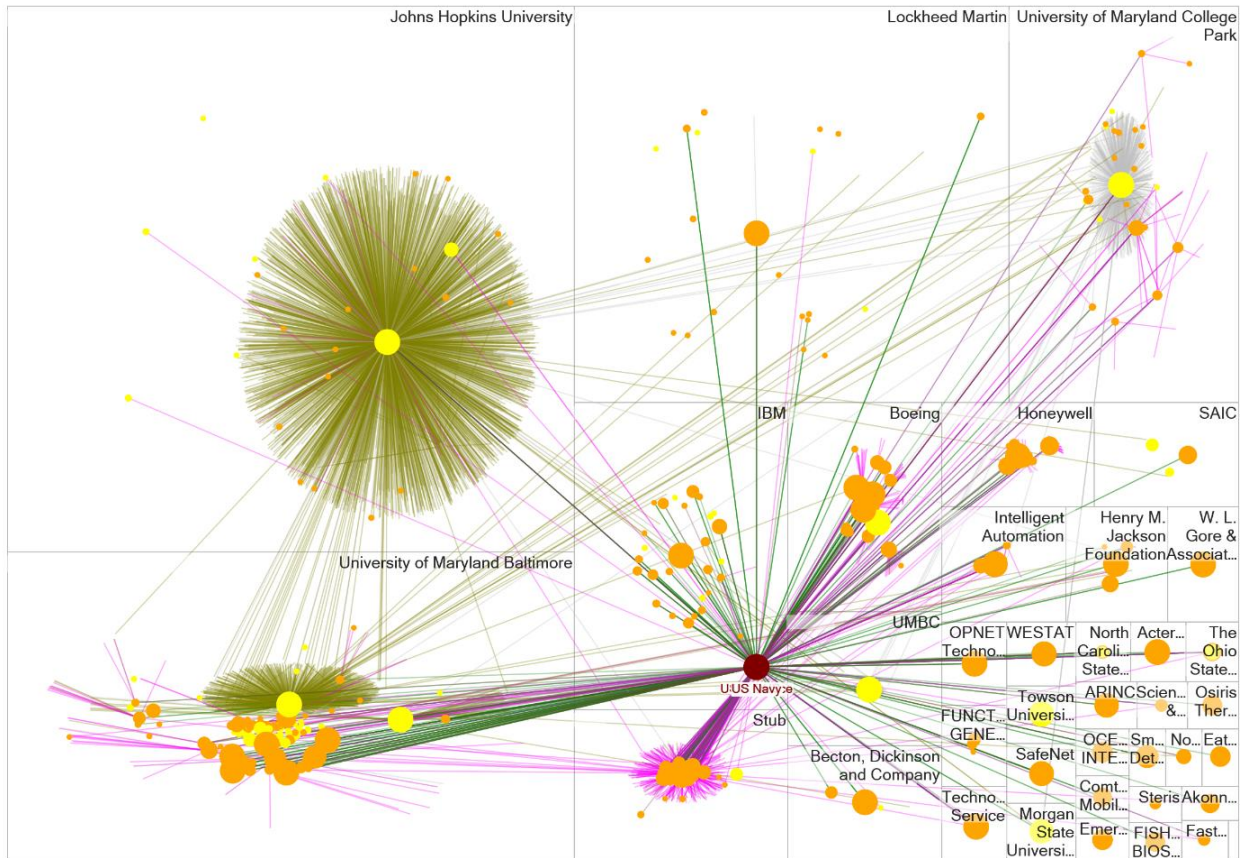
U.S. Army	U.S. Navy	U.S. Air Force	U.S. DOD
Henry M. Jackson Foundation for the Advancement of Military Medicine Inc.	OPNET Technologies	Stub	Stub
OPNET Technologies	Stub	Technology Service	Technology Service
Stub	Acterna	AAI	AAI
Meridian Medical Technologies	Technology Service	ARINC	SafeNet
Technology Service	AAI	Smiths Detection	Alliant Techsystems
AAI	SafeNet	Akonni Biosystems	Smiths Detection
Xerox	Alliant Techsystems	SURVICE Engineering Company	Fisher Bioservices
WESTAT	Smiths Detection	Emergent Space Technologies	Comtech Mobile Datacom
ARINC	Oceaneering International	Syntonics	Syntonics

Source: Tertius Analytics

6.3 Research and Contracts Network

To better understand how the overall network, depicted in Figure 52 and Figure 53, relates to DoD and other government spending, the research and contracts network was created using only ties relating to research grants (olive ties), SBIR/STTR grants (fuchsia ties), and federal contracts (dark green ties) with DoD agencies. The networks reviewed in this section only highlight activity relating to the aforementioned grants and contracts; therefore, things like weak ties (lime green ties), which impacted the view in the preceding figures, have been removed from the proceeding figures. By focusing specifically on the grant and contract ties after these other variables have been removed, different array of networks or inter-network activity may be revealed. Figure 57 shows the research and contracts network with only these connections. With this configuration there are far fewer connections between the main subnetworks, yet there are still important links—especially between the university subnetworks.

Figure 57: Research and Contracts Network – Large Groups¹⁵¹



Source: Tertius Analytics

¹⁵¹ To easily access the information in this figure, it has been edited with ties to smaller groups (that would appear in the bottom right corner) removed. These groups represent teams of people (inventors or researchers) that are connected directly to one or more agencies through patents or research grants.

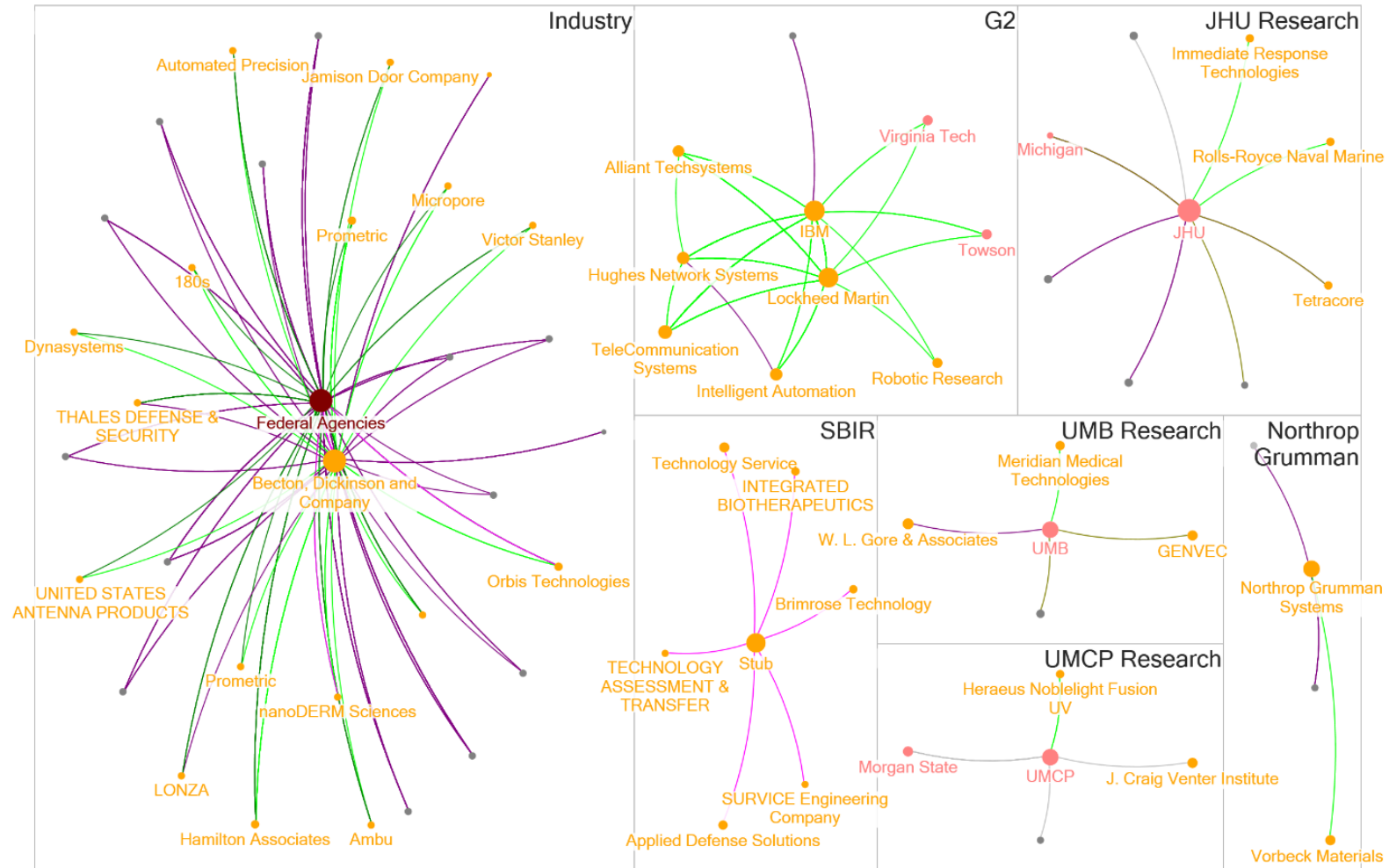
When focusing on the grants and contracts, many of the same groups appear in Figure 57 as were depicted in earlier figures looking at the overall networks. For example, large universities such as JHU, UMB, and UMCP are still located in pivotal positions on this image. Comparing the previous figures and the current figure, there are some anomalies found. For example, the relationship between the Navy and universities is more prominent in the current image, Figure 57. In addition, the smaller groups that did not appear in previous figures provide more of a variety of connections across Maryland, including Morgan State University, Towson University, and Westat. Connections focusing on grants and contracts with out-of-state institutions are also depicted in this figure, notably: North Carolina State University and the Ohio State University.

This section has provided an overview of the research and contracts network. While many of the same academic institutions and private companies are represented in both the overall network and the research and contracts network, by removing the weak ties and the patent ties, this section has highlighted a more diverse array of collaborators both in Maryland and outside of the state. Up until this point, the report has drilled down into the overall networks identified in Section 6.2. Moving forward, the overall network will be described as a meta-network, in which each group from the overall network is represented as a node in a new network. Rather than denoting a person, company, agency, or institution, in meta-networks, nodes will represent an actual group.

6.4 Innovation Meta-Networks

This section focuses on the meta-network, where the inter-group ties in the overall network become the ties connecting the group nodes. This new meta-network graph in Figure 58 is literally a network of networks, in which each node represents the entire subnetwork within the designated group. The node labels correspond to the most central actor in each group from the overall network.

Figure 58: Maryland Innovation Meta-Network



Source: Tertius Analytics

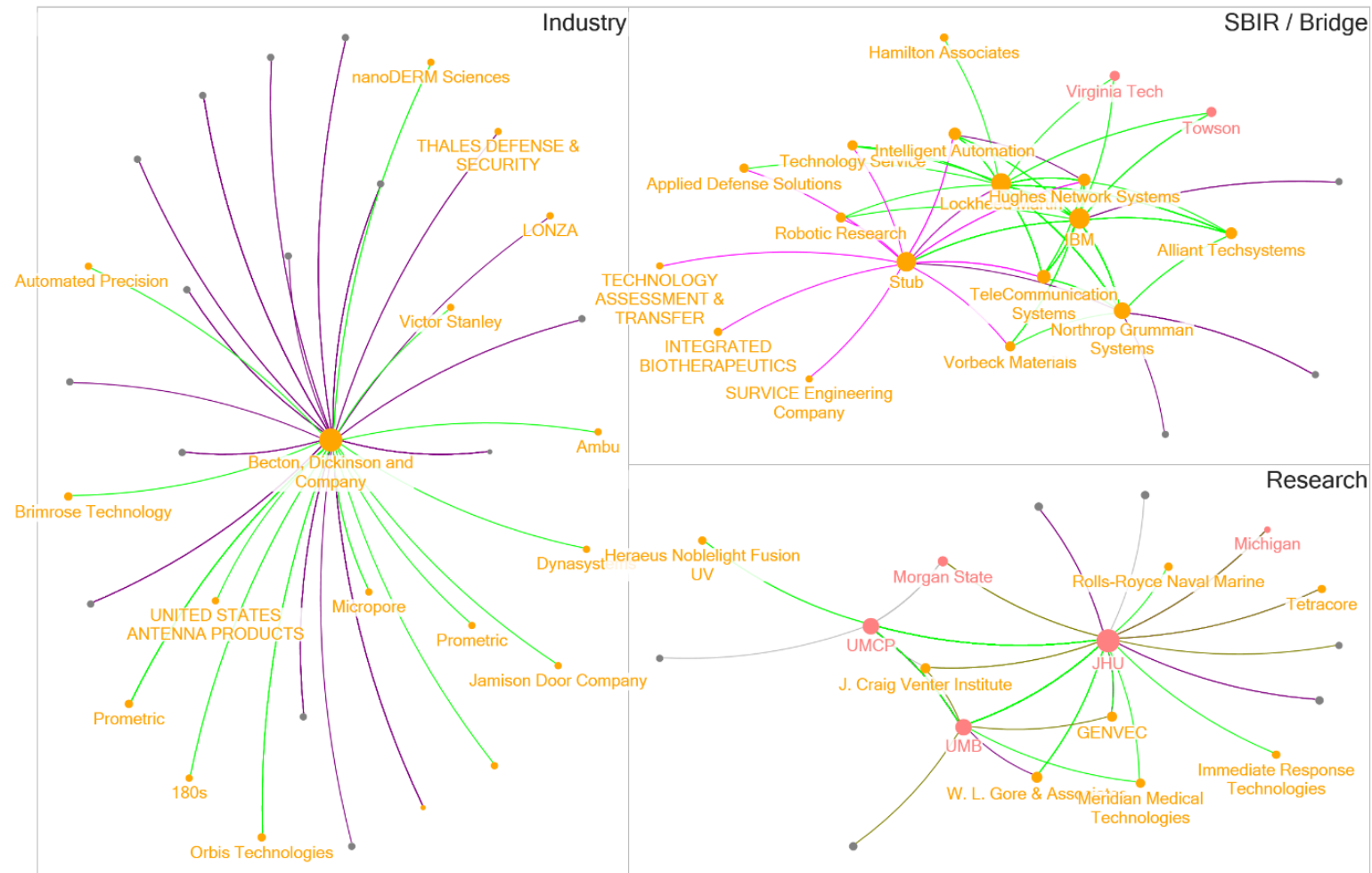
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The name of each network in the meta-network is located in the top-right corner of each sub-box. The color scheme for the nodes varies slightly in this figure and the next figure with institutions now represented as pink nodes, with orange nodes and maroon nodes continuing to represent organizations and agencies, respectively. The ties colors remain the same for meta-networks, with fuchsia ties for SBIR/STTR collaboration, purple ties for patents, lime green ties for weak ties, and olive ties for research grants.

Reviewing the meta-network information presented in Figure 58, two of the groups here—Industry and Northrop Grumman—are predominantly company-based with patent and contractual ties. Three of the groups are focused on research at JHU, UMB and UMCP. The remaining groups are largely built around SBIR and weak ties. Such ties are often indicators of active or potential commercialization activity.

The network depicted in Figure 59 uses the same network model as the previous image, Figure 58, but uses the Clauset-Newman-Moore grouping algorithm, yielding three groups: an industry group, a research group (mostly universities) and an SBIR/STTR/Bridging group.

Figure 59: Maryland Innovation Meta-Network with Clauset-Newman-Moore Grouping



Source: Tertius Analytics

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The arrangement illustrated in Figure 59 is particularly useful for applications related to understanding the “valley of death.” The valley of death refers to the issues encountered by researchers who are trying to cross the bridge between conducting innovative research and bringing the innovations to market. This valley can be applied to any type of research but it is commonly discussed in regards to biomedical research where studies are conducted—often through federal funding—but there is a gap between the research and the patients for whom this research would benefit.¹⁵² In regards to Figure 59, the meta-network highlights that the bridge, where researchers can avoid the valley of death, between research and industry is present in Maryland through the SBIR/Bridge group (top right corner).

Using an array of data sources ranging from patent data to federal contracts, this section has highlighted the collaboration between organizations, institutions, agencies, and people in Maryland. The following section will use the information derived from the SNA and well as the cluster analysis sections to discuss the two topics together. In addition, the following section will highlight an emerging cluster that was derived from the SNA. As the emerging cluster is a combination of other clusters that were originally identified in Sections 4 and 5, such as Telecommunications and Aerospace and Defense, it will be analyzed in Section 7.

7.0 Combination Cluster - Social Network Analysis

This section relates the networks found using the SNA in Section 6 to those clusters identified in the state and regional cluster analysis (Sections 4 and 5), where possible. Connecting the SNA with the cluster analysis helps to provide further context for how the networks and clusters relate to economic development in Maryland, and identify priorities for potential policy interventions.

Section 7 will continue as follows. Section 7.1 reviews the network clusters identified by the SNA in relation to the industry clusters presented in Sections 4 and 5. Section 7.2 will review the emerging cluster that was identified in the SNA, developing from several clusters identified in Sections 4 and 5.

7.1 Overview of Identified Clusters

The clusters discussed in this section are derived using two different datasets using different methodologies. Industry clusters were created from a review of employment data which tends to lag behind innovation-based data (patents and research grants, for example) used to construct network models. These clusters rely on aggregated employment levels in industry classifications (e.g. NAICS codes) that are inflexible, slow to change, and subject to data suppression when the number of firms is small. In comparison, the SNA produced network clusters that are based on actual innovation interactions between organizations—not

¹⁵² Declan Butler, “Translational Research: Crossing the Valley of Death.”

classifications. These clusters may not align to the industry clusters, indicating an emerging cluster that industry cluster methods cannot yet detect. Therefore, network clusters may be detecting activity in emerging industries, industries for which data may be suppressed, or for companies that do not fit easily into existing NAICS classifications.

While industry clusters offer a useful high-level view of state or regional economic structure, network clusters offer details on the structural activity of the innovation ecosystems within local industry clusters. Network clusters can reveal characteristics that industry cluster analysis cannot, such as unique or emerging clusters, and cluster adaptations. It is important to note that network cluster analysis generally affirms the findings of industry cluster analysis and enhances those findings with additional details. Both methodologies support the same or similar underlying theories, and there are no known instances of network analysis contradicting industry cluster analysis.

Comparing the networks and industry clusters yields three groups of network clusters: clusters that align well with industry clusters; clusters that are misaligned or that align with pieces of multiple industry clusters (local adaptations); and clusters that do not correspond well to any existing industry cluster (emergent clusters). Cluster strategies vary for each of these three groups. This section will review the first and third types of network clusters.

Tertius Analytics identified five network clusters that align with the industry cluster definitions (as defined by Delgado, Porter, and Stern) and are significant for innovation in Maryland. Four of the five social networks' corresponding industry clusters received large amounts of funding from the DoD, averaging over \$10 billion annually as a group, as shown in Figure 60.¹⁵³ The top vendor for the highest-funded clusters, at both state and regional level, is presented in Appendix F. The top vendor for services performed relating to each cluster, and the amount they received in rewards for services in that cluster on average annually were:

- **Business Services:** Mantech Sensor Technologies, Inc. (\$318 million);
- **Aerospace Vehicles and Defense:** AAI Corporation (\$486 million);
- **Communications Equipment and Services:** Lockheed Martin Corporation (\$348 million);
- **Information Technology and Analytical Instruments:** Hewlett-Packard Company (\$45 million); and
- **Biopharmaceuticals:** AcetRx Pharmaceuticals, Inc., nearly \$13 million.

¹⁵³ Biopharmaceuticals is presented even though it received relatively little DoD funding, as it helps to provide overall background on a Maryland's economy.

Figure 60: DoD Funding, Estimated Jobs, and Average Wages for Top Maryland Cluster Networks Identified by the SNA

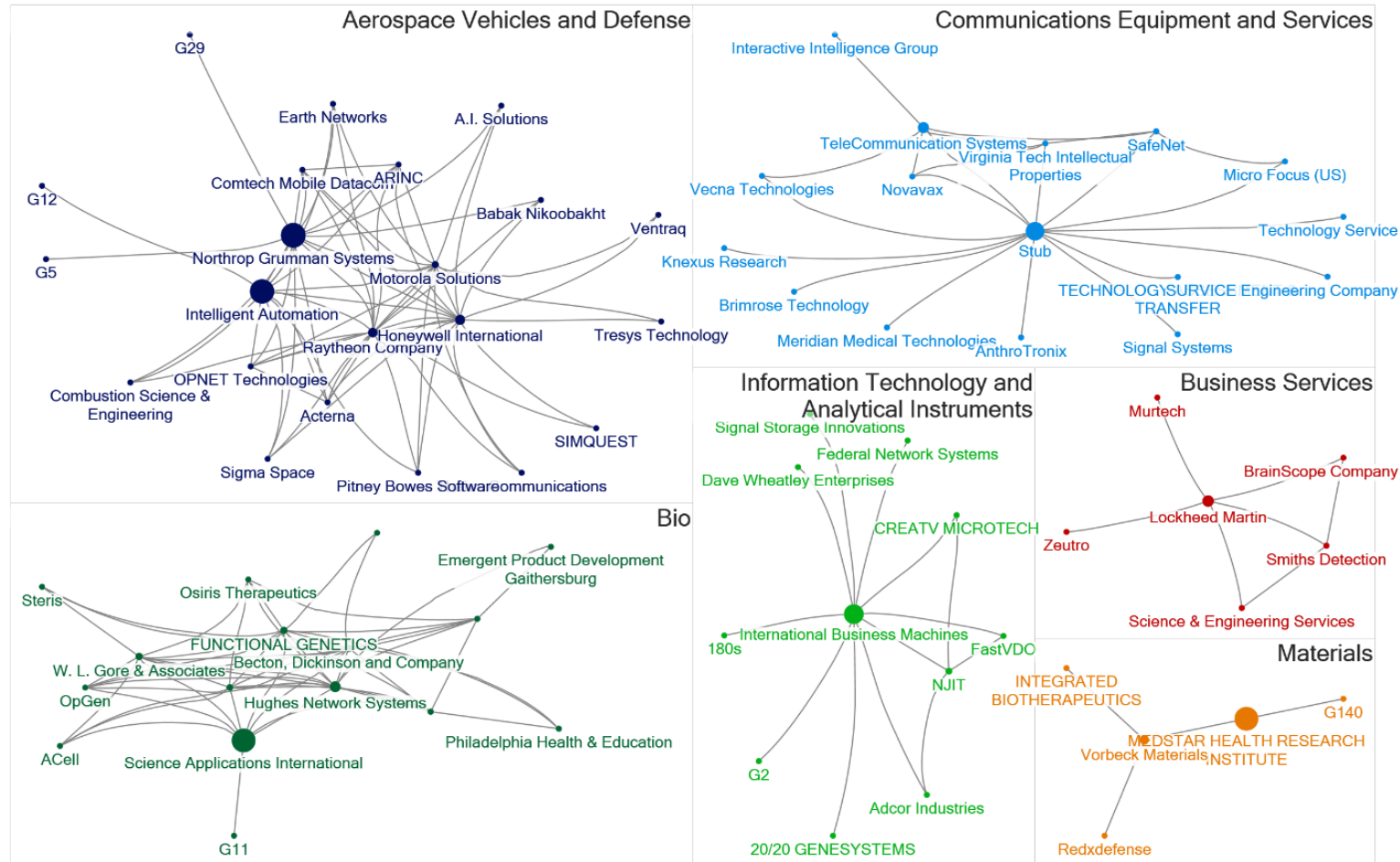
Cluster	Average Annual Dollars Obligated, 2011-2015	Statewide Job Estimate, 2014	Average Wage, 2015
Business Services	\$7,299,282,121	315,659	\$76,688
Aerospace Vehicles and Defense	\$1,240,767,978	10,881	\$85,290
Communications Equipment and Services	\$1,103,423,851	10,725	\$73,561
Information Technology and Analytical Instruments	\$438,013,070	12,456	\$94,160
Biopharmaceuticals	\$35,802,625	5,528	\$75,051
Selected Clusters Total	\$10,117,289,645	355,250	\$77,444

Sources: BLS OES; Delgado, Porter, and Stern; RESI; U.S. Census CBP

These top clusters employ over 355,000 individuals and pay an average annual wage of \$77,444—significantly higher than the state average of \$52,402. Based on the presence of these clusters in the SNA, these industries are not only attracting a considerable amount of DoD funding—thereby supporting jobs and wages—but are also hubs of collaborative activity. This trifecta of wages, employment, and collaboration makes these clusters of significant importance to the state, particularly regarding their stability in the future, with the potential reduction in DoD funding.

Using these five clusters, as well as the emerging Materials cluster (forthcoming in Section 7.2), a network cluster image was developed. This image, shown below in Figure 61, illustrates the collaborative activity that would most closely align with industry cluster definitions.

Figure 61: Network Clusters that Align with Industry Cluster Definitions



Source: Tertius Analytics

The nodes and ties in Figure 61 are not colored coded in the same way as previous images have been. For example, the lines are depicting a connection that is not defined as a patent or a research grant as in the previous figures. In addition, the color coding does not vary between agencies, organizations, institutions, etc.; rather, it varies by the group being reviewed. For example, all of the nodes in the Bio group in the bottom left corner are green. The color depicts that all of the nodes contribute to the Bio cluster. Additionally, the size of the node highlights the level of influence that actor(s) has in the cluster, with the larger node having more influence. Furthermore, in several groups, there is a “G” node, which represents teams of people (inventors or researchers) that are connected directly to one or more agencies. This is most noticeable in the G12, G5, and G29 nodes in the Aerospace and Defense Cluster.

For this figure, the agencies, places, and major university nodes were removed. The groups were then exported and re-clustered with individual nodes representing each group. Because companies tend to be the central nodes of each group, this yields network clusters that generally correspond to identified industry clusters. The cluster labels in this network image match specific industry clusters from the Sections 4 and 5. Group names have been added to the network image that align with the industry cluster names. As with previous similar networks, these group names correspond to the largest, most connected node in each group. The larger the node, the more influence it has within the group. Each node in the network above may represent multiple firms and institutions in addition to the one listed.

While the agencies, places and universities were stripped away to highlight the industry cluster in Figure 61, the following subsections will review each industry cluster as a network cluster, adding in the nodes observed in previous images. The ties as well as the node colors will be as follows:

- Nodes (Dots)
 - People – White or Transparent
 - Organizations – **Orange**
 - Institutions – **Yellow**
 - Agencies – **Maroon**
 - Places – **Blue**
- Ties (Lines)
 - Patents – **Purple**
 - Research Grants (NIH, NSF, NASA) – **Olive**
 - SBIR/STTR – **Fuchsia**
 - Federal Contracts – **Green**
 - Weak Ties – **Lime Green**
 - Location Ties – **Blue**

7.1.1 Business Services Cluster Network

The Business Services industry cluster received an average of nearly \$7.3 billion annually in DoD funding between 2011 and 2015. This cluster is important to Maryland's economy as it employs over 315,000 individuals—the second-largest cluster by employment in the state. As detailed in Appendix I, the Business services cluster in Maryland has an average annual wage of \$76,688. The cluster provides high-wage skilled jobs in Maryland, and has a large impact on Maryland's economy creating an estimated 35,446 jobs in the state, as detailed in Section 4.1.2.

The Business Services cluster has 2,982 unique companies receiving DoD funding that are located in or performing work in Maryland, identified by Data Universal Numbering System (DUNS) number. Figure 62 shows the 13 vendors with unique DUNS numbers that received over \$100 million in average annual funding. BAE Systems Technology Solutions & Services Inc. was the largest individual vendor, receiving an average of more than \$600 million from the DoD annually.

Figure 62: Maryland Top Business Services Cluster Vendors by DoD Average Annual Funding per Company

DUNS	Vendor Name	Average Annual Dollars Obligated, 2011-2015
103933453	BAE Systems Technology Solutions & Services Inc.	\$600,429,936
845451228	Mantech Sensor Technologies, Inc.	\$317,955,839
836196972	Lockheed Martin Integrated Systems, Inc.	\$309,643,213
083070925	URS Federal Technical Services, Inc.	\$270,932,008
147286186	Lockheed Martin Corporation	\$226,166,689
041014242	Honeywell Technology Solutions Inc.	\$185,512,165
091808832	Northrop Grumman Systems Corporation	\$165,554,674
805258373	Lockheed Martin Services, Inc.	\$130,423,259
067641597	General Dynamics Information Technology, Inc.	\$126,395,139
835130485	International Business Machine	\$124,102,785
073871048	URS Federal Support Services, Inc.	\$113,995,115
008046331	Adams Communication & Engineering Technology, Inc.	\$112,753,173
075916762	Booz Allen Hamilton Engineering Services LLS	\$100,163,093

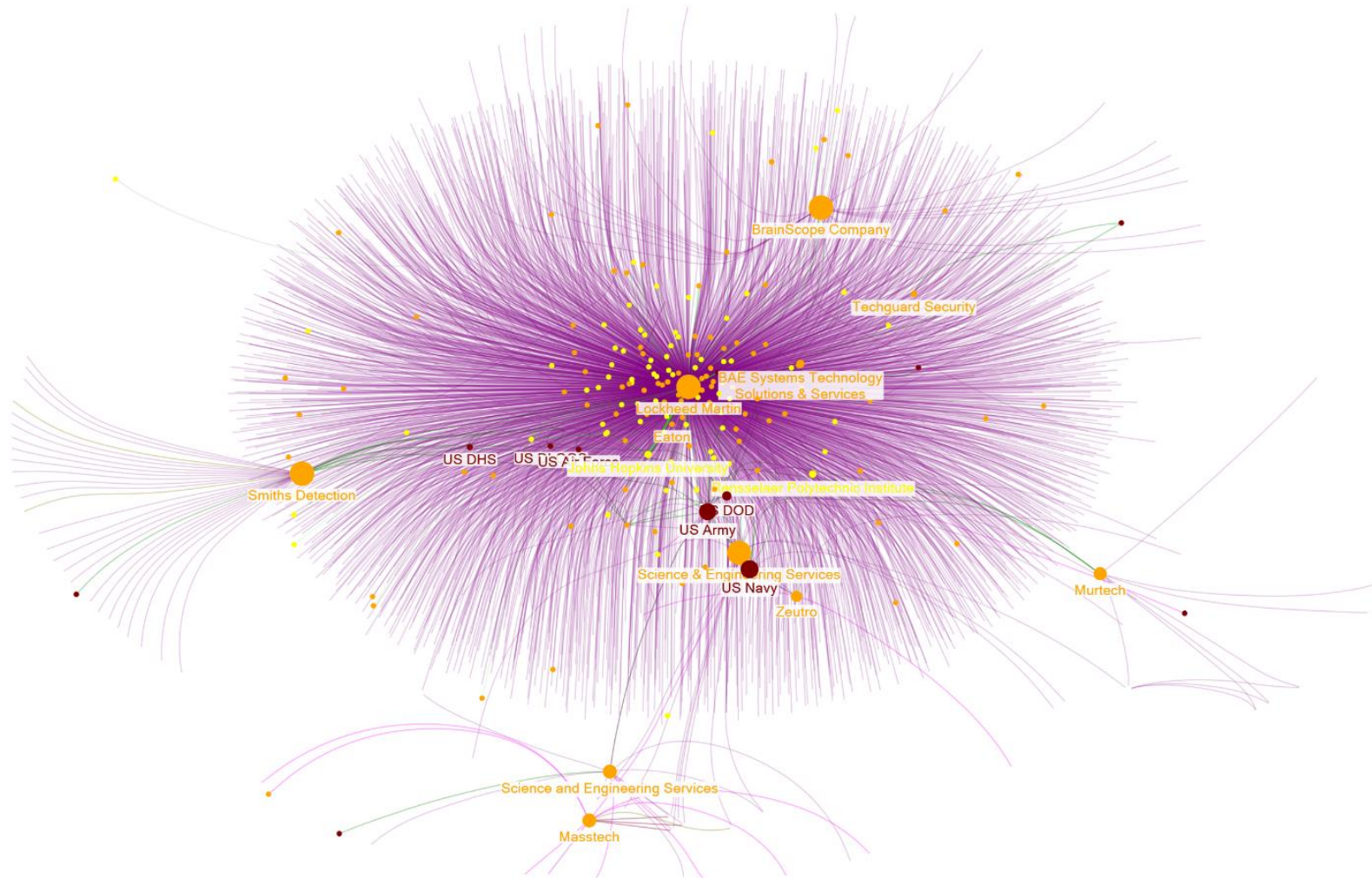
Sources: USA Spending, RESI

In terms of its collaboration capacity, the network cluster, illustrated in Figure 63, is structured much like the Information Technology cluster network (Section 7.1.4), with Lockheed Martin representing the largest star-shaped subnetwork. Through three combined entities, Lockheed Martin Integrated Systems, Inc., Lockheed Martin Corporation, and Lockheed Martin Services,

Inc., Lockheed Martin receives the largest amount of funding for this cluster.¹⁵⁴ The network groups with the simple “star” appearance have one central node surrounded by many other nodes that are connected only to the central node (i.e. nodes to nowhere). However, unlike the Information and Technology and Analytical Instruments cluster network, the smaller subnetworks are not well defined or developed, and they all have some connection to Lockheed Martin.

¹⁵⁴ As noted above the SNA uses patents, research grants, SBIR/STTR, and federal contract data for the analysis. The cluster analysis and the DoD vendor list uses USA Spending data, and the lists given in the vendor charts may or may not appear in the SNA database.

Figure 63: Business Services Cluster Network



Source: Tertius Analytics

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Another difference between Business Services and Information and Technology and Analytical Instruments is that while Lockheed Martin is at the center of a large star network, there is clear, albeit limited, interaction among other nodes in the cluster. This suggests that while Lockheed is clearly the dominant player, they may be open to collaboration. This also might suggest the emergence of a cluster around business services where Lockheed Martin has enjoyed market dominance for many years.

7.1.2 Aerospace and Defense Cluster Network

According to the industry cluster analysis in Section 4, the Aerospace Vehicles and Defense cluster received over \$1.2 billion in DoD funding obligations, on average, between 2011 and 2015. As shown in Appendix I.2, this cluster employs over 10,800 individuals, and pays an average wage of \$85,290. The cluster is estimated to employ 10,881 individuals and create 5,418 jobs as a result of DoD spending.

The Aerospace and Defense cluster has 370 unique companies receiving DoD funding that are located in or performing work in Maryland, identified by DUNS number. Figure 64 shows the 12 vendors receiving at least \$20 million in annual funding. AAI Corporation was the largest vendor, receiving an average of nearly \$473 million annually. Note that Northrop Grumman Systems Corporation shows up in the list multiple times because it received funding under distinctly different entities, as defined by DUNS numbers.

Figure 64: Maryland Top Aerospace and Defense Cluster Vendors by DoD Average Annual Funding per Company

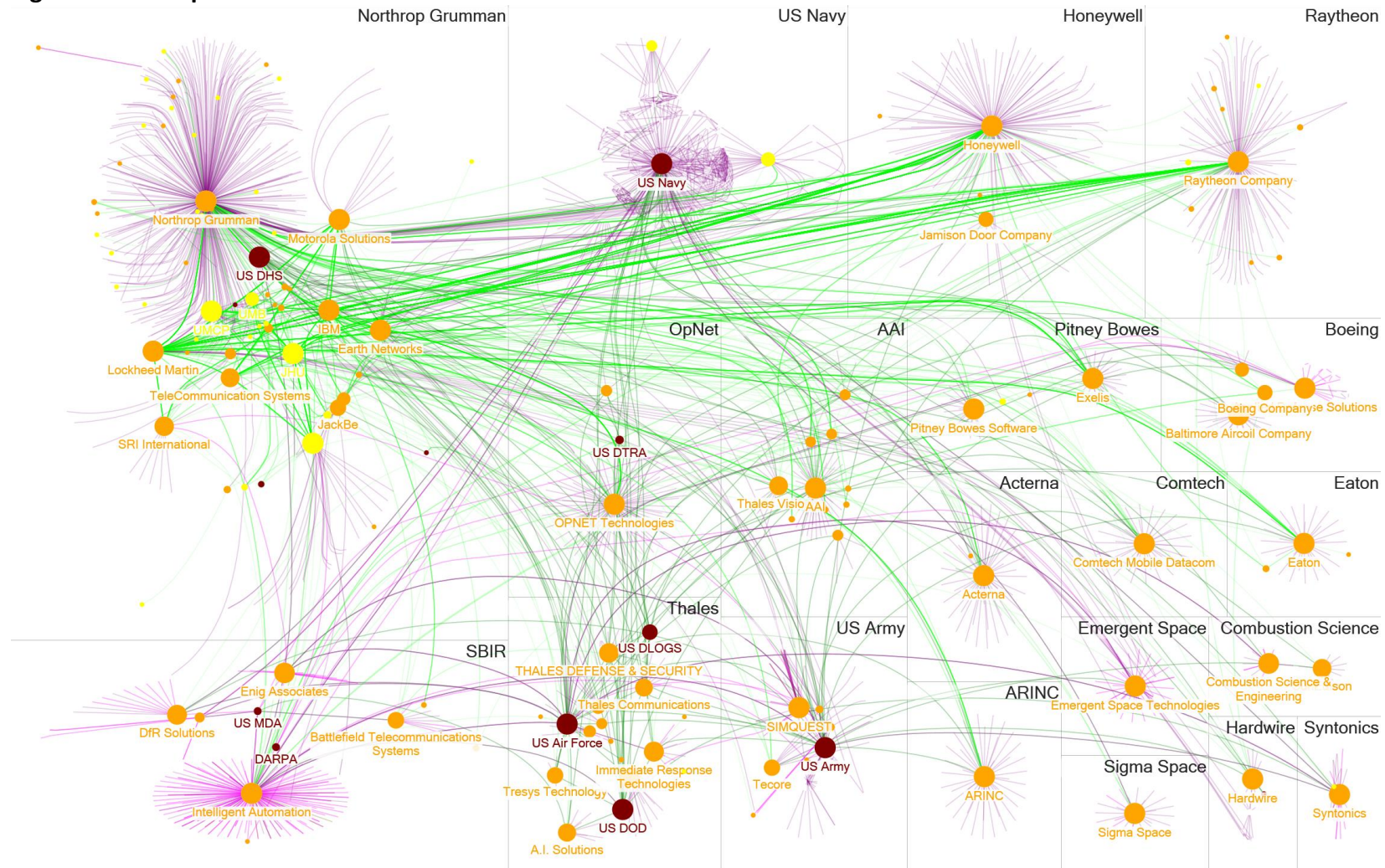
DUNS	Vendor Name	Average Annual Dollars Obligated, 2011-2015
003090198	AAI Corporation	\$472,522,668
091808832	Northrop Grumman Systems Corporation	\$125,976,821
784127763	Northrop Grumman Systems Corporation	\$119,354,134
103933453	BAE Systems Technology Solutions & Services Inc.	\$91,826,258
830660739	Agentase, LLC	\$80,061,844
800131955	Northrop Grumman Systems Corporation	\$60,222,174
074946559	TCOM, Limited Partnership	\$49,675,553
194239018	Smiths Detection Edgewood Incorporated	\$39,800,645
108994732	Raytheon Company	\$24,506,039
149879157	The Boeing Company	\$22,262,918
003253788	Thales Communications, Inc.	\$21,006,153
608461898	Dyncorp International LLC	\$20,023,610

Sources: USA Spending, RESI

As depicted in Figure 65, the Northrop Grumman group represents the core of the Aerospace and Defense network in Maryland. Through various entities, the company received the second-largest amount of DoD funding in the state at over \$245 million annually.¹⁵⁵ The group exhibits complex structure and potential (weak) ties between multiple large and small firms, most notably Northrop Grumman, Lockheed Martin, IBM, Telecommunication Systems and Earth Networks; major Maryland research institutions including UMCP, UMB and JHU; and federal agencies including DHS and Commerce. As a reminder, weak ties connect nodes that either have an existing relationship as competitors or as part of a supply chain (i.e. not innovative collaboration) and have the potential to cooperate.

¹⁵⁵ As noted above the SNA uses patents, research grants, SBIR/STTR, and federal contract data for the analysis. The cluster analysis and the DoD vendor list uses USA Spending data, and the lists given in the vendor charts may or may not appear in the SNA database.

Figure 65: Aerospace and Defense Cluster Network



Source: Tertius Analytics

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The Thales group also exhibits some internal complexity with multiple members—Thales Defense & Security and Thales Corporation—along with other firms and agencies including the U.S. Air Force, DLOGS and DoD. This is denoted in the group by a number of nodes, representing both agencies (maroon) and organizations (orange), of the same size or the same influence. Additionally, the U.S. Army and Navy each have a distinct group, however the structure of the groups are notably different. The U.S. Navy group shows extensive direct patenting activity, which likely reflects invention at NAS Pax River, Bethesda Naval Hospital, and residences of inventors assigned to the Naval Research Lab in Washington, D.C. In comparison, the U.S. Army group shows limited direct patenting activity, focusing instead on federal contracts (with a number of weak ties present). Both the U.S. Army and Navy groups show extensive connections to other corporate groups, and the Army groups has some within-group companies, most notably Simquest (located in Annapolis, MD) and Tecore (located in Hanover, MD).

7.1.3 Communications Equipment and Services Cluster Network

As detailed in the industry cluster analysis in Section 4, the Communications Equipment and Services cluster received an average of over \$1.1 billion in annual DoD funding obligations between 2011 and 2015. Appendix I.3 shows that the Communications Equipment and Services cluster employs over 10,700 people and pays an average wage of \$73,561. The cluster has a similar, disproportionately large impact on the economy as the Aerospace Vehicles and Defense cluster. The Communications Equipment and Services cluster is estimated to employ 10,725 individuals, and create 5,586 jobs as a result of DoD spending.

The Communications Equipment and Services cluster has 717 unique companies receiving DoD funding that are located in or performing work in Maryland, identified by DUNS number. Figure 66 shows that of the unique vendors in the data set, there are 10 that receive over \$20 million in average annual funding. Lockheed Martin Corporation was the largest vendor, receiving over \$336 million annually.

Figure 66: Maryland Top Communications Equipment and Services Cluster Vendors by DoD Average Annual Funding per Company

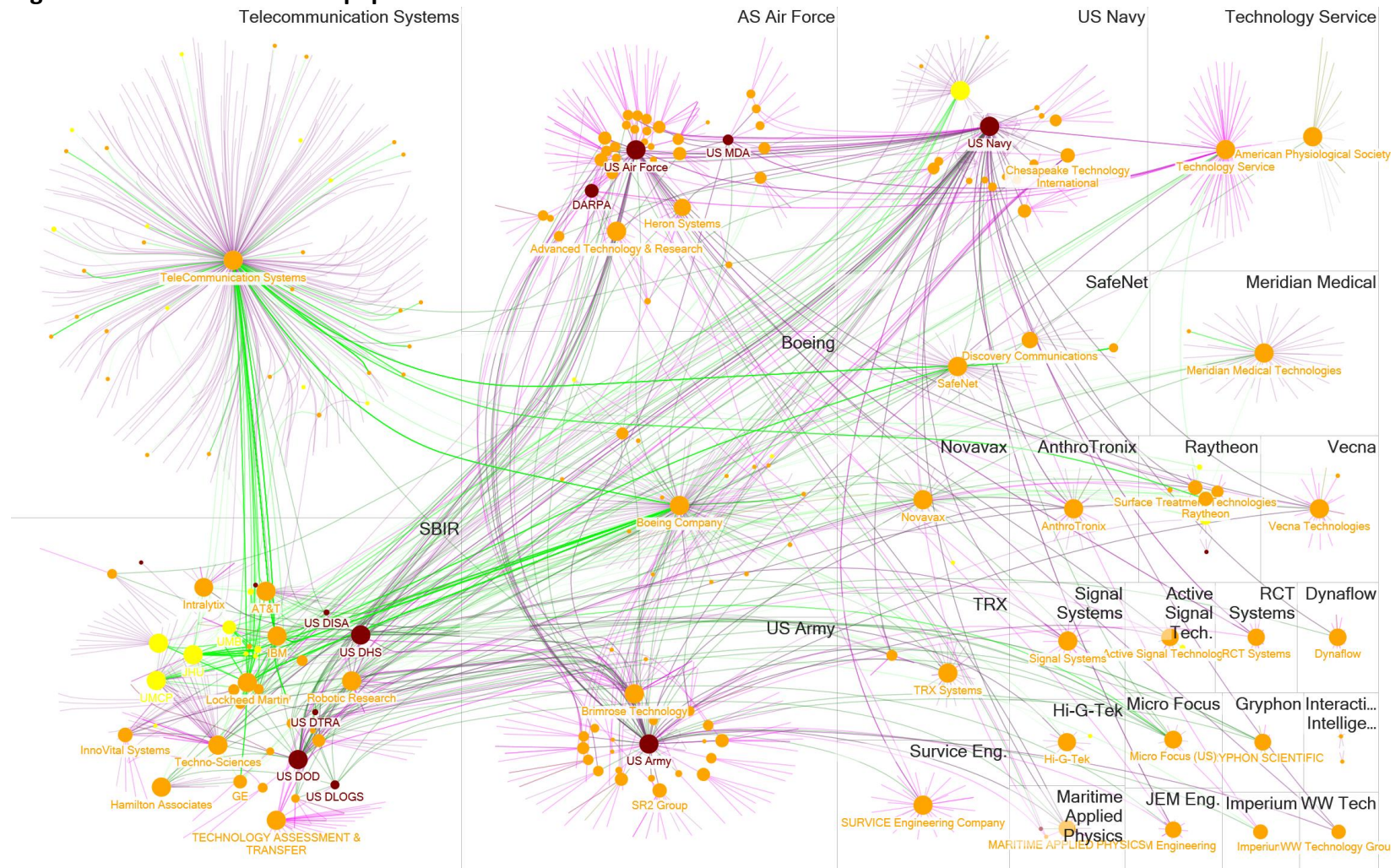
DUNS	Vendor Name	Average Annual Dollars Obligated, 2011-2015
834951691	Lockheed Martin Corporation	\$336,163,172
196970503	Telecommunication Systems Incorporated	\$98,419,347
103933453	BAE Systems Technology Solutions & Services Inc.	\$76,381,088
179328117	Neany, Inc.	\$69,791,072
127190358	Intelsat General Corporation	\$65,283,120
003253788	Thales Communications, Inc.	\$44,504,216
803186295	Comtech Mobile Datacom Corporation	\$34,888,460
148549087	Iridium Satellite LLC	\$34,144,323
069373090	Motorola Solutions, Inc.	\$26,700,962
784127763	Northrop Grumman Systems Corporation	\$20,526,498

Sources: USA Spending, RESI

TeleCommunication Systems Inc. is at the center of this network's largest subnetwork and despite its size, it exhibits a classic star configuration with few inter-network member ties. This type of network structure has useful security and control characteristics, but is also characterized by limited collaboration activity and limited resilience. Essentially, if TeleCommunication Systems Inc. suffers a shock, all of the other nodes in the cluster will be affected with no visible alternative markets for collaboration or sales. TeleCommunication Systems Inc. also is important to the cluster in terms of DoD funding, receiving the second-highest amount at an average of more than \$98 million annually.¹⁵⁶

¹⁵⁶ As noted above the SNA uses patents, research grants, SBIR/STTR, and federal contract data for the analysis. The cluster analysis and the DoD vendor list uses USA Spending data, and the lists given in the vendor charts may or may not appear in the SNA database.

Figure 67: Communications Equipment and Services Cluster Network



Source: Tertius Analytics

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In contrast, the U.S. Air Force, U.S. Army, U.S. Navy, and Boeing groups all exhibit subgroups that are more complex. These subgroups are likely to be more collaborative, more innovative and more resilient. However, the connectivity that defines these complex subnetworks also makes them more vulnerable to information security breaches. In broad terms, this cluster illustrates a basic tradeoff: resiliency and faster, more effective innovation; or tighter information security, command and control.

7.1.4 Information Technology Cluster Network

Figure 68 below shows the Information Technology cluster, which received an annual average of over \$438 million in DoD funding between 2011 and 2015. As detailed in Section 4.1.2, the cluster employs nearly 12,500 people and pays a high average wage of \$94,160 annually. DoD spending in the cluster is estimated to create 1,732 total jobs in Maryland.

The Information Technology cluster has 2,982 unique companies receiving DoD funding that are located in or performing work in Maryland, identified by DUNS number. This cluster had 10 vendors with unique DUNS numbers that received over \$10 million in average annual funding, detailed in Figure 68 below. The Hewlett-Packard Company was the largest vendor, receiving nearly \$47 million annually.

Figure 68: Maryland Top Information Technology Cluster Vendors by DoD Average Annual Funding per Company

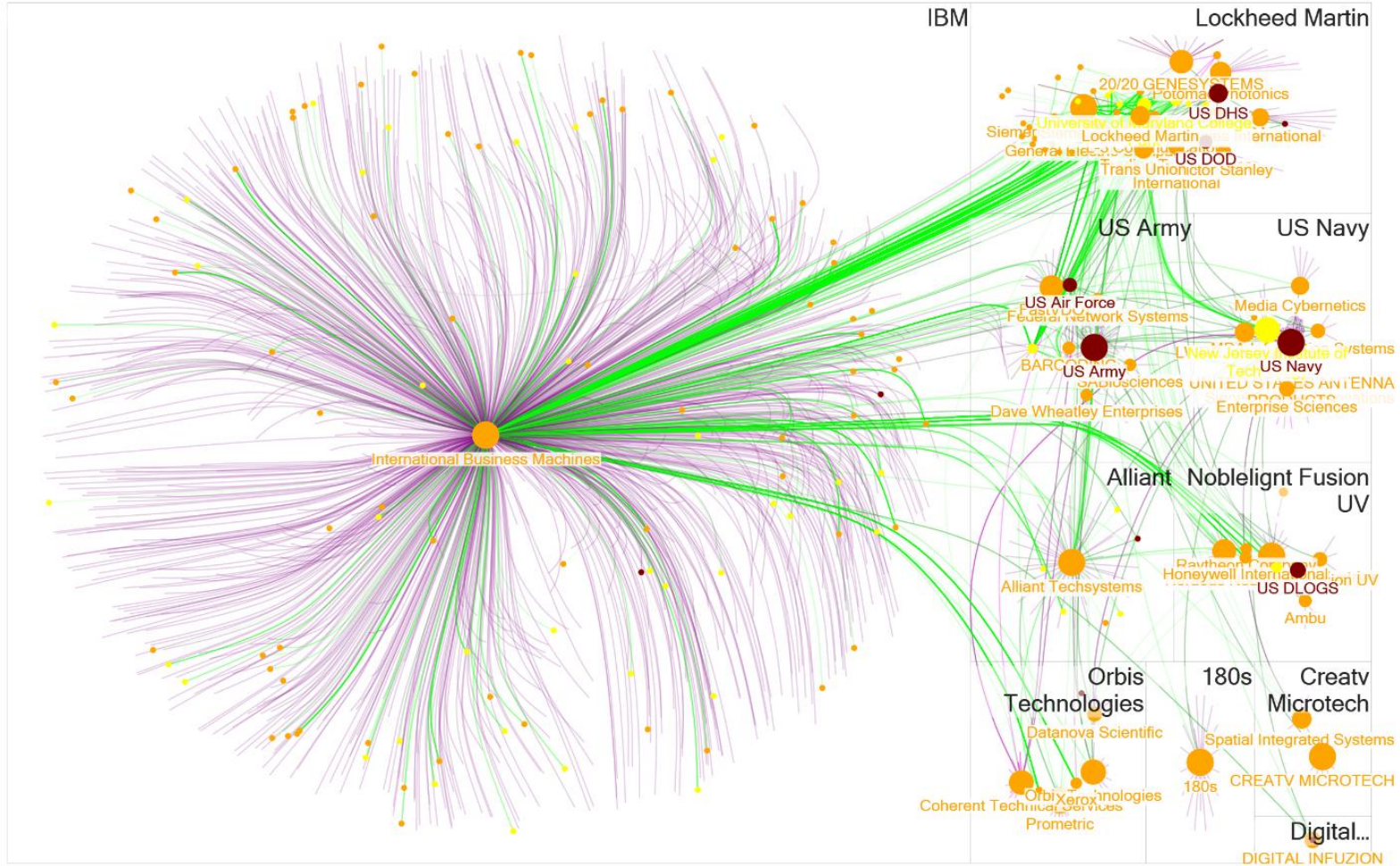
DUNS	Vendor Name	Average Annual Dollars Obligated, 2011-2015
134303192	Hewlett-Packard Company	\$46,907,424
556054591	Force 3, Inc.	\$31,005,145
193694577	Cray Inc.	\$26,840,000
103933453	BAE Systems Technology Solutions & Services Inc.	\$18,733,886
830660739	Agentase, LLC	\$16,028,273
140766028	Silicon Graphics Federal, Inc.	\$14,324,986
153901095	Sybase, Inc.	\$13,796,551
003090198	AAI Corporation	\$12,795,937
003253788	Thales Communications, Inc.	\$12,127,213
194239018	Smiths Detection Edgewood Incorporated	\$10,418,819

Sources: USA Spending, RESI

The Information Technology cluster network, shown below in Figure 69, exhibits the same overall structural dynamics as the Telecommunications cluster network with IBM occupying the central location in the largest subnetwork. Few companies are able to compete effectively at the scale of IBM. Still, the dynamics of this cluster are similar to those of the

Telecommunications cluster and could be problematic if faced with a cluster-specific shock like a reduction in core funding or if IBM left the cluster.

Figure 69: Information Technology Cluster Network



Source: Tertius Analytics

Lockheed Martin, the U.S. Army, the U.S. Navy, Alliant, Noblelight Fusion and Orbis Technologies are other subnetworks in the group that show significant linkages with other subnetworks. However, in terms of connections, IBM is still the dominate member of this network. Lockheed Martin receives significant funding for this cluster, combining the funding that the Lockheed Martin Services, Inc. and Lockheed Martin Corporation receive the company receives over \$17 million yearly on average in this cluster.¹⁵⁷

7.1.5 Biopharmaceuticals Cluster Network

Figure 70 below shows the Biopharmaceuticals cluster network, which received a relatively low average of nearly \$36 million in annual DoD funding between 2011 and 2015. This cluster employs an estimated 5,529 individuals and has an average salary of \$75,051. In Maryland, this cluster has a location quotient of 1.15, indicating that the state has proportionally more workers in this cluster than the country as a whole. This value, combined with the fact that the cluster is identified by the SNA (which utilizes intellectual property through inclusion of patent information), signifies that this cluster could have growth potential and be a target for economic development.

Using USA Spending data, RESI constructed a list of the top vendors for the Biopharmaceuticals cluster. The cluster has 160 unique companies receiving DoD funding that are located in or performing work in Maryland, identified by DUNS number. The Biopharmaceuticals cluster has 12 vendors with unique DUNS numbers that received \$600,000 or more in average annual funding, detailed below in Figure 70. AcetRx Pharmaceuticals, Inc. was the largest vendor, receiving nearly \$13 million in annual DoD funding.

¹⁵⁷ As noted above the SNA uses patents, research grants, SBIR/STTR, and federal contract data for the analysis. The cluster analysis and the DoD vendor list uses USA Spending data, and the lists given in the vendor charts may or may not appear in the SNA database.

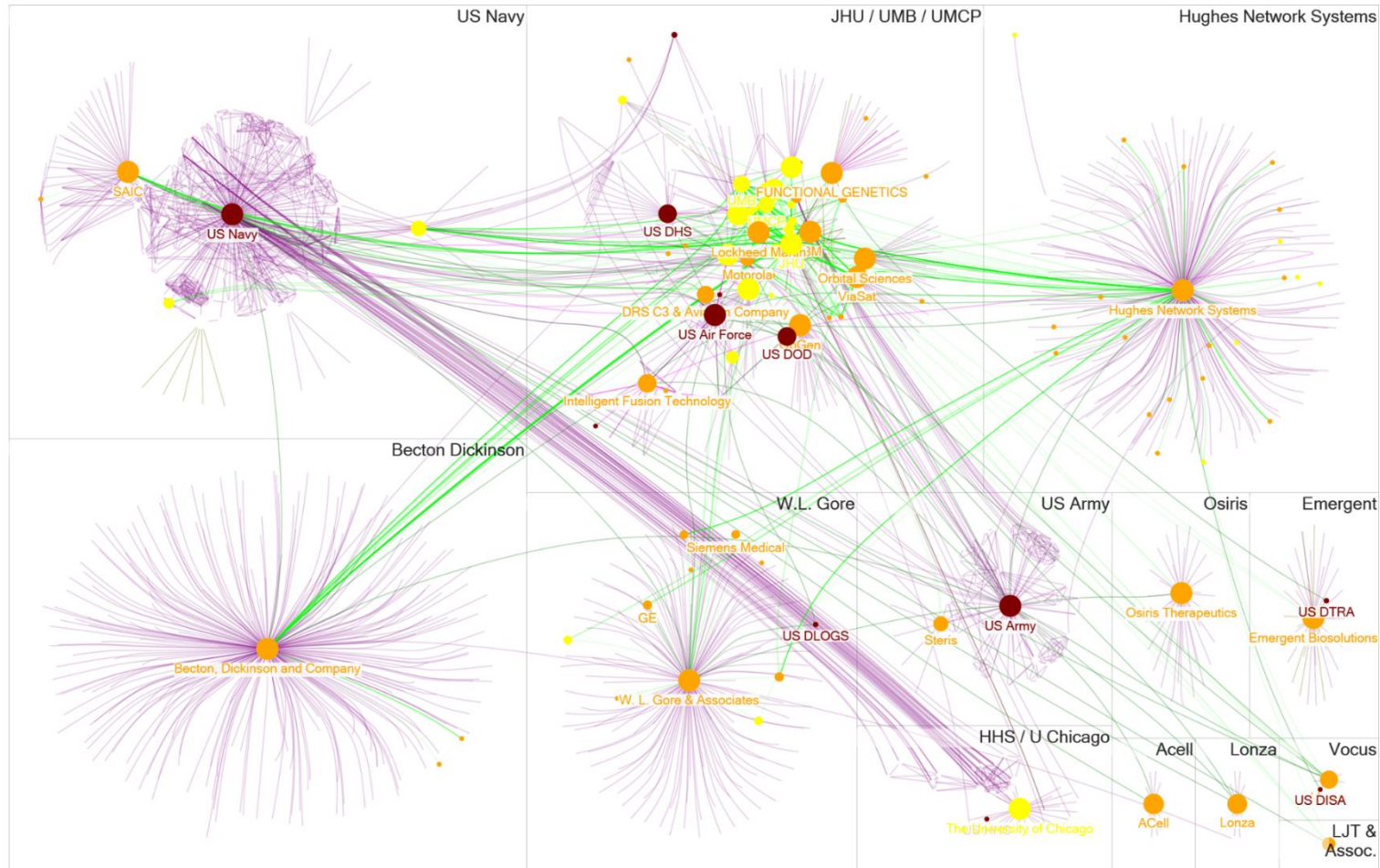
Figure 70: Maryland Top Biopharmaceuticals Cluster Vendors by DoD Average Annual Funding per Company

DUNS	Vendor Name	Average Annual Dollars Obligated, 2011-2015
789244774	AcelRx Pharmaceuticals, Inc.	\$12,647,049
967384921	Medimmune Biologics, Inc.	\$10,844,144
049504624	Meridian Medical Technologies, Inc.	\$10,776,152
190578984	Medimmune, LLC	\$9,624,988
026068138	Pharmakon Pharmaceutical, Inc.	\$3,000,000
833130532	Path sensors, Inc.	\$971,343
113033224	Meso Scale Diagnostics, LLC	\$902,910
806729547	Genvec, Inc.	\$847,171
115337123	Gen-Probe Incorporated	\$805,791
033429783	Diasorin Inc.	\$769,399
024671414	Greer Laboratories, Inc.	\$748,706
170755479	Thermo Fisher Scientific LLC	\$600,000

Sources: USA Spending, RESI

The Biopharmaceuticals cluster exhibits a unique pattern—one single firm does not dominate the largest subnetwork. Rather, it is a very complex, highly interconnected subnetwork with multiple firms, research institutions, and federal agencies, as detailed in Figure 71.

Figure 71: Biopharmaceuticals Cluster



Source: Tertius Analytics

Though several corporate “star” subnetworks comprise the network, each subnetwork exhibits some connection to the research cluster. The U.S. Army and Navy subnetworks show substantial internal patenting (purple ties) along with direct firm connections to Steris and SAIC (orange nodes), respectively. There is clearly a substantial defense-related component to the overall Biopharmaceutical cluster network, as discussed below.

The cluster is characterized by the important and differentiated pillars of Becton Dickinson, W.L. Gore, Osiris, Hughes Networks and Emergent Biosolutions. This shows that this particular cluster is not tied to one set of innovation-based activities, but is diverse across healthcare consumables (Benton Dickinson), medical devices (Gore), regenerative medicine (Osiris), mobile health and telemedicine (Hughes), and Vaccines (Emergent and others). Not only is this cluster diverse in products, but it also has dominant anchor companies in each group with a network of small business innovators.

These large defense industry stakeholders are tied into R&D hubs at the Navy, Army, and U.S. Department of Health and Human Services, along with smaller businesses and government contractors and prominent research universities. The diverse landscape represents a resilient subcluster of innovation-based activities due to the large agency footprint in Maryland with Walter Reed Army Institute for Research, Edgewood Chemical & Biological Center, and the Applied Physical Laboratory. The key component for Maryland-based activities to continue are these installations and, notably, the presence of Fort Detrick, which houses the majority of the U.S. Army Medical Research and Material Command (USAMRMC).

Becton Dickinson (BD) is an important incumbent provider of technology to the U.S. medical defense industry, supplying tubing, adapters, disposable syringes, blood collection devices, and medication containers to the military. From this list, BD provide the military with a stockpile of critical components. In addition, a significant amount of their R&D work in Maryland is tied to diagnostics in microbiology. While BD’s diverse products are important for Maryland, they are not a requisite for its presence here. Pulling BD into collaborative opportunities around R&D activities will only strengthen innovation ecosystems in Maryland.

W.L. Gore is Maryland’s largest medical device company. This entity has fundamental knowledge in vascular repair and tissue engineering, and supplies devices such as hernia meshes to both military and civilian populations. Much like BD, W.L. Gore’s innovation network is diffused through a network of other corporate collaborators and is not fundamentally driven by academic or federal agency ties. W.L. Gore’s greater business pursuits, which are predominantly in advanced materials, do not put the locational activities at risk from defense-related funding shifts.

Osiris is a significant player in the global landscape of regenerative medicine with products to improve the warfighter and for commercial and military related surgical settings. On behalf of

the U.S. Government, Emergent Biosolutions manufactures the nation's stockpile of the anthrax vaccine. As a company, Emergent has diversified into oncology and other life sciences technologies that have spun out in the U.S., but will remain integral to biodefense in Maryland due to its vaccine production in Baltimore.

Given its position in the top right corner of Figure 71, Hughes Network Systems appears to be an outlier at face value. However, telecommunications research and development has been tied into building solutions in mobile health and remote medical monitoring and treatment for many years. The innovation network for Hughes is similar to BD and Gore and does not pose any challenges to the growth of the subcluster.

7.2 Emerging Materials Cluster

As stated at the beginning of this section, there are differences between industry clusters and network clusters. Industry clusters are based on employment data, which tends to lag behind the innovation-based data (e.g. patents and research grants) used to construct network models. Thus, network clusters that do not align well with industry data (ie. NAICS codes) may indicate an emerging cluster that industry cluster methods cannot yet detect. This section was developed after reviewing the Aerospace and Defense cluster, the Biopharmaceuticals cluster, and the Telecommunications cluster in Sections 4, 5, and 6 and discovering that the social network findings indicated a Materials cluster is emerging from these three clusters. This cluster includes the actual physical materials, and the R&D that goes into them, used in industrial products. For example, Figure 72 shows Pixelligent Technologies is included in this cluster. This company produces high refractive index materials for lighting, displays, and optical components.¹⁵⁸

There are three possible reasons why Materials appears as a network cluster and not an industry cluster. First, as an industry cluster, Materials is strongly oriented towards NAICS codes in manufacturing. At the same time, nearly all scientific research and development are lumped together in NAICS codes and clusters for professional services or education and knowledge creation. However, when network clusters are identified they are based entirely on innovation-related relationships. One explanation is that while the network analysis is picking up groups of people and firms that are working together, that group becomes fragmented into multiple industry clusters due to their NAICS code classifications. In other words, Materials may not show up as an industry cluster due to limitations of NAICS-based industry cluster definitions.

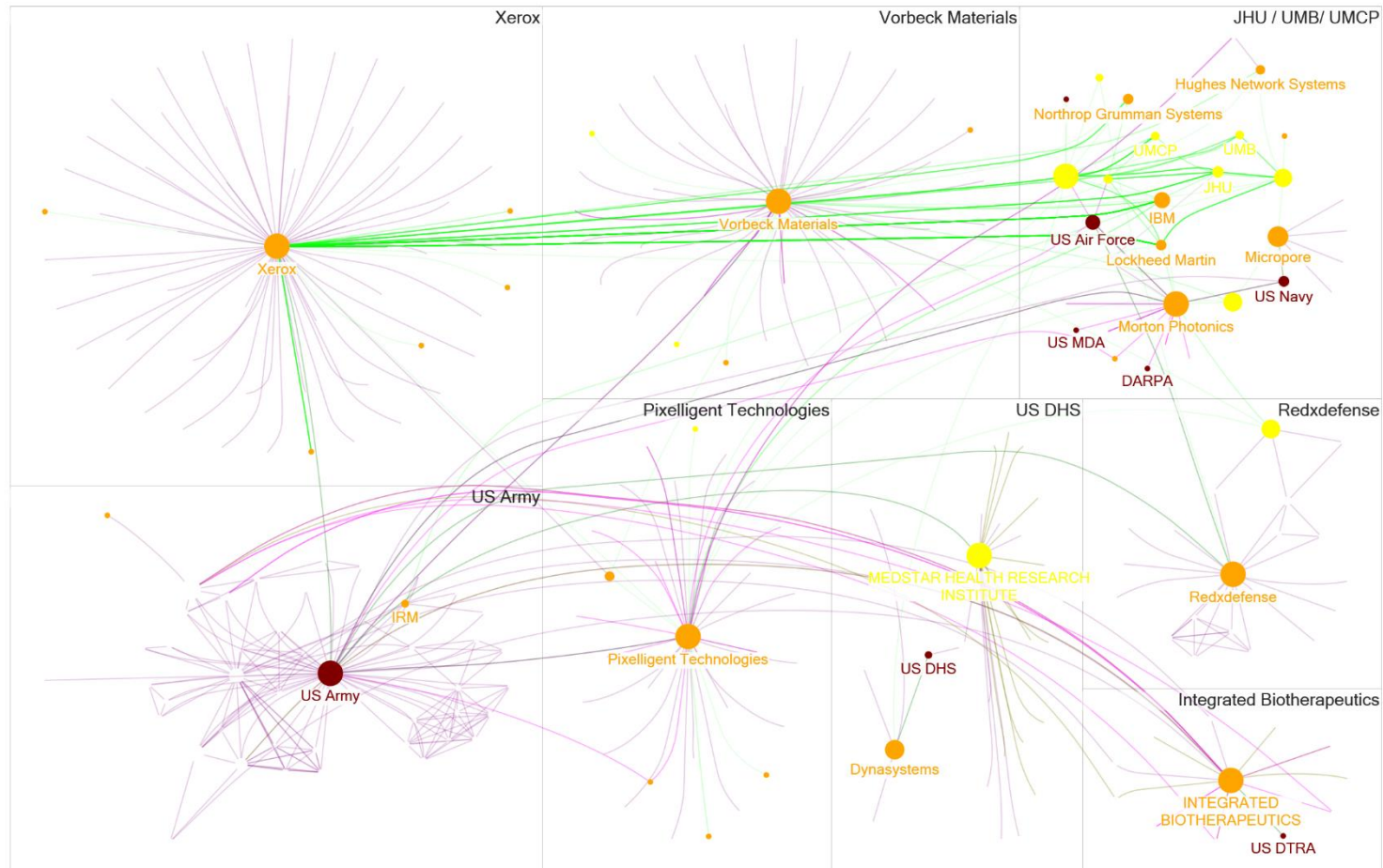
A second possibility is that the network analysis has detected an emerging cluster that is not yet visible in the industry cluster analysis because it is in its infancy. Innovation network models utilize the most recent innovation-related data, such as research grants and patent applications. Research and invention patenting activities typically precede production activities

¹⁵⁸ "Pixelligent," Pixelligent, accessed February 2, 2017, <http://www.pixelligent.com/>.

by several years, yet it is the lagging production-related employment that is measured in cluster analyses. It is possible that the innovation-related activities identified in the Materials network cluster will lead to new production jobs in a Materials industry cluster over the next few years.

A third possibility is that while Maryland supports an innovation network cluster in Materials, the production activities associated with that innovation occur in places outside of Maryland. Figure 72 highlights the Materials cluster.

Figure 72: Materials Network



Source: Tertius Analytics

Figure 72 represents a network cluster that does not correspond directly to a strong *industry* cluster in Materials. Innovation network analysis enhances industry cluster analysis, revealing internal cluster mechanics, analogous to x-rays illuminating the internal structure of the body. Thus, when the combined analysis of industry clusters and network clusters shows a materials research network without a corresponding industry cluster, it sends a clear signal to economic developers that this is an unusual situation requiring further investigation. In many cases, it also reveals where economic development interventions are likely to produce above-average impacts in terms of economic growth and job creation.

In terms of the Materials network itself, most of the corporate subnetworks are relatively sparse star networks(e.g. Xerox and Vorbeck Materials). The JHU/UMB/UMCP group shows a clear academic research affiliation with ties to multiple corporate subnetworks, and a strong U.S. Army group with extensive internal patenting and SBIR activity. The firms in this network may be relatively more resilient and able to move into new markets more easily, since new materials may have applications in multiple products and markets. Innovation itself becomes a source of resilience. The USAMRMC at Fort Detrick is a key network mobilizer for the growth of the materials innovation cluster. Xerox emerges as a large incumbent in this space with the increased advances in 3-D printing and imaging. This large company presence serves as an important anchor for coalition activities.

As noted, this is an emerging innovation sector within the defense industry composed highlighted by the marked growth firms of Vorbeck Materials (Jessup), Pixelligent Technologies (Baltimore), and RedxDefense (Rockville). Smart Connected devices (Vorbeck), optics using nanotechnology (Pixelligent) and advanced materials detection (Redx) represent differentiated yet interconnected product drivers within this cluster. Core competencies of these firms, combined with academic and agency collaborators and drivers, may likely produce dense clusters of these niche technologies if provided greater resources and support. The appeal of nurturing these types of firms is the very lucrative non-defense markets for the technologies. Medstar Health poses as a strong contributor, as their research and human factors laboratories pose as a significant market enabler for testing new smart materials in the healthcare setting.

The cluster analysis presented in Sections 4 and 5 provided a wealth of information on the economic impact of DoD funding on industry clusters in the State of Maryland. In addition, it provides details on the leading businesses performing work in those clusters, based on DoD spending. Section 6 introduced the SNA, which focused on observed innovation interactions between entities working in Maryland. Section 7 ties five network clusters that align well with the industry clusters presented in this report into the economic impact information presented in Section 4. Aside from the contribution that these networks make to innovation in Maryland (i.e. patents, research grants, federal contracts), four of the five network clusters receive significant DoD funding and create DoD-funded jobs. Further, the SNA showed that firms receiving large amounts of DoD funding were important in contributing to innovation and

collaborative activity in Maryland. Large vendors such as Lockheed Martin Corporation, BAE Systems Technology Solutions & Services Inc., and Northrup Grumman Corporation, which receive significant amounts of DoD funding and support a large number of jobs, are cornerstones to Maryland's economy as evident by their prominent role in the collaboration networks presented in this section. Section 8 will recap the findings from these sections, and then utilize information from Sections 4 through 7 to make specific recommendations on industry clusters that should be developed to diversify Maryland's economy in the future.

8.0 Conclusion

Companies in the State of Maryland received on average approximately \$18 billion from the DoD every year from 2011 – 2015. To meet the original aim of the study, RESI identified industry clusters that received DoD funding in the state and analyzed the flow of DoD funds to determine both the current and future economic impact of those funds in Maryland. This analysis was complimented by the social network analysis provided by Tertius Analytics that served as an x-ray of the cluster. This x-ray highlighted the collaborative activity within the clusters as well as across clusters, identifying specific core relationships between businesses, academia, and government institutions both within and outside of Maryland.

This section will provide information on the following:

- A brief overview of the main findings outlined in this report,
- Recommendations to guide the Maryland Department of Commerce in their future diversification efforts.

The recommendations, which are derived from the findings, will highlight the industry clusters and the regions most impacted by DoD funding, serving as a guide for future outreach and diversification efforts.

8.1 Statewide Findings

The DoD-funding received by businesses in Maryland is not distributed equally to industry clusters in the state. As a result, RESI analyzed the distribution of the DoD funds at the state and regional levels. An overview of the findings at the state level will be outlined here, while an outline of the findings at the regional level will be outlined in Section 8.2.

To get an understanding of the distribution of DoD funds across industry clusters in Maryland, RESI reviewed the secondary data on industry clusters, defining the clusters in the State, and then analyzed the USA Spending data. The aim of this multi-method approach to defining the industry clusters that would be reviewed in this study was to determine the level of DoD-funding, if any, that was attributed to the industry clusters from 2011 – 2015. As a result of this approach, RESI identified 11 clusters in Maryland that received at least \$300 million in DoD

funding per year on average over this time period, ranging from the Transportation and Logistics cluster to the Business Services cluster.

Beyond the concentration of DoD funding directed at these 11 clusters as well as their ability to employ a large number of individuals, RESI analyzed the economic impact of these cluster focusing on jobs and wages. Based on the 2011-2015 data, the total job impacts from DoD spending allocated to these top clusters accounted for over 86,000 jobs, or approximately 85 percent of the total jobs—direct, indirect, and induced—resulting from reported DoD funding to private contractors in the state. The jobs that are directly supported in these clusters by DoD funding are in general higher paying jobs, meaning that, in general, cuts in DoD funding will have the most direct impact on higher wage jobs.

The obligated DoD funding is one source of funding, of many, to the industry clusters that are receiving funding. The level of funding obligated by the DoD varies from 2011-2015 per cluster and therefore any fluctuations in DoD funding will have a varied impact on these clusters, given their other funding sources. Through this analysis, RESI found that the impacts of DoD spending are not limited to traditionally defined defense contractors. While clusters that would be expected to be greatly impacted such as Aerospace and Defense are significantly dependent, seemingly unlikely clusters are also highly impacted, such as the Local Real Estate, Construction, and Development cluster. This highlights the non-traditional aspects of DoD-funding in the State as well as the encompassing nature of the study.

RESI analyzed location quotients to better understand how these clusters impact the state's economy. From this location quotient analysis, RESI found that Maryland is home to five clusters with a location quotient meeting the 1.25 threshold.¹⁵⁹ These include the Business Services; Education and Knowledge Creation; Local Education and Training; Local Personal Services (Non-Medical); and Local Real Estate, Construction, and Development clusters. In terms of the allocation of DoD funds to these clusters, each of these clusters is dependent upon DoD funding and received more than \$1 billion in average annual funding obligations between 2011 and 2015. The Business Services cluster receives nearly four times as much as the next closest cluster, with nearly \$7.3 billion in average annual funding obligations between 2011 and 2015.

¹⁵⁹ Analyzing clusters by location quotient is helpful because it reveals the concentration of a local industry relative to the national concentration of that industry. Location quotients greater than one show that there is more employment in that cluster relative to the national average, while location quotients less than one indicate an employment concentration that is lower than the national average. Moreover, location quotients provide important information for economic developers when assessing local strengths. In general, an industry with a location quotient higher than 1.25 is expected to be an export industry and the industry is expected to produce more in the region than the region consumes.

In addition to analyzing the more established clusters in the state, RESI's analysis also accounted for emerging clusters or clusters that are not easily defined by NAICS codes. Through solely using NAICS codes, it would be easy to overlook clusters such as Research and Development (R&D) or Cyber security. However, through the review of the existing literature such as the SWOT analysis, RESI found that R&D spending was especially vulnerable to funding changes and that cyber security was likely to be a growth industry.

RESI estimates that between 2011 and 2015:

- The R&D cluster in Maryland received an average of nearly \$2.7 billion yearly in spending obligations. This cluster employs over 195,000 persons in Maryland.
- The Information Technology/Cyber Security cluster in Maryland received an average of nearly \$1.8 billion in annual spending obligations. This cluster employs over 203,000 persons.

From the increased collaboration between military, academia, and companies (outlined in the SNA) the R&D customized cluster will continue to be pertinent in Maryland, particularly with the federal research being conducted by the National Security Agency (NSA), the National Institute of Standards and Technology (NIST), and the Intelligence Advanced Research Projects Activity (IARPA) located in the state. RESI also expects the Information Technology/Cyber Security cluster to continue to flourish in the state with the research being carried out at Maryland academic institutions including the UMCP, UMBC, and JHU.

8.2 Regional Findings

The state-level findings focus on the distribution of DoD funds across industry clusters in the state. This section will focus on both the distribution of DoD funding across the five regions of the state as well as the clusters that receive the funding within each region.

Maryland's regions are diverse in terms of rural and urban populations, and this is largely reflected in the number of jobs and the average wages estimated to be located in each region. For example, the Capital and Central regions have nearly 2 million of the overall 2.4 million jobs that are able to be assigned at the regional level.¹⁶⁰ In addition, the average wages are significantly higher for the Capital and Central region, at approximately \$54,199 and \$52,630, respectively, than the rest of the state. In comparison, the Eastern Shore and Western Maryland are the two lowest average wage areas of the state, at over \$44,700 and over \$44,500, respectively. In general, this fits with the pattern that rural areas tend to have lower cost of living and lower wages than urban areas. Southern Maryland falls in between the two

¹⁶⁰ Note that due to data suppression that occurs at the county level the totals for the regions does not add up to the total for the state, and the state average salary is higher due to inclusion of data for the state that is assigned to the "999" county code for privacy purposes.

extremes in terms of wages, and has a value of approximately \$48,500. Southern Maryland is rural in nature, but still has a close proximity to Washington, D.C.

Mimicking the job and wage distribution, the Capital and Central regions of Maryland received the vast majority of Maryland's DoD funding obligations, at over \$15.5 billion annually on average, between 2011 and 2015. During this time, the remaining funding was provided to companies in Southern Maryland, which received nearly \$2 billion on average per year. The Eastern Shore, and Western Maryland receive relatively little DoD Spending, averaging nearly \$174 million and over \$77 million yearly, between 2011 and 2015.

Southern Maryland is the most dependent on DoD funding in terms of total jobs derived from the spending compared to total jobs overall. Proportionally, the region receives the largest share of DoD spending obligations in terms of funding-to-jobs. RESI's impact analysis indicates that DoD funding in Southern Maryland is expected to support 7,600 direct, indirect, and induced jobs annually or approximately 8.88 percent of the region's total private non-farm jobs in 2014. Using the distribution of DoD funding across clusters in the region from 2011 – 2015, RESI estimates that approximately 63 percent of these 7,600 jobs will be from spending in the Business Services cluster. In comparison, the same analysis indicates that DoD funding in the Capital region is predicted to support 40,000 direct, indirect, and induced, jobs annually over the next ten years. This amounts to 4.85 percent of the region's total private non-farm jobs in 2014. Using the distribution of DoD funding across clusters in the region from 2011 – 2015, RESI estimates that approximately 40 percent of these 40,000 jobs will be from spending in the Business Services cluster. This comparison between the Southern Maryland region and the Capital region highlights the diverse sources of funding (DoD and non-DoD) that impact the economy of the Capital region (due to the lower impact on jobs derived from DoD funding) and the main source of funding (DoD) impacting the economy of Southern Maryland. The considerable economic impact of DoD funding on the Southern Maryland region will be addressed as a point of interest in the recommendations below.

8.3 Social Network Analysis Findings

The SNA conducted by Tertius Analytics highlighted the collaborative activity, or lack thereof, within clusters as well as between clusters in Maryland. Through Tertius Analytics' proprietary dataset, relationships between military, academia, and private companies were outlined in the SNA. The overwhelming majority of the relationship existed within Maryland with Tertius Analytics finding significant collaboration between large defense contractors and major universities in Maryland; notably, Johns Hopkins; University of Maryland, Baltimore; University of Maryland Baltimore County; and University of Maryland, College Park. From the SNA, major defense contractors in the state include Lockheed Martin, International Business Machines (IBM), Boeing, and Honeywell International. Examples of these collaborations include patents, research grants, and federal contracts. Collaborations between universities and defense contractors are an asset to the state and foster innovation within the defense industry.

The SNA also found that certain innovation networks appear to be vulnerable due to their dependence upon a single company to connect members of the network. For example, the Communications Equipment and Services cluster is entirely dependent on Telecommunications Systems, Inc. This dependency is a significant threat, since any innovation originating from this cluster would suffer a serious shock if something happened to that central company. Similarly, if that company experiences a serious shock, the local supply chain surrounding that company would be impacted.

According to the SNA, the main industry clusters supporting innovation in Maryland include the Aerospace Vehicles and Defense, Biopharmaceuticals, Business Services, Communications Equipment and Services, and the Information Technology and Analytical Instruments industry clusters. Collectively, these clusters employ over 355,000 Marylanders and pay an average annual wage of approximately \$77,500.¹⁶¹ The SNA also showed an emerging Materials network, which is being supported by the defense industry and originating from the Aerospace and Defense network, the Bio network, and the Telecommunications network.

8.4 Recommendations

Using the main findings from this report, RESI has developed three recommendations to guide the Maryland Department of Commerce in their future company outreach and state cluster diversification strategy. These recommendations focus on diversifying the revenue streams of industry clusters and regions that are heavily dependent on DoD-funding. The analysis in Sections 4 and 5 highlighted which clusters receive the largest share of DoD funding in the state from 2011 - 2015, and have the largest estimated impact on total jobs in the state. These sections are the basis for the recommendations outlined below.

8.4.1 Diversifying DoD-Dependent Clusters in Maryland

Comparing the total job impacts from the DoD spending to the amount of employees in each cluster demonstrates the relative impact on overall employment that each cluster has on the state's economy. As detailed in Sections 4.1.2, the state's top 11 clusters by DoD spending from 2011 to 2015 all received at least \$300 million. Three of these clusters – (1) Water Transportation, (2) Communications Equipment and Services, and (3) Aerospace Vehicles and Defense – have a disproportionate impact on total jobs supported due to DoD spending, compared to their total employment estimates for the state.^{162,163} For example, RESI estimates that DoD spending for services in the Water Transportation cluster, which includes naval contracts for ship building, will support over 5,347 direct, indirect, and induced jobs annually on

¹⁶¹ Cluster employment data was estimated using U.S. Census CBP data for 2014. Wage estimates were calculated using occupation profile and wage data for industries in Maryland from BLS OES data for 2015. In both cases the data used was the most recent available.

¹⁶² See section 4.1.6. RESI is using total estimated jobs supported in this report because it gives a better indication of how DoD spending at the cluster level impacts Maryland's overall economy.

¹⁶³ See section 4.1.1, 4.1.2, and Appendix E. Estimates here are based on the 2014 CBP data.

average over the next ten years. In addition, RESI estimates that the cluster itself employed only 4,469 people in the state, in 2014. Focusing on the Communications Equipment and Services cluster DoD funding supports an estimated 5,586 direct, indirect, and induced jobs annually on average in Maryland, while the cluster was estimated to employ 10,725 individuals, in 2014. DoD spending in the Aerospace Vehicles and Defense cluster is estimated to support 5,418 direct, indirect, and induced jobs annually on average in Maryland, while the cluster was estimated to employ 10,881 workers, in 2014. Essentially, due to the high level of DoD funding that these three clusters receive and the number of individuals that they employ, their employee positions are heavily funded by DoD funds.

Of these three clusters, the Communications Equipment and Services cluster and the Water Transportation cluster have DoD funding heavily concentrated in contracts to Lockheed Martin Corporation. Focusing on the Water Transportation cluster, Lockheed Martin Corporation, has an average yearly funding level of over \$800 million for spending on activities in this cluster, which is over 94 percent of the spending in the Water Transportation cluster of \$871 million spent in the state. The Communications Equipment and Services cluster is also dominated by the Lockheed Martin Corporation, which received approximately \$348 million in funding for contracts for activities classified in this cluster. For the state, there was a total of \$1.1 billion on average spent annually for these activities. In comparison, the Aerospace Vehicles and Defense cluster has AAI Corporation as the largest contractor in this cluster and receives over \$486 million of the over \$1.2 billion spent on average annually in Maryland.

RESI's analysis found that these three clusters should be targeted for economic development efforts aimed at diversifying their revenue sources. While Lockheed Martin and AAI are global corporations that can absorb a fluctuation in DoD funding, they are also valuable economic drivers in the state that have a supply chain of smaller businesses that may not be as agile. Based on this, the aim of this finding would not be to diversify Lockheed Martin or AAI; rather, it would be to focus on conducting outreach with these smaller businesses in the clusters' supply chain to target alternative sources of revenue. To make the outreach efforts as successful as possible, it is recommended that the state provide matchmaking events to small businesses from these clusters that would be impacted by a reduction in DoD funding. These events would be theme based, with more than one industry represented to encourage a collaborative environment. Economic developers would need to have an intimate knowledge of both the businesses in attendance as well as their products to create a forum for matchmaking versus a traditional networking event. To incentivize participation and future collaboration, economic incentives to small businesses that are willing to diversify their funding streams through successful collaborative efforts could be provided.

8.4.2 Diversifying Integral Firms

In Section 5, RESI reviewed the forecasted impact based on DoD funding obligated from 2011 – 2015 on clusters at the regional level in Maryland. By focusing on the five regions in the state,

RESI analyzed the flow of DoD dollars at a more granular level, highlighting the distribution of funds across the regions and the clusters. After identifying the top clusters in each region by the amount of DoD funds obligated to it, RESI then sought to identify the DoD vendor receiving the highest amount of DoD funds in each cluster. For example, RESI found that the Business Services cluster dominated the Capital region for DoD funding, receiving over \$3.7 billion per year from the DoD. During this period, BAE Systems Technology Solutions and Services Inc. received the highest amount of DoD funding in that cluster in the Capital region with over \$600 million obligated regionally. A diverse array of other companies ranging from Hewlett-Packard Company to IBM to Lockheed Martin occupied top spots within other clusters in the Capital region.

Not all regions in Maryland had this level of diversity in the companies occupying the top vendor lists per cluster. As reviewed in Section 5, in two regions—the Eastern Shore and Western Maryland—the same company was listed as a top vendor across multiple clusters. For the Eastern Shore, the Federal Resources Supply Company received the largest funding obligations from the DoD for five of the top ten clusters, including: Aerospace Vehicles and Defense, Distribution and Electronic Commerce, Medical Devices, Furniture, and Information Technology and Analytical Instruments. Average annual funding to this company for these five clusters amounts to approximately \$54.5 million. In Western Maryland, a similar situation is present with the company Garrett Container System Inc. This company was the top vendor for five of the top ten clusters in the region including: Recreational and Small Electric Goods, Apparel, Downstream Metal Products, Medical Devices, and Local Industrial Products and Services. Average annual funding to this company for these five clusters amounts to approximately \$8.1 million.

As each of these respective vendors span several clusters in these regions and receive a high-level of DoD funding (in contrast to the other vendors) they would be prime targets for diversification outreach efforts. In comparison to the three other regions in the state, neither the Eastern Shore region nor the Western Maryland region is particularly dependent on DoD funding. However, these two companies, which may have a local supply chain are receiving a high-level of funding from the DoD. As a result, a proactive approach to diversifying these companies is still recommended. Given the breadth of their products and services, impacting multiple clusters, the diversification effort should be aimed at diversifying the vendors funding sources.

8.4.3 Diversifying Southern Maryland

From the findings in Section 5, RESI identified clusters in each of Maryland's five regions that received DoD funding from 2011 -2015 and have a considerable economic impact – jobs and wages- in each region. The analysis of these clusters highlighted that some regions in the state are more vulnerable to fluctuations in DoD funding than others. For example, the Capital and Central regions house clusters that receive a large amount of DoD funding that impacts local

employment; however, these regions also house a diverse array of other clusters that are not relying on DoD funding. In contrast, RESI identified the Southern Maryland region as an area of particular concern given the regional clusters high reliance on DoD funding, limited other clusters in the region, and high-skilled workforce. While this region's dependence on DoD funding has been noted throughout this report as well as in other literature, potential ways to diversify this region will be outlined here.

For Southern Maryland, RESI recommends five clusters that should be targeted for diversification efforts. These clusters are presented in order of average yearly DoD funding, including:

- Business Services (\$1,352 million),
- Transportation and Logistics (\$172 million),
- Aerospace Vehicles and Defense (\$80 million),
- Communications Equipment and Services (\$65 million), and
- Information Technology and Analytical Instruments (\$19 million).

In terms of economic impacts, DoD spending in the Business Services cluster is estimated to support 4,824 direct, indirect and induced jobs annually on average over the next ten years, while it is estimated that there were approximately 15,089 jobs in this cluster in total in the region in 2014. DoD spending in the Transportation and Logistics cluster is estimated to support 974 direct, indirect, and induced jobs annually on average over the next ten years, while the cluster was estimated to employ approximately 413 in the region in 2014. DoD spending in the Aerospace Vehicles and Defense cluster is estimated to support 260 direct, indirect, and induced jobs in the region annually on average over the next ten years, while 107 jobs were estimated to be in the region in the cluster in 2014. For the Communications Equipment cluster RESI estimated that 255 jobs direct, indirect, and induced jobs will be supported on average annually over the next year, and that there were 189 total in region in 2014. Lastly, the Information Technology and Analytical Instruments cluster was estimated to support 60 direct, indirect, and induced jobs, annually on average over the next ten years, and to have only employed 16 workers in the region in 2014.

These clusters contribute a high number of jobs to the region and, in comparison to the rest of the jobs in the region, the cluster jobs have high wages. All of the clusters have an estimated wage that is greater than the estimated average wage for the region of approximately \$48,500 annually. The Business Services cluster is estimated to have an annual average wage of over \$78,100. The Transportation and Logistics cluster, has the lowest wage of these clusters, and is just above the regional average, with an estimated average wage over \$49,000 annually. The Aerospace Vehicles and Defense, has the second highest wage of any cluster in the region, paying an estimated annual average wage of over \$85,300. The Communications Equipment and Services is estimated an annual average wage of \$71,200. Lastly, the Information

Technology and Analytical Instruments is estimated to pay the highest annual wage at over \$86,000.

Based on the information presented thus far in this subsection, it can be assumed that the high-wage jobs created by DoD funding in Southern Maryland are for high-skilled individuals. With little diversity in the regional economy and the rural nature of Southern Maryland, a reduction in DoD funding to the region could have both short-term and long-term effects. In the short-term, the negative economic impact on jobs and wages associated with the DoD dependent clusters would translate into a higher unemployment rate. In the long-term, with limited absorptive capacity, the high-skilled workers in the region may leave having an impact on the indirect and induced jobs in the wider regional economy and potentially the housing prices.

Taking these points into account, RESI recommends that key stakeholders in the region, such as military installation representatives, business organizations, university and college representatives, and the local governments in each of the counties that comprise Southern Maryland meet to take an inventory of the skills of their workforces as well as the businesses that they have in the area. The aim of these meetings three-fold. First, the meetings would be used to ascertain the industry and workforce strengths of the region. Second, the meetings would be a way for the individual counties that comprise the region to work together. This is an important component as any plans derived at the regional level will be more effective if there is county-based stakeholder buy in. Third, the meetings need to highlight the urgency of the matter, noting the economic impact of a reduction in DoD funding in the region, to incentivize all of the stakeholders present to take action.

Taking the information provided in this report, one potential example of using the existing regional strengths to diversify is by focusing on the Electric Power Generation and Transmission cluster and the Local Utilities cluster. The Electric Power Generation cluster is prominent in the region due to the presence of the Calvert Cliffs Nuclear Power plant. In addition, the Local Utilities cluster is also relatively strong in the area, with a location quotient of 1.44. Having these two clusters in the same region, and potentially collaborating together, could enable the development of energy from other sources. There is potential for renewable energy projects, especially solar in the region.

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Appendix A: Data Collection and Analysis Overview

This appendix will provide a detailed overview of the data used in Sections 4, 5, 6, and 7. This data includes primary and secondary data as well as the data used in the social network analysis completed by Tertius Analytics. The approaches that were used to analyze the data are also explained in detail in this section.

A.1 Secondary Data & Secondary Analysis Review

Data for this analysis was collected from a variety of different sources. The primary two data sets processed for estimates and calculations were County Business Pattern (CBP) data from the U.S. Census Bureau, and the Department of Defense (DoD) spending from USA Spending. This strengths and limitations of this data will be discussed here along with an explanation of data analysis approach.

A.1.1 County Business Pattern Data

RESI collected County business Pattern (CBP) data from the U.S. Census Bureau for every county in Maryland.¹⁶⁴ This dataset contains the number of employing establishments, the number of employees, and payroll information. The big advantage to CBP data over BLS Quarterly Census of Employment and Wage (QCEW) data is that when there is data suppression due to too few employers, CBP gives the ranges of employment. These ranges are for 1 to 4, 5 to 9, 10 to 19, 20 to 49, 50 to 99, 100 to 249, 250 to 499, 500 to 999, 1000 to 1,499, 1,500 to 2,499, 2,500 to 4,99, and over 5,000 or more. RESI used the mid-point for the estimate of employment for each of these ranges. For the 5,000 or more category, RESI used 5,000 as the estimate for employment for that establishment. These estimates were then merged with cluster definitions using six-digit NAICS codes.

Figure 73 shows the county and equivalent Federal Information Processing Standard (FIPS) code RESI used to merge the employment county estimates to the regional level. Due to the way that data is reported by CBP, over 32,000 estimated jobs cannot be mapped to a region, because the county FIPS code is reported as "999." As a result, regional estimates will not add up to the same level as State estimates and regional estimates are likely to be biased downward.

¹⁶⁴ "CBP Data Tables," U.S. Census Bureau, accessed September 14, 2016, <http://www.census.gov/programs-surveys/cbp/data/tables.html>.

Figure 73: County Region Distribution

County FIPS Code	County Name	Region
1	Allegany County	Western
3	Anne Arundel County	Central
5	Baltimore County	Central
9	Calvert County	Southern
11	Caroline County	Eastern Shore
13	Carroll County	Central
15	Cecil County	Eastern Shore
17	Charles County	Southern
19	Dorchester County	Eastern Shore
21	Frederick County	Capital
23	Garrett County	Western
25	Harford County	Central
27	Howard County	Central
29	Kent County	Eastern Shore
31	Montgomery County	Capital
33	Prince George's County	Capital
35	Queen Anne's County	Eastern Shore
37	St. Mary's County	Southern
39	Somerset County	Eastern Shore
41	Talbot County	Eastern Shore
43	Washington County	Western
45	Wicomico County	Eastern Shore
47	Worcester County	Eastern Shore
510	Baltimore City	Central

Sources: CBP, RESI

A.1.2 Occupational Employment Statistics Data

Due to data suppression issues with salary for the CBP data, RESI used OES data to estimate occupation category breakdowns and wages for each cluster.¹⁶⁵ OES provides a crosswalk of industries at the four-digit NAICS code levels to occupational breakdowns. This data also includes average salaries for those occupations by industry sector. RESI first estimated total employment in each six-digit NAICS sector. OES data was collected at the four-digit level, for each four digit-NAICS code by major occupation category. These were mapped to corresponding six-digit NAICS codes, by using the first four-digits of each category's code. RESI employed this method for estimating wages because it allowed for occupation estimates and

¹⁶⁵"Occupational Employment Statistics," U.S. Bureau of Labor Statistics, accessed September 27, 2016, <http://www.bls.gov/oes/tables.htm>.

provided greater detail of estimates since it allows for estimations even when data suppression is present.

A.1.3 USA Spending Data

USA spending data provides a large amount of information, but requires significant processing to enable analysis. All work that was awarded to a vendor based in Maryland, or listing Maryland as the place of performance is used for this analysis. This has the potential of inflating the numbers, as not all of the money is spent in Maryland, but there is no certain way to know the exact workings inside companies.

Before starting the analysis there were a few data issues that needed to be addressed to allow for RESI's analysis. First, since the data does not include county information for contractors, the data needed to be geocoded in other ways. Spending USA data has been geocoded and joined to the other datasets by NAICS codes to enable a detailed state and regional analysis of DoD spending by industry groupings by the Center for GIS at Towson University. The data for this merge was extracted from USA Spending on June 15, 2016.

The study utilized NAICS codes from USA Spending for assigning defense spending for both the cluster and economic impact analysis. USA Spending includes over \$300 million entries with outdated NAICS codes. To bring these observations into the analysis, 2002 and 2007 NAICS codes were mapped to 2012 NAICS codes using the NACIS code crosswalk from the U.S. Census Bureau.¹⁶⁶ The NAICS codes were used to map to the cluster definitions, and to map to the REMI PI+ industry groupings for forecasting impacts. Once these steps were completed, there were still a number of observations that did not have a NAICS codes. Since these data did not have the ability to be mapped, they were not included in the analysis. Figure 74 shows the number of missing observations and the value of those observations. These missing observations account for roughly .06 to .33 percent of the totals.

Figure 74: Number of Missing NAICS and Corresponding Dollars Obligated by Fiscal Year

Fiscal Year	Missing NAICS	Dollars Obligated	Percent of Dollars Obligated per Year
2011	122	\$47,440,251	0.25%
2012	74	\$63,588,774	0.33%
2013	51	\$37,834,900	0.22%
2014	38	\$9,920,903	0.06%
2015	28	\$13,804,559	0.08%

Sources: RESI, USA Spending

¹⁶⁶ "North American Industry Classification System: Concordances," U.S. Census Bureau.

USA Spending data also includes details on the type of category of product or service procured. To define the spending for R&D and for Information Technology and Cyber Security performed in Maryland, RESI used the “psc_cat” variable in USA Spending. This variable provides a categorization of the detailed “product or service code” variable.¹⁶⁷ Missing “psc_cat” observations were filled in based on the product or service codes, when the “psc_cat” variable was missing and the “product or service code” variable was defined.

The time period for the analysis was determined to be for the five-year period between 2011 and 2015. This time period was selected to keep the analysis current, and to maximize the quality of the data. USA Spending data has improved in quality over time as evidenced by the number of missing NAICS code data exhibited in Figure 74.

Figure 75 shows that DoD funding has generally decreased from a high in 2012, both in Maryland as whole and regionally. A similar situation has been occurring across all levels—national, state, and regional. This is particularly noticeable in the post-2013 period with the winding down of war funding as well as the impact of sequestration.

¹⁶⁷ USA Spending, "USAspending.gov Data Downloads Data Dictionary," accessed October 4, 2016, <https://www.usaspending.gov/DownloadCenter/Documents/USAspending.govDownloadsDataDictionary.pdf>.

Figure 75: Annual DoD Funding Obligations by Region (Spending in \$Millions)

Region	2011 Spending	2012 Spending	2013 Spending	2014 Spending	2015 Spending	Average
Capital Region	\$8,675,189,199	\$8,450,174,276	\$7,357,105,943	\$7,316,160,345	\$6,626,862,463	\$7,685,098,445
Central Region	\$8,069,691,366	\$8,528,268,203	\$7,472,301,922	\$8,158,467,302	\$8,182,390,752	\$8,082,223,909
Eastern Shore	\$195,599,649	\$140,891,155	\$108,541,005	\$119,540,412	\$277,704,600	\$168,455,364
Southern Maryland	\$1,991,431,236	\$2,095,563,303	\$1,795,231,529	\$1,890,594,968	\$1,948,732,674	\$1,944,310,742
Western Maryland	\$75,285,305	\$91,928,948	\$81,075,242	\$58,249,077	\$101,276,606	\$81,563,036
Maryland Total	\$19,007,196,755	\$19,306,825,885	\$16,814,255,641	\$17,543,012,104	\$17,136,967,095	\$17,961,651,496

A.1.4 Secondary Data Analysis

The secondary data outlined above was analyzed with a focus on both the current economic impact of the clusters in the State of Maryland, and the forecasted economic impacts of these clusters over the next ten years. To quantify the economic impacts of a specific economic event or events, RESI uses the Regional Economic Models, Inc. (REMI) PI+ model version 1.7. The REMI PI+ model is a high-end dynamic modeling tool used by various federal and state government agencies in economic policy analysis. Utilization of REMI PI+ helps RESI to build a sophisticated model that is calibrated to the specific demographic features of the study area. This model enumerates the economic and fiscal impacts of each dollar earned and spent by the following: employees relating to the economic events, other supporting vendors (business services, retail, etc.), each dollar spent by these vendors on other firms, and each dollar spent by the households of the event's employees, other vendors' employees, and other businesses' employees.

REMI PI+ features the ability to capture price effects, wage changes, and behavioral effects through time. The REMI PI+ model allows RESI to capture the effects occurring between industries and minimize the potential for double counting in employment, output, and wages. The ability to capture effects throughout a span of time provides a detailed representative of an economic event over time and its effects on the study area.

To better understand the spending and benefits in not only each region but in each cluster, RESI estimated the cluster-level employment impacts using the spending-to-wage ratio for each individual cluster in every region. This ratio was derived by dividing the funding obligation amount by the average wage for each cluster at the regional level. Next, the ratio was summed for all clusters in each region to obtain the regional sum of spending-to-wage ratios. The percentage of benefits accruing from each cluster was derived by dividing each individual cluster's spending-to-wage ratio by the regional sum of the spending-to-wage ratio across all clusters. This percentage was then multiplied by the number of local jobs estimated for each region. This method was adopted because the dynamic nature of the model does not allow for individual estimates to be independently pulled from the regional figures.

A.2 Maryland Defense Network Survey

During the course of the survey dissemination period for the data used in this report, from April 2016 until October 2016, there were four rounds of survey dissemination. The survey asked basic questions regarding business dynamics as well as more project-related questions regarding the companies' dependency on DoD funding. Alongside the survey questions, respondents were also asked to submit their supplier lists. The aim of requesting this list was to increase the sample, continue to survey a new group of companies impacted by DoD funding, and drill down further (beyond prime and first-tier companies) in the DoD supply chain in Maryland.

A.2.1 Survey Dissemination

In Round 1, RESI supplied Commerce with a list of companies that were pulled from USA Spending as well as from the Small Business Association (SBA) website. In total, 6851 unique companies were surveyed during this round with many companies being contacted through three email addresses associated with the company. The USA Spending data, with 4566 companies, was solely for prime and first-tier companies. The primary aim of surveying these companies was to get their self-reported dependency information as well as their supplier lists. The SBA data, with 2285 unique companies, was for small businesses that may be a part of the defense industry and may be second-tier+ in the supply chain. The primary aim of surveying these companies was to get them to self-verify their contribution to the defense industry (if any), acquire their self-reported dependency information as well as their supplier lists. Commerce also disseminated the survey to facilitators that were identified during the user groups that were held in the run up to and continued during the survey dissemination period. A list of user group attendees that worked as survey facilitators was not created. However, it is anticipated that facilitators would include regional economic developers, regional small business liaisons, council members, etc.

The response to the traditional survey in Round 1 was considerably higher than the response to the supplier list upload. RESI received 274 responses to the traditional survey from the USA Spending list and 108 responses from the SBA list.¹⁶⁸ Four supplier lists (not other company marketing material, which was common) were also submitted. To create the Round 2 survey dissemination list, RESI called 128 companies that responded to the survey but did not provide a supplier list. RESI chose these companies based on their response to the “can Commerce contact” question and aimed to call as many companies as possible before the next round of the survey. From those 128 companies, 20 percent noted that they did not have suppliers, they could not supply this information or they asked to be removed from any list and declined further participation. Of the remaining companies, seven verbally noted that they would forward the supplier list and only one company forwarded the list. This company forwarded a list of 600 unique businesses that were cross-checked with the Round 1 list. Approximately 200 companies remained after that check.

In Round 2, RESI supplied Commerce with a list of 225 companies that were listed as suppliers in Round 1. Given the check against the USA Spending data from Round 1, these 225 companies were believed to be second-tier+ companies. From this round, RESI received approximately 35 responses to the traditional survey and none of the companies provided a supplier list. Realizing the reduced response and the need for survey contacts in Round 3, RESI evolved their process.

¹⁶⁸ During Round 1, an additional 30 companies responded to the survey but they were not a part of the original list from USA Spending or SBA. These companies could have been forwarded the survey by companies in these lists or by a facilitator.

For Round 3, RESI received the names of the companies sent a smaller survey in the Southern Maryland region. RESI found email addresses for these companies and added them to the Round 3 list. At this time, RESI also noticed the lack of cyber security companies listed in the survey participant lists from the previous two rounds. Based on this, RESI began searching for reliable information on cyber security companies in Maryland. RESI mined the Cyber Security Maryland Cluster Map as well as the Commerce Cyber Security Directory, adding this information to the Southern Maryland companies to form the Round 3 list. In total, 94 unique companies were sent the survey in Round 3. As these companies were checked against the previous companies surveyed, it is assumed that all of these companies were second-tier+. From this list, RESI received approximately 27 responses to the survey. During this period, RESI also contacted the Small Business Liaison Offices at well-known prime contractors—Lockheed Martin, Northrop Grumman, BAE Systems, Booz Allen Hamilton, Mantech—in the State of Maryland requesting information on their supplier lists. While contact was established with more than one prime contractor, no supplier lists were provided.

The Round 4 survey list was a list of suppliers for the APG installation cross-checked against the companies surveyed in the previous rounds of the survey. After this cross-check, the list was narrowed down to 305 companies. Based on this cross-check, it is believed that these companies were all second-tier+ companies. From this round, approximately 51 companies responded to the traditional survey and none of the companies provided a supplier list. Given the low number of responses at this stage (August 2016) as well as the expertise of a local research center, RESI contracted the Schaefer Center for Public Policy at the University of Baltimore to continue conducting the survey via phone. The survey remained open for those who received the URL but the primary means of disseminating the survey from September 2016 onwards was through the Schaefer Center.

RESI provided the Schaefer Center with a call list focusing on the second-tier+ firms, then the SBA firms that may be a part of the DoD supply chain, then the prime or first-tier companies. This call list was composed of the contacts emailed the survey in the preceding rounds. A script was also provided to the Schaefer Center as well as the online survey URL. The number of questions in the survey was reduced during this period to the essential questions to encourage participation. Each company was called at least three times. During the phone survey period outlined in this report, 96 responses were entered into the survey tool. As the survey was open to both the phone respondents as well as live through the URL, it is estimated that a small percent of companies may have organically responded to the survey online during this period. However, the overwhelming majority of respondents during this period responded as a direct result of their interaction with the Schaefer Center. Over the entire survey period accounted for in this report, 591 companies responded – 477 in full and 114 in part – to the survey.

Due to the multiple methods of disseminating the survey – through email, via phone, through facilitators—a traditional response rate cannot be determined. In addition, the respondents

provided limited information that could be used for the cluster analysis. As a result, InfoUSA data was used to complete profiles of business survey respondents. However, this primary data is still useful. It will be used by Commerce to conduct outreach activity to companies that are highly dependent on DoD funding as well as by the RESI research team for other aspects of the project, namely the Maryland Defense Network (MDN) interactive supply chain tool.

A.2.2 Survey Analysis Overview

RESI collected the survey online responses and organized the survey data in three stages:

1. Create a filterable Excel spreadsheet.
2. Add the survey data gathered through the online survey tool to the spreadsheet.
3. Clean the survey data.

The filterable Excel spreadsheet was created by RESI for two purposes. First, it was generated with the ability to organize the survey results to easily identify where respondents failed to answer questions and, with it being filterable, identify any trends in the responses. Second, a spreadsheet was used in lieu of other data management tools as it allows for additional columns as well as additional rows of data to be easily added. The original spreadsheet had a column for every question that was on the survey. The spreadsheet was later manipulated with new columns added for additional data that could be found on each respondent through publicly available data, such as a business email address, a point of contact, and DUNS number.

The next step was to add the survey data gathered through the online survey tool (both full and partial responses) into the spreadsheet. The data was cut from the survey tool by RESI analysts throughout the course of the survey dissemination period (while maintaining the continuity of the survey) to continuously update the additional information from the publicly available sources. RESI also ensured that any survey data added to the spreadsheet was placed in the correct column, particularly after the number survey questions was reduced in September 2016. Please see Appendix A for more information on the survey dissemination and data collection.

Once the data was correctly added to the spreadsheet, RESI staff cleaned the data, removing duplicates. As many of the companies that were surveyed had more than one location in Maryland, “duplicate companies” were only those companies with the same name and the same address. If a company was verified as being a duplicate, RESI used the most complete response in the filterable spreadsheet. If both duplicates were complete, RESI relied on the most recently completed survey response. In addition, for the purposes of the cluster analysis, RESI also used data from InfoUSA to further support the partial survey responses, such as number of employees.

After the data were organized in these three phases, the filterable spreadsheet was used by RESI to find trends in the data that are outlined in Sections 4 and 5 of this report. Further analysis will be completed on the final dataset after the survey conclusion in December 2016.

A.3 Social Network Analysis

Tertius Analytics analyzed the following sources of data to complete the SNA:

- U.S. Patent and Trademark Office data on patent grants and patent applications,
- National Institute of Health (NIH) research grants,
- National Science Foundation (NSF) research grants,
- Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants, and
- USA Spending.

This section outlines how the data was organized for the analysis and how to interpret the findings from the networks presented in Sections 6 and 7.

A.3.1 Data Extraction, Cleaning and Matching

For each document taken from the above datasets, an activity network is extracted. Each activity network consists of nodes and ties. Nodes represent the individuals, organizations, institutions, and agencies listed in each document. They are depicted as dots on the network image. Node attributes include:

- Node type (individual, organization, institution, agency, or place);
- Node role (sponsor, recipient, contractor, subcontractor, assignee, inventor, principal investigator, establishment location, or residence location); and
- May include source-specific or general ID numbers (e.g. DUNS or Commercial and Government Entity Codes).

Network ties represent the relationships between nodes embedded in each document. They are depicted as lines on the network image. Tie attributes include:

- Tie type (patent, NIH, NSF, SBIR, STTR, contract, subcontract, location, weak);
- Tie value (may represent size of the grant amount or may simply be “1” indicating that the tie exists);
- Document number;
- Start date;
- End date;
- Technology classification (i.e. patent class or topic); and
- Keywords.

In terms of tie types, many of the examples provided are common knowledge, with the exception “weak ties.” In terms of innovation networks, this term refers to a potential connection between nodes based on similarities in the technological focus of the activities

being undertaken. For example, if two companies have applied for different patents with the same class and subclass, there is a suspected or potential relationship between those companies. They may be competitors or part of the same supply chain; or, they may have the potential for future collaboration. These technology-based suspected or potential edges are known as weak ties. Similarly, it should be noted that “tie values” can either be given a dollar figure or represented as “1: if a non-monetary relationship exists. For example, for research grants, including the dollar value may be useful for some types of analyses. It also allows for aggregating the total dollar volume of grants or contracts between two nodes. For many network metrics tie value beyond 0 or 1 is meaningless i.e. values greater 1 are treated as 1.

A.3.2 Social Network Overview

After extracting the activity networks, node names need to be cleaned and matched both within and across data sources. Cleaning involves fixing stray characters, extra spaces, punctuation, typos, etc. plus making sure that character encoding is consistent. Matching involves connecting records that refer to the same name. For example, I.B.M. would not match to International Business Machines; nor would IBM, Inc. Extra spaces, punctuation, abbreviations, and misspellings must all be identified and transformed. Differences in business type extensions also present difficulty. For example, the same company may have LLC, Inc., and Ltd extensions. While the differences may or may not be important for legal reasons they are typically moot when it comes to innovation. To deal with these and several other difficulties in matching records based on names, specialized data cleaning and matching algorithms have been developed that resolve about 80 percent of mismatches. The remainder are resolved manually as they are identified. This process is necessary to identify key nodes that connect subnetworks through their involvement in multiple activities.

Once the data was cleaned and matched, it was added to NodeXL, an add-in for Microsoft Excel that performs the analysis and generated the graphics for this report.¹⁶⁹ The software provides enhanced analytics and visualization in an easy-to-use package and offers several community-finding algorithms. The analysis makes extensive use of algorithms that map the connectivity of the data, such as the Clauset-Newman-Moore algorithm.¹⁷⁰ These algorithms tend to identify groups centered on specific organizations or institutions.

Once groups are identified, Tertius Analytics includes place and agency nodes and calculates the graph (network) metrics. Specific metrics are described and discussed in other sections of this report. These metrics, along with other node and tie attributes, are used to set the visual properties of the network model such as node size, shape, color, opacity, labeling, visibility, etc., and tie color, style, width, opacity, visibility, labeling, etc. Group labels may initially be set

¹⁶⁹ NodeXL is available through <https://nodexl.codeplex.com/>.

¹⁷⁰ Aaron Clauset, M.E.J. Newman, and Christopher Moore, “Finding Community Structure in Very Large Networks,” 1-4.

to either group numbers or the name of the largest node in each group. Through an iterative process, smaller sections of networks are analyzed to allow for a greater level of insight into the collaborative structures that drive innovation.

Appendix B: Additional Details for Largest Clusters by Spending

This appendix presents all of the NAICS code level spending details for the top clusters definitions presented in section 3.4. Specifically, the top five clusters from section 3.4.1, and the custom clusters that were created to better understand the policy implications of R&D and Information Technology/Cyber Security from section 3.4.2 are presented in detail here.

B.1 Business Services Cluster Spending by NAICS Code

The Business Services cluster receives nearly \$7.3 billion per year in obligated DoD funding, or approximately 40.6 percent of the total spending in Maryland. Figure 76 presents the average yearly spending by NAICS for Business Services related NAICS as reported by USA Spending for all 26 different NAICS codes receiving some funding in this category.

Figure 76: Average DoD Funding by NAICS Code in the Maryland Business Services Cluster¹⁷¹

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD Business Services Spending
541330	Engineering Services	\$3,900,165,526	26.72%
541519	Other Computer Related Services	\$581,629,896	3.98%
561210	Facilities Support Services	\$531,938,340	3.64%
541512	Computer Systems Design Services	\$508,764,041	3.48%
541511	Custom Computer Programming Services	\$471,336,358	3.23%
541611	Administrative Management And General Management Consulting Services	\$410,445,952	2.81%
541990	All Other Professional, Scientific, And Technical Services	\$218,730,021	1.50%
541513	Computer Facilities Management Services	\$209,280,652	1.43%
541618	Other Management Consulting Services	\$115,826,731	0.79%
541690	Other Scientific And Technical Consulting Services	\$113,999,868	0.78%
541614	Process, Physical Distribution, And Logistics Consulting Services	\$73,316,999	0.50%
518210	Data Processing, Hosting, And Related Services	\$63,947,404	0.44%
541310	Architectural Services	\$49,029,593	0.34%
541930	Translation And Interpretation Services	\$31,717,383	0.22%

¹⁷¹ Note that totals may not add up precisely due to rounding.

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD Business Services Spending
541612	Human Resources Consulting Services (2007), Human Resources And Executive Search Consulting Services (2002)	\$4,980,474	0.03%
561422	Telemarketing Bureaus And Other Contact Centers	\$4,280,121	0.03%
485999	All Other Transit And Ground Passenger Transportation	\$3,154,939	0.02%
532112	Passenger Car Leasing	\$1,797,760	0.01%
541199	All Other Legal Services	\$1,644,828	0.01%
561920	Convention And Trade Show Organizers	\$880,748	0.01%
541320	Landscape Architectural Services	\$800,400	0.01%
561421	Telephone Answering Services	\$771,990	0.01%
541340	Drafting Services	\$761,297	0.01%
561330	Professional Employer Organizations (Formerly Employee Leasing Services)	\$421,834	0.00%
561311	Employment Placement Agencies	\$78,154	0.00%
485320	Limousine Service	\$46,677	0.00%
Total Maryland Business Services Cluster		\$7,299,282,121	100.00%

Sources: USA Spending, RESI

B.2 Education and Knowledge Creation Cluster Spending by NAICS Code

The Education and Knowledge Creation cluster receives nearly \$1.9 billion per year in obligated DoD funding, or approximately 10.4 percent of the total spending in Maryland.

Figure 77 presents the average yearly spending by NAICS for Education and Knowledge Creation related NAICS as reported by USA Spending for all 15 different NAICS codes receiving some funding in this category.

Figure 77: Average DoD Funding by NAICS Code in the Maryland Education and Knowledge Creation Cluster¹⁷²

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD Education and Knowledge Creation Spending
541712	Research And Development In The Physical, Engineering, And Life Sciences (Except Biotechnology)	\$1,210,423,155	64.93%
541711	Research And Development In The Physical, Engineering, And Life Sciences	\$436,595,880	23.42%
611512	Flight Training	\$59,893,663	3.21%
541711	Research And Development In Biotechnology	\$45,861,172	2.46%
611430	Professional And Management Development Training	\$34,488,575	1.85%
611710	Educational Support Services	\$23,493,953	1.26%
611630	Language Schools	\$17,106,730	0.92%
611420	Computer Training	\$14,813,099	0.79%
611699	All Other Miscellaneous Schools And Instruction	\$9,883,888	0.53%
611310	Colleges, Universities, And Professional Schools	\$4,738,935	0.25%
611210	Junior Colleges	\$3,140,714	0.17%
541720	Research And Development In The Social Sciences And Humanities	\$3,124,671	0.17%
813920	Professional Organizations	\$571,988	0.03%
611513	Apprenticeship Training	\$149,599	0.01%
611691	Exam Preparation And Tutoring	\$25,728	0.00%
Total Maryland Education and Knowledge Creation Cluster		\$1,864,276,683	100.00%

Sources: USA Spending, RESI

B.3 Local Real Estate, Construction, and Development Cluster Spending by NAICS Code

The Local Real Estate, Construction, and Development cluster receives nearly \$1.5 billion per year in obligated DoD funding, or approximately 8.3 percent of the total spending in Maryland.

¹⁷² Note that totals may not add up precisely due to rounding.

Figure 78 presents the average yearly spending by NAICS for Real Estate, Construction, and Development related NAICS as reported by USA Spending for all 46 different NAICS codes receiving some funding in this category.

Figure 78: Average DoD Funding by NAICS Code in the Maryland Local Real Estate, Construction, and Development Cluster¹⁷³

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD Local Real Estate, Construction, and Development Spending
236220	Commercial And Institutional Building Construction	\$1,263,464,472	84.91%
541370	Surveying And Mapping (Except Geophysical) Services	\$47,622,340	3.20%
237310	Highway, Street, And Bridge Construction	\$39,663,044	2.67%
238220	Plumbing, Heating, And Air-Conditioning Contractors	\$29,775,586	2.00%
237110	Water And Sewer Line And Related Structures Construction	\$23,553,471	1.58%
238210	Electrical Contractors And Other Wiring Installation Contractors	\$17,934,739	1.21%
238990	All Other Specialty Trade Contractors	\$15,710,472	1.06%
238160	Roofing Contractors	\$13,015,764	0.87%
238290	Other Building Equipment Contractors	\$7,914,254	0.53%
238910	Site Preparation Contractors	\$7,901,566	0.53%
238390	Other Building Finishing Contractors	\$3,081,088	0.21%
531190	Lessors Of Other Real Estate Property	\$2,811,672	0.19%
238330	Flooring Contractors	\$1,896,590	0.13%
238320	Painting And Wall Covering Contractors	\$1,844,270	0.12%
238350	Finish Carpentry Contractors	\$1,390,744	0.09%
541191	Title Abstract And Settlement Offices	\$1,092,139	0.07%
238110	Poured Concrete Foundation And Structure Contractors	\$985,671	0.07%
238190	Other Foundation, Structure, And Building Exterior Contractors	\$917,328	0.06%

¹⁷³ Note that totals may not add up precisely due to rounding.

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD Local Real Estate, Construction, and Development Spending
236115	New Single-Family Housing Construction (Except For-Sale Builders)	\$874,083	0.06%
531110	Lessors Of Residential Buildings And Dwellings	\$816,237	0.05%
531120	Lessors Of Nonresidential Buildings (Except Miniwarehouses)	\$734,750	0.05%
423320	Brick, Stone, And Related Construction Material Merchant Wholesalers	\$659,659	0.04%
238140	Masonry Contractors	\$575,049	0.04%
327390	Other Concrete Product Manufacturing	\$525,955	0.04%
238310	Drywall And Insulation Contractors	\$521,074	0.04%
423740	Refrigeration Equipment And Supplies Merchant Wholesalers	\$502,114	0.03%
332322	Sheet Metal Work Manufacturing	\$339,259	0.02%
562991	Septic Tank And Related Services	\$264,065	0.02%
531210	Offices Of Real Estate Agents And Brokers	\$227,752	0.02%
531320	Offices Of Real Estate Appraisers	\$218,263	0.01%
236118	Residential Remodelers	\$207,989	0.01%
238120	Structural Steel And Precast Concrete Contractors	\$138,306	0.01%
423720	Plumbing And Heating Equipment And Supplies (Hydronics) Merchant Wholesalers	\$134,064	0.01%
444190	Other Building Material Dealers	\$113,976	0.01%
423730	Warm Air Heating And Air-Conditioning Equipment And Supplies Merchant Wholesalers	\$102,633	0.01%
238150	Glass And Glazing Contractors	\$102,273	0.01%
238340	Tile And Terrazzo Contractors	\$98,281	0.01%
237210	Land Subdivision	\$91,676	0.01%
238130	Framing Contractors	\$86,357	0.01%
423310	Lumber, Plywood, Millwork, And Wood Panel Merchant Wholesalers	\$45,566	0.00%
423330	Roofing, Siding, And Insulation Material Merchant Wholesalers	\$39,808	0.00%

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD Local Real Estate, Construction, and Development Spending
423390	Other Construction Material Merchant Wholesalers	\$21,171	0.00%
337212	Custom Architectural Woodwork And Millwork Manufacturing	\$19,920	0.00%
444110	Home Centers	\$18,873	0.00%
238170	Siding Contractors	\$14,782	0.00%
327320	Ready-Mix Concrete Manufacturing	\$7,871	0.00%
Total Maryland Local Real Estate, Construction, and Development Cluster		\$1,487,297,165	100.00%

Sources: USA Spending, RESI

B.4 Aerospace Vehicles and Defense by NAICS Code

The Aerospace Vehicles and Defense cluster receives over \$1.2 billion per year in obligated DoD funding, or approximately 6.9 percent of the total spending in Maryland. Figure 79 presents the average yearly spending by NAICS for Aerospace Vehicles and Defense related NAICS as reported by USA Spending for all seven different NAICS codes receiving some funding in this category.

Figure 79: Average DoD Funding by NAICS Code in the Maryland Aerospace Vehicles and Defense Cluster¹⁷⁴

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD Aerospace Vehicles and Defense Spending
336411	Aircraft Manufacturing	\$595,776,338	48.02%
334511	Search, Detection, Navigation, Guidance, Aeronautical, And Nautical System And Instrument Manufacturing	\$498,430,333	40.17%
336413	Other Aircraft Parts And Auxiliary Equipment Manufacturing	\$109,301,175	8.81%
336419	Other Guided Missile And Space Vehicle Parts And Auxiliary Equipment Manufacturing	\$23,163,488	1.87%
336412	Aircraft Engine And Engine Parts Manufacturing	\$11,407,528	0.92%
336414	Guided Missile And Space Vehicle Manufacturing	\$2,514,688	0.20%
336415	Guided Missile And Space Vehicle Propulsion Unit And Propulsion Unit Parts Manufacturing	\$174,427	0.01%
Total Maryland Aerospace Vehicles And Defense Cluster		\$1,240,767,978	100.00%

Sources: USA Spending, RESI

B.5 Communications Equipment and Services by NAICS Code

The Communications Equipment and Services cluster receives over \$1.1 billion per year in obligated DoD funding, or approximately 6.1 percent of the total spending in Maryland. Figure 80 presents the average yearly spending by NAICS for Communications Equipment and Services related NAICS as reported by USA Spending for all 10 different NAICS codes receiving some funding in this category.

¹⁷⁴ Note that totals may not add up precisely due to rounding.

Figure 80: Average DoD Funding by NAICS Code in the Maryland Communications Equipment and Services Cluster¹⁷⁵

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD Communications Equipment and Services Spending
334220	Radio And Television Broadcasting And Wireless Communications Equipment Manufacturing	\$555,829,293	50.37%
517410	Satellite Telecommunications	\$167,313,252	15.16%
334290	Other Communications Equipment Manufacturing	\$145,102,962	13.15%
334210	Telephone Apparatus Manufacturing	\$72,687,833	6.59%
517919	All Other Telecommunications	\$65,097,760	5.90%
517919	Other Telecommunications	\$61,953,874	5.61%
517210	Wireless Telecommunications Carriers (Except Satellite)	\$33,317,450	3.02%
335912	Primary Battery Manufacturing	\$1,200,511	0.11%
517210	Cellular And Other Wireless Telecommunications	\$777,248	0.07%
515210	Cable And Other Subscription Programming	\$147,105	0.01%
Total Maryland Communications Equipment And Services		\$1,103,423,851	100.00%

Sources: USA Spending, RESI

B.6 R&D Spending by NAICS Code

The R&D cluster receives more than \$2.9 billion per year in obligated DoD funding, or approximately 16 percent of the total spending in Maryland. As detailed in Figure 7 in Section 3.4, the Maryland R&D cluster was defined as nine different six-digit sectors that composed at least 1 percent of funding. Figure 81 presents the average yearly spending by NAICS for R&D activities as reported by USA Spending for all 122 different NAICS codes receiving some funding in this category.

¹⁷⁵ Note that totals may not add up precisely due to rounding.

Figure 81: Average DoD Funding by NAICS Code in the Maryland R&D Cluster¹⁷⁶

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD R&D Spending
541712	Research And Development In The Physical, Engineering, And Life Sciences (Except Biotechnology)	\$963,035,465	32.93%
541330	Engineering Services	\$658,933,947	22.53%
541711	Research And Development In The Physical, Engineering, And Life Sciences	\$371,771,391	12.71%
334220	Radio And Television Broadcasting And Wireless Communications Equipment Manufacturing	\$349,547,710	11.95%
541511	Custom Computer Programming Services	\$182,525,609	6.24%
541611	Administrative Management And General Management Consulting Services	\$63,417,304	2.17%
541512	Computer Systems Design Services	\$40,178,099	1.37%
NA	Missing Naics Information	\$35,918,089	1.23%
334511	Search, Detection, Navigation, Guidance, Aeronautical, And Nautical System And Instrument Manufacturing	\$33,781,385	1.16%
541711	Research And Development In Biotechnology	\$30,629,588	1.05%
236220	Commercial And Institutional Building Construction	\$27,091,643	0.93%
541310	Architectural Services	\$24,448,721	0.84%
541690	Other Scientific And Technical Consulting Services	\$20,731,464	0.71%
334516	Analytical Laboratory Instrument Manufacturing	\$16,074,634	0.55%
541990	All Other Professional, Scientific, And Technical Services	\$12,509,312	0.43%
488190	Other Support Activities For Air Transportation	\$9,778,771	0.33%
517410	Satellite Telecommunications	\$7,974,578	0.27%

¹⁷⁶ Note that totals may not add up precisely due to rounding.

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NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD R&D Spending
336413	Other Aircraft Parts And Auxiliary Equipment Manufacturing	\$7,688,241	0.26%
517110	Wired Telecommunications Carriers	\$6,942,003	0.24%
325412	Pharmaceutical Preparation Manufacturing	\$6,323,525	0.22%
336411	Aircraft Manufacturing	\$4,895,420	0.17%
611710	Educational Support Services	\$4,855,187	0.17%
541513	Computer Facilities Management Services	\$4,772,752	0.16%
561210	Facilities Support Services	\$4,712,077	0.16%
541519	Other Computer Related Services	\$3,905,914	0.13%
541380	Testing Laboratories	\$3,252,005	0.11%
334419	Other Electronic Component Manufacturing	\$2,600,782	0.09%
541720	Research And Development In The Social Sciences And Humanities	\$2,372,409	0.08%
561110	Office Administrative Services	\$1,854,038	0.06%
332994	Small Arms, Ordnance, And Ordnance Accessories Manufacturing	\$1,561,251	0.05%
611310	Colleges, Universities, And Professional Schools	\$1,264,510	0.04%
481219	Other Nonscheduled Air Transportation	\$1,243,266	0.04%
561720	Janitorial Services	\$1,166,947	0.04%
335999	All Other Miscellaneous Electrical Equipment And Component Manufacturing	\$1,153,309	0.04%
334290	Other Communications Equipment Manufacturing	\$1,054,234	0.04%
336412	Aircraft Engine And Engine Parts Manufacturing	\$941,934	0.03%
485111	Mixed Mode Transit Systems	\$875,872	0.03%
921190	Other General Government Support	\$863,025	0.03%
325414	Biological Product (Except Diagnostic) Manufacturing	\$824,447	0.03%

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD R&D Spending
237990	Other Heavy And Civil Engineering Construction	\$740,653	0.03%
923120	Administration Of Public Health Programs	\$682,679	0.02%
336414	Guided Missile And Space Vehicle Manufacturing	\$675,240	0.02%
621999	All Other Miscellaneous Ambulatory Health Care Services	\$567,240	0.02%
541110	Offices Of Lawyers	\$473,700	0.02%
541618	Other Management Consulting Services	\$451,209	0.02%
333314	Optical Instrument And Lens Manufacturing	\$430,858	0.01%
237310	Highway, Street, And Bridge Construction	\$416,798	0.01%
335911	Storage Battery Manufacturing	\$340,922	0.01%
238210	Electrical Contractors And Other Wiring Installation Contractors	\$326,775	0.01%
334413	Semiconductor And Related Device Manufacturing	\$316,666	0.01%
621399	Offices Of All Other Miscellaneous Health Practitioners	\$316,359	0.01%
333318	Other Commercial And Service Industry Machinery Manufacturing	\$315,044	0.01%
336611	Ship Building And Repairing	\$306,493	0.01%
333999	All Other Miscellaneous General Purpose Machinery Manufacturing	\$305,390	0.01%
493110	General Warehousing And Storage	\$280,789	0.01%
325411	Medicinal And Botanical Manufacturing	\$276,398	0.01%
334515	Instrument Manufacturing For Measuring And Testing Electricity And Electrical Signals	\$243,012	0.01%
541930	Translation And Interpretation Services	\$232,646	0.01%
334510	Electromedical And Electrotherapeutic Apparatus Manufacturing	\$226,967	0.01%

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NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD R&D Spending
611699	All Other Miscellaneous Schools And Instruction	\$190,242	0.01%
238110	Poured Concrete Foundation And Structure Contractors	\$178,500	0.01%
339113	Surgical Appliance And Supplies Manufacturing	\$169,950	0.01%
334519	Other Measuring And Controlling Device Manufacturing	\$163,638	0.01%
325211	Plastics Material And Resin Manufacturing	\$150,000	0.01%
541810	Advertising Agencies	\$149,999	0.01%
325413	In-Vitro Diagnostic Substance Manufacturing	\$142,794	0.00%
811219	Other Electronic And Precision Equipment Repair And Maintenance	\$134,259	0.00%
423490	Other Professional Equipment And Supplies Merchant Wholesalers	\$132,676	0.00%
561990	All Other Support Services	\$102,649	0.00%
334210	Telephone Apparatus Manufacturing	\$90,439	0.00%
561621	Security Systems Services (Except Locksmiths)	\$79,842	0.00%
484210	Used Household And Office Goods Moving	\$79,244	0.00%
511120	Periodical Publishers	\$77,000	0.00%
621340	Offices Of Physical, Occupational And Speech Therapists, And Audiologists	\$75,942	0.00%
493120	Refrigerated Warehousing And Storage	\$74,892	0.00%
927110	Space Research And Technology	\$73,490	0.00%
541490	Other Specialized Design Services	\$69,082	0.00%
314910	Textile Bag And Canvas Mills	\$57,160	0.00%
334111	Electronic Computer Manufacturing	\$44,168	0.00%
485113	Bus And Other Motor Vehicle Transit Systems	\$43,125	0.00%
339999	All Other Miscellaneous Manufacturing	\$43,005	0.00%
541620	Environmental Consulting Services	\$40,183	0.00%
561320	Temporary Help Services	\$38,939	0.00%

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NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD R&D Spending
518210	Data Processing, Hosting, And Related Services	\$38,751	0.00%
561622	Locksmiths	\$29,176	0.00%
561431	Private Mail Centers	\$28,223	0.00%
519120	Libraries And Archives	\$28,210	0.00%
532210	Consumer Electronics And Appliances Rental	\$25,032	0.00%
424720	Petroleum And Petroleum Products Merchant Wholesalers (Except Bulk Stations And Terminals)	\$22,952	0.00%
621511	Medical Laboratories	\$21,998	0.00%
562910	Remediation Services	\$18,711	0.00%
511210	Software Publishers	\$15,600	0.00%
562920	Materials Recovery Facilities	\$15,374	0.00%
424690	Other Chemical And Allied Products Merchant Wholesalers	\$14,932	0.00%
237120	Oil And Gas Pipeline And Related Structures Construction	\$14,886	0.00%
238160	Roofing Contractors	\$14,150	0.00%
492110	Couriers And Express Delivery Services	\$13,504	0.00%
453920	Art Dealers	\$12,900	0.00%
621111	Offices Of Physicians (Except Mental Health Specialists)	\$12,500	0.00%
923130	Administration Of Human Resource Programs (Except Education, Public Health, And Veterans' Affairs Programs)	\$12,500	0.00%
722320	Caterers	\$12,360	0.00%
813920	Professional Organizations	\$9,850	0.00%
721110	Hotels (Except Casino Hotels) And Motels	\$9,838	0.00%
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing	\$9,736	0.00%
334513	Instruments And Related Products Manufacturing For Measuring,	\$9,410	0.00%

NAICS Code	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD R&D Spending
	Displaying, And Controlling Industrial Process Variables		
485510	Charter Bus Industry	\$9,409	0.00%
519190	All Other Information Services	\$9,082	0.00%
483211	Inland Water Freight Transportation	\$8,800	0.00%
238990	All Other Specialty Trade Contractors	\$7,990	0.00%
488330	Navigational Services To Shipping	\$6,523	0.00%
541320	Landscape Architectural Services	\$5,865	0.00%
541940	Veterinary Services	\$5,800	0.00%
812320	Drycleaning And Laundry Services (Except Coin-Operated)	\$5,561	0.00%
811310	Commercial And Industrial Machinery And Equipment (Except Automotive And Electronic) Repair And Maintenance	\$4,742	0.00%
813910	Business Associations	\$4,400	0.00%
332117	Powder Metallurgy Part Manufacturing	\$4,340	0.00%
326199	All Other Plastics Product Manufacturing	\$4,084	0.00%
541910	Marketing Research And Public Opinion Polling	\$3,595	0.00%
611420	Computer Training	\$2,965	0.00%
493190	Other Warehousing And Storage	\$1,412	0.00%
238220	Plumbing, Heating, And Air-Conditioning Contractors	\$1,125	0.00%
611430	Professional And Management Development Training	\$503	0.00%
333318	Commercial Laundry, Drycleaning, And Pressing Machine Manufacturing	\$198	0.00%
Total Maryland R&D		\$2,924,274,895	100.00%

Sources: RESI, USA Spending

B.7 Information Technology & Cyber Security Spending by NAICS Code

The Information Technology and Cyber Security sectors received on average more than \$1.8 billion per year, or approximately 10 percent of the total DoD spending in Maryland.

Figure 8 in Section 3.4 shows that the Maryland Information Technology and Cyber Defense cluster was defined to consist of 11 different six-digit NAICS code sectors, which received at least one percent of the total funding. Figure 82 shows that that 101 different NAICS code categories received nearly \$1.9 billion in average annual funding between 2011 and 2015.

Figure 82: Average Annual DoD Spending by NAICS Industry in the Maryland IT/Cyber Security Cluster¹⁷⁷

NAICS	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD IT/Cyber Security Spending
517110	Wired Telecommunications Carriers	\$341,192,864	18.22%
541519	Other Computer Related Services	\$311,110,209	16.61%
541512	Computer Systems Design Services	\$294,235,699	15.71%
541511	Custom Computer Programming Services	\$196,606,658	10.50%
541330	Engineering Services	\$180,302,559	9.63%
541513	Computer Facilities Management Services	\$164,822,830	8.80%
541712	Research And Development In The Physical, Engineering, And Life Sciences (Except Biotechnology)	\$99,691,836	5.32%
517410	Satellite Telecommunications	\$99,451,891	5.31%
518210	Data Processing, Hosting, And Related Services	\$34,341,776	1.83%
517919	All Other Telecommunications	\$26,049,985	1.39%
443142	Computer And Software Stores	\$19,746,285	1.05%
517210	Wireless Telecommunications Carriers (Except Satellite)	\$17,798,060	0.95%
541611	Administrative Management And General Management Consulting Services	\$13,878,333	0.74%
334111	Electronic Computer Manufacturing	\$12,654,388	0.68%
511210	Software Publishers	\$10,539,129	0.56%

¹⁷⁷ Note that totals may not add up precisely due to rounding.

NAICS	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD IT/Cyber Security Spending
811212	Computer And Office Machine Repair And Maintenance	\$7,054,223	0.38%
541711	Research And Development In The Physical, Engineering, And Life Sciences	\$6,744,978	0.36%
611420	Computer Training	\$3,880,781	0.21%
334220	Radio And Television Broadcasting And Wireless Communications Equipment Manufacturing	\$3,704,072	0.20%
541690	Other Scientific And Technical Consulting Services	\$3,520,818	0.19%
541990	All Other Professional, Scientific, And Technical Services	\$3,454,354	0.18%
517911	Telecommunications Resellers	\$3,031,325	0.16%
517919	Other Telecommunications	\$2,229,078	0.12%
541618	Other Management Consulting Services	\$1,934,505	0.10%
561210	Facilities Support Services	\$1,902,452	0.10%
811213	Communication Equipment Repair And Maintenance	\$1,325,253	0.07%
221112	Fossil Fuel Electric Power Generation	\$1,250,078	0.07%
334210	Telephone Apparatus Manufacturing	\$912,211	0.05%
334118	Computer Terminal And Other Computer Peripheral Equipment Manufacturing	\$786,873	0.04%
561990	All Other Support Services	\$765,478	0.04%
541340	Drafting Services	\$761,297	0.04%
519130	Internet Publishing And Broadcasting And Web Search Portals	\$742,068	0.04%
541370	Surveying And Mapping (Except Geophysical) Services	\$721,480	0.04%
313310	Broadwoven Fabric Finishing Mills	\$584,111	0.03%

NAICS	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD IT/Cyber Security Spending
423430	Computer And Computer Peripheral Equipment And Software Merchant Wholesalers	\$511,306	0.03%
511199	All Other Publishers	\$487,147	0.03%
322121	Paper (Except Newsprint) Mills	\$458,344	0.02%
621511	Medical Laboratories	\$452,800	0.02%
561110	Office Administrative Services	\$353,172	0.02%
511120	Periodical Publishers	\$202,034	0.01%
561621	Security Systems Services (Except Locksmiths)	\$176,865	0.01%
611310	Colleges, Universities, And Professional Schools	\$158,213	0.01%
334290	Other Communications Equipment Manufacturing	\$149,102	0.01%
541614	Process, Physical Distribution, And Logistics Consulting Services	\$139,750	0.01%
334512	Automatic Environmental Control Manufacturing For Residential, Commercial, And Appliance Use	\$133,805	0.01%
517210	Cellular And Other Wireless Telecommunications	\$124,834	0.01%
519190	All Other Information Services	\$84,355	0.00%
541430	Graphic Design Services	\$81,607	0.00%
515210	Cable And Other Subscription Programming	\$74,328	0.00%
541219	Other Accounting Services	\$73,775	0.00%
334310	Audio And Video Equipment Manufacturing	\$70,437	0.00%
561499	All Other Business Support Services	\$70,163	0.00%
238210	Electrical Contractors And Other Wiring Installation Contractors	\$68,751	0.00%
541211	Offices Of Certified Public Accountants	\$57,324	0.00%
334419	Other Electronic Component Manufacturing	\$55,271	0.00%

NAICS	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD IT/Cyber Security Spending
541199	All Other Legal Services	\$52,723	0.00%
811219	Other Electronic And Precision Equipment Repair And Maintenance	\$48,838	0.00%
519110	News Syndicates	\$48,750	0.00%
532420	Office Machinery And Equipment Rental And Leasing	\$44,392	0.00%
333316	Other Computer Peripheral Equipment Manufacturing	\$44,332	0.00%
333316	Photographic And Photocopying Equipment Manufacturing	\$38,331	0.00%
334112	Computer Storage Device Manufacturing	\$37,640	0.00%
511130	Book Publishers	\$36,598	0.00%
561320	Temporary Help Services	\$34,733	0.00%
492210	Local Messengers And Local Delivery	\$33,713	0.00%
422920	Book, Periodical, And Newspaper Wholesalers	\$33,095	0.00%
519120	Libraries And Archives	\$32,764	0.00%
335921	Fiber Optic Cable Manufacturing	\$31,050	0.00%
813920	Professional Organizations	\$29,000	0.00%
423690	Other Electronic Parts And Equipment Merchant Wholesalers	\$28,375	0.00%
335314	Relay And Industrial Control Manufacturing	\$28,093	0.00%
333244	Printing Machinery And Equipment Manufacturing	\$27,666	0.00%
334515	Instrument Manufacturing For Measuring And Testing Electricity And Electrical Signals	\$26,284	0.00%
541613	Marketing Consulting Services	\$24,154	0.00%
811310	Commercial And Industrial Machinery And Equipment (Except Automotive And	\$18,891	0.00%

NAICS	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD IT/Cyber Security Spending
	Electronic) Repair And Maintenance		
334614	Software And Other Prerecorded Compact Disc, Tape, And Record Reproducing	\$17,625	0.00%
561920	Convention And Trade Show Organizers	\$15,339	0.00%
238220	Plumbing, Heating, And Air-Conditioning Contractors	\$15,031	0.00%
335999	All Other Miscellaneous Electrical Equipment And Component Manufacturing	\$12,986	0.00%
541930	Translation And Interpretation Services	\$11,985	0.00%
611430	Professional And Management Development Training	\$11,050	0.00%
611691	Exam Preparation And Tutoring	\$10,380	0.00%
423420	Office Equipment Merchant Wholesalers	\$10,346	0.00%
332510	Hardware Manufacturing	\$10,283	0.00%
339940	Carbon Paper And Inked Ribbon Manufacturing	\$10,091	0.00%
333249	All Other Industrial Machinery Manufacturing	\$9,021	0.00%
517110	Internet Service Providers	\$8,663	0.00%
811211	Consumer Electronics Repair And Maintenance	\$7,991	0.00%
323113	Commercial Screen Printing	\$7,594	0.00%
561421	Telephone Answering Services	\$6,876	0.00%
488330	Navigational Services To Shipping	\$6,132	0.00%
541490	Other Specialized Design Services	\$6,042	0.00%
333517	Machine Tool (Metal Cutting Types) Manufacturing	\$5,802	0.00%
424920	Book, Periodical, And Newspaper Merchant Wholesalers	\$5,756	0.00%

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NAICS	NAICS Description	Average Annual Dollars Obligated, 2011-2015	Percent of Total MD DoD IT/Cyber Security Spending
541711	Research And Development In Biotechnology	\$5,000	0.00%
611710	Educational Support Services	\$4,817	0.00%
236220	Commercial And Institutional Building Construction	\$3,516	0.00%
922190	Other Justice, Public Order, And Safety Activities	\$2,305	0.00%
334614	Software Reproducing	\$1,817	0.00%
921110	Executive Offices	\$490	0.00%
333318	Other Commercial And Service Industry Machinery Manufacturing	\$435	0.00%
Total Maryland IT/Cyber Security		\$1,872,618,106	100.00%

Sources: RESI, USA Spending

Appendix C: Additional Details for Cluster Analysis

This section will provide further survey details for the rest of the clusters in the State of Maryland.

C.1 Additional Survey Results

Of the 494 companies that provided dependency ranges, 158 identified their dependency on DoD spending as high (above 70 percent of their revenue), 50 identified their dependency as mid-level (between 35 to 69 percent of their revenue), and 286 companies identified their dependency on DoD contracts as low (34 percent or less of their revenue). There were 290 responses with cluster information and dependency response.

Figure 83 presents all of the clusters represented in the responses for dependency information.

Figure 83: Dependency on DoD Spending by Cluster

Cluster Name	Low	Medium	High	Total Responses
Business Services	33	8	35	76
Local Real Estate, Construction, and Development	21	2	6	29
Local Commercial Services	13	1	6	20
Local Entertainment and Media	13	0	4	17
Education and Knowledge Creation	10	2	1	13
Distribution and Electronic Commerce	8	0	3	11
Local Industrial Products and Services	6	1	1	8
Information Technology and Analytical Instruments	3	2	1	6
Plastics	1	0	3	4
Local Health Services	2	1	1	4
Recreational and Small Electric Goods	1	1	2	4
Local Motor Vehicle Products and Services	1	0	3	4
Local Household Goods and Services	2	1	1	4
Construction Products and Services	0	0	4	4
Aerospace Vehicles and Defense	3	0	0	3
Production Technology and Heavy Machinery	2	1	1	4
Local Community and Civic Organizations	3	0	1	4
Communications Equipment and Services	3	0	0	3
Local Food and Beverage Processing and Distribution	2	1	0	3
Marketing, Design, and Publishing	1	0	1	2
Hospitality and Tourism	0	2	1	3
Biopharmaceuticals	2	0	1	3
Local Logistical Services	2	0	1	3

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Cluster Name	Low	Medium	High	Total Responses
Video Production and Distribution	2	0	0	2
Local Retailing of Clothing and General Merchandise	1	0	1	2
Furniture	1	0	1	2
Downstream Metal Products	1	0	1	2
Transportation and Logistics	1	0	1	2
Upstream Metal Manufacturing	1	1	0	2
Automotive	0	1	1	2
Paper and Packaging	0	0	0	0
Water Transportation	1	0	0	1
Environmental Services	1	0	0	1
Lighting and Electrical Equipment	0	0	0	0
Local Personal Services (Non-Medical)	1	0	0	1
Metalworking Technology	0	0	1	1
Livestock Processing	0	0	1	1
Financial Services	1	0	0	1
Local Financial Services	0	1	0	1
Local Hospitality Establishments	1	0	0	1
Food Processing and Manufacturing	1	0	0	1
Total	145	26	84	255

Sources: Delgado, Porter, and Stern; RESI

Many of the respondents indicated that there were problems with finding qualified employees. There was a theme in the comments that skilled labor (i.e. machinists and welders), information technology experts, and other educated skilled (i.e. engineers) workers were difficult to find. The respondents especially indicated that it was hard to find workers with the necessary skills and security clearances. Figure 84 shows the results by cluster for the statement, “Please select the statement that best reflects the experience with workforce supply for your company’s Maryland location with which you are affiliated. (Select only one).”

- My company has some difficulty finding qualified employees.
- My company has no difficulty finding qualified employees.
- My company has a lot of difficulty finding qualified employees.

Figure 84: Level of Difficulty in Hiring Qualified Employees

Cluster Name	Very Difficult	Somewhat Difficult	Not Difficult	Total Responses
Business Services	14	31	20	65
Local Real Estate, Construction, and Development	6	13	7	26
Local Commercial Services	4	5	9	18
Local Entertainment and Media	3	8	4	15
Education and Knowledge Creation	4	6	2	12
Distribution and Electronic Commerce	3	2	5	10
Local Industrial Products and Services	1	5	0	6
Information Technology and Analytical Instruments	1	4	1	6
Recreational and Small Electric Goods	1	1	1	3
Local Health Services	0	1	1	2
Plastics	2	1	1	4
Aerospace Vehicles and Defense	0	2	2	4
Local Community and Civic Organizations	1	1	1	3
Local Household Goods and Services	1	1	1	3
Construction Products and Services	2	1	0	3
Local Motor Vehicle Products and Services	2	1	1	4
Communications Equipment and Services	0	1	1	2
Production Technology and Heavy Machinery	1	0	3	4
Biopharmaceuticals	0	1	1	2
Local Food and Beverage Processing and Distribution	1	2	0	3
Marketing, Design, and Publishing	1	0	0	1
Hospitality and Tourism	1	1	1	3
Local Logistical Services	1	1	0	2
Transportation and Logistics	0	1	1	2
Downstream Metal Products	0	0	1	1
Video Production and Distribution	0	0	0	0
Furniture	2	0	0	2
Upstream Metal Manufacturing	0	1	1	2

Cluster Name	Very Difficult	Somewhat Difficult	Not Difficult	Total Responses
Automotive	2	0	0	2
Local Retailing of Clothing and General Merchandise	0	1	1	2
Local Hospitality Establishments	0	1	0	1
Local Financial Services	0	1	0	1
Water Transportation	1	0	0	1
Paper and Packaging	0	0	0	0
Environmental Services	0	0	0	0
Metalworking Technology	0	1	0	1
Local Personal Services (Non-Medical)	0	0	0	0
Food Processing and Manufacturing	0	0	1	1
Livestock Processing	0	1	0	1
Lighting and Electrical Equipment	0	0	0	0
Financial Services	0	0	0	0
Total	55	96	67	218

Sources: Delgado, Porter, and Stern; RESI

C.2 REMI PI+ Model Overview

To quantify the economic impacts of a specific economic event or events, RESI uses the Regional Economic Models, Inc. (REMI) PI+ model version 1.7. The REMI PI+ model is a high-end dynamic modeling tool used by various federal and state government agencies in economic policy analysis. Utilization of REMI PI+ helps RESI to build a sophisticated model that is calibrated to the specific demographic features of the study area. This model enumerates the economic and fiscal impacts of each dollar earned and spent by the following: employees relating to the economic events, other supporting vendors (business services, retail, etc.), each dollar spent by these vendors on other firms, and each dollar spent by the households of the event's employees, other vendors' employees, and other businesses' employees.

REMI PI+ features the ability to capture price effects, wage changes, and behavioral effects through time. The REMI PI+ model allows RESI to capture the effects occurring between industries and minimize the potential for double counting in employment, output, and wages. The ability to capture effects throughout a span of time provides a detailed representative of an economic event over time and its effects on the study area.

In this paper, wages estimated through REMI PI+ are presented in nominal dollars while output estimated through REMI PI+ is presented in chained 2009 dollars. Output is reported this way to

remain consistent with how the BEA reports measures of output and GDP.¹⁷⁸ BEA uses chained dollars instead of real or nominal dollars because chain weighting is more accurate.¹⁷⁹ Real weighting is accurate as long as the base year is relatively close to the current or estimated year. However, rapid changes in technology and production prices have led the BEA to report output and GDP in chained dollars in order to minimize potential bias.¹⁸⁰

C.3 Modeling Assumptions

RESI determined economic and fiscal impacts based on data from USA Spending (see Appendix A.1.3). RESI then analyzed REMI PI+ industry sectors based on the yearly reported dollars obligated. RESI's analysis includes the following modeling assumptions:

- Economic impact multipliers are developed from REMI PI+ input/output software.
- REMI PI+ data are based on the North American Industrial Classification System (NAICS).
- REMI PI+ employment multipliers are adjusted for inflation using the Bureau of Labor Statistic's CPI-U.
- Impacts were based on 2011 to 2015 data for DoD Spending Maryland that was modeled as exogenous demand in the model.¹⁸¹
- Employment impacts include both full- and part-time employees. REMI PI+ does not differentiate between full- and part-time employment numbers.

The DoD spending for the state in this time produced 270 distinct region level inputs across 63 different industrial sectors, and averaged approximately \$18 billion per year.

C.4 Estimation of Cluster-Level Benefits

To better understand the spending and benefits in not only each region but in each cluster, RESI estimated the cluster level employment impacts using the spending-to-wage ratio for each individual cluster in every region. This ratio was derived by dividing the funding obligation amount by the average wage for each cluster at the regional level. The resulting spending-to-wage ratio, is a unitless number since both the numerator and denominator are both expressed

¹⁷⁸ BEA. "National Income and Product Accounts - Gross Domestic Product: Third Quarter 2016 (Third Estimate) Corporate Profits: Third Quarter 2016 (Revised Estimate)." BEA (December 22, 2016). Accessed January 13, 2016. <https://www.bea.gov/newsreleases/national/gdp/gdpnewsrelease.htm>

¹⁷⁹ Steindel, Charles. "Chain-Weighting: The New Approach to Measuring GDP." Federal Reserve Bank of New York. Current Issues in Economics and Finance. (December 1995). Accessed January 13, 2017. <http://users.wfu.edu/cottrell/ecn207/readings/chained.pdf>

¹⁸⁰ Ibid.

¹⁸¹ RESI used exogenous demand to estimate impacts because it allows for work being performed outside of Maryland. Not all awards in the database were performed inside of Maryland, but were awarded to a Maryland contractor. RESI is not able to determine which portion of the contract stays in Maryland, and which portion goes outside of Maryland. As such RESI utilized REMI's exogenous demand options for modeling, because it will model imports from other regions when local production does not support the type of work performed. There are cases where the size of the contract is larger than the estimated Maryland level industry sector's total output. This method corrects with that and fits with conditions observed in USA Spending data.

in dollars. Next, the ratio was summed for all clusters in each region to obtain the regional sum of spending-to-wage ratios. The percentage of benefits accruing from each cluster was derived by dividing each individual cluster's spending-to-wage ratio by the regional sum of the spending-to-wage ratio across all clusters. This percentage was then multiplied by the number of local jobs estimated for each region. This method was adopted because the dynamic nature of the model does not allow for individual estimates to be independently pulled from the regional figures.

Figure 85 below demonstrates these calculations for the Business Services cluster in the Capital region. The total dollars obligated for the Business Services cluster, approximately \$3.8 billion, divided by the cluster's average wage of \$80,110 to determine the spending-to-wage ratio. The spending-to-wage ratio is summed for each cluster in the Capital region, totaling 116,688. The Business Services cluster spending-to-wage ratio (46,993) is divided by the summed regional spending-to-wage ratio (116,688), producing the percentage of Business Services value of 40.3 percent. This is multiplied by the REMI estimate for total employment of 40,324, creating a total employment impact estimate of 16,239 from the Business Services cluster in the Capital region.

Figure 85: Illustrative Example of DoD-Supported Employment by Cluster for the Capitol Region

Cluster Name	Dollars Obligated	Cluster Avg. Wage	Spending To Wage Ratio	Percent	Total Employment from DoD Spending	Jobs Supported by DoD Spending
Business Services	\$3,764,580,776	\$80,110	46,993	40.3%	40,324	16,239
Total	\$7,685,333,309		116,688	100%	40,324	40,324

Sources: BLS OES, Delgado, Porter, and Stern, REMI PI+, RESI

C.5 Estimation of Cluster-Level Employment Location Quotients

Using the CBP data described in Appendix A.1.1, RESI calculated the location quotient for employment for each cluster in Maryland and in each region. For the state RESI calculated the location quotient for each cluster by dividing the employment in the cluster at the state level by the total employment at the state level. This number was divided by the total employment in the cluster at the national level, divided by the total employment for the nation. For each region the employment in the cluster at the regional level was divided by the total employment at the regional level, was divided by the corresponding calculation at the national level. An example can be seen in the calculation for the Business Services cluster's location quotient for Maryland:

$$\text{Location Quotient} = \frac{\frac{\text{State Level Business Services Employment}}{\text{Overall State Employment}}}{\frac{\text{National Level Business Services Employment}}{\text{Overall National Employment}}}$$

Specifically, for the cluster this calculation is:

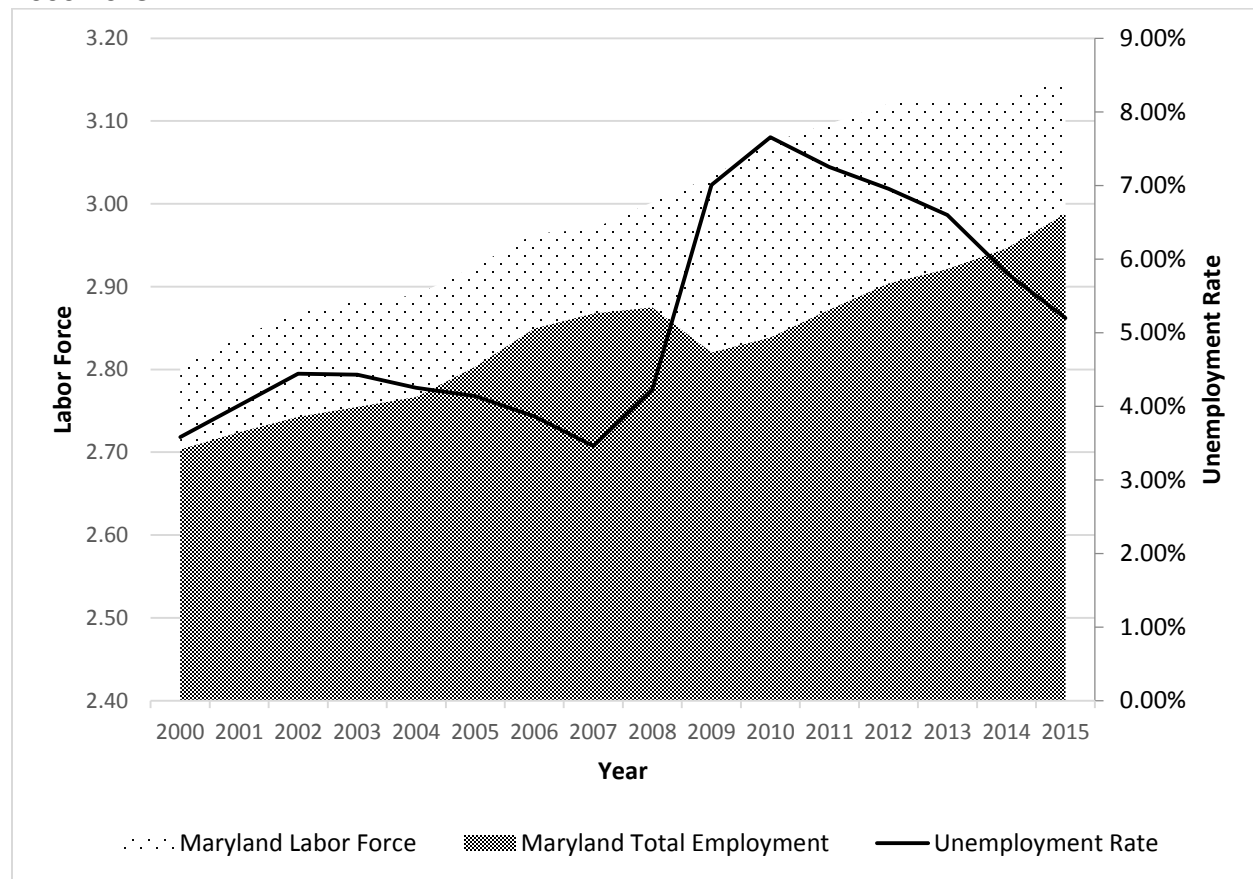
$$1.34 = \frac{\frac{315,659}{2,460,099}}{\frac{11,572,491}{121,181,772}}$$

Appendix D: Labor Markets

D.1 Maryland Labor Market

Figure 86 shows that since 2000, Maryland's labor force has grown by 12.4 percent.¹⁸² Maryland's labor force was nearly 2.8 million people in 2000, with approximately 2.7 million employed. In 2015, Maryland's labor force was nearly 3.2 million workers, with approximately 3.0 million workers employed. This growth was not consistent, however, as the Great Recession created a large increase in unemployment. The unemployment rate in Maryland peaked in 2010 at 7.7 percent when the overall labor force in Maryland was 3.1 million people, with approximately 2.8 million employed.

Figure 86: Labor Force, Total Employment, and Historical Unemployment Rate—Maryland, 2000-2015



Source: BLS LAUS

¹⁸² "Local Area Unemployment Statistics," U.S. Bureau of Labor Statistics, accessed September 27, 2016, <http://www.bls.gov/lau/#tables>.

As illustrated in Figure 87, between 2005 and 2015, the composition of Maryland's workforce changed according to industry of occupation. There was overall growth in this time period of stable jobs, defined as jobs that last at least one full quarter. However, also shown in Figure 87 is that at the two-digit NAICS sector level, there was great variation in stable job growth. Between 2005 and 2015, the Manufacturing sector had over 24,800 more stable job separations than hires (a net contraction of stable jobs). At the same time, the Health Care and Social Assistance sector had over 68,400 more stable job hires than separations. Further, during this time, the Retail Trade sector had the most employee turnover, with the number of stable job hires and separations both reaching nearly 1.2 million positions.

Figure 87: Stable Job Starts and Separations by Two-Digit NAICS Code—Maryland, 2005-2015

NAICS Code	NAICS Description	Job Starts	Job Separations	Net Job Change
11	Agriculture, Forestry, Fishing and Hunting	21,467	19,629	1,838
21	Mining, Quarrying, and Oil and Gas Extraction	4,588	4,588	0
22	Utilities	12,201	12,222	-21
23	Construction	623,669	618,618	5,051
31-33	Manufacturing	244,085	268,921	-24,836
42	Wholesale Trade	242,348	238,341	4,007
44-45	Retail Trade	1,179,121	1,165,606	13,515
48-49	Transportation and Warehousing	233,552	221,007	12,545
51	Information	132,438	140,291	-7,853
52	Finance and Insurance	253,845	265,177	-11,332
53	Real Estate and Rental and Leasing	149,455	147,979	1,476
54	Professional, Scientific, and Technical Services	727,264	676,247	51,017
55	Management of Companies and Enterprises	55,324	56,440	-1,116
56	Administrative and Support and Waste Management and Remediation Services	796,900	759,972	36,928
61	Educational Services	571,254	535,294	35,960
62	Health Care and Social Assistance	981,355	912,912	68,443
71	Arts, Entertainment, and Recreation	204,798	183,254	21,544
72	Accommodation and Food Services	1,097,764	1,051,144	46,620
81	Other Services (except Public Administration)	314,944	304,904	10,040
92	Public Administration	199,698	204,969	-5,271
Total		8,046,070	7,787,515	258,555

Sources: RESI, U.S. Census LEHD, U.S. Census NAICS

To better understand how individual clusters impact Maryland's economy in terms of the occupations present in that cluster and the relative wages associated with those occupations, it is necessary to know the distribution of the overall employment in Maryland by occupational category. BLS also provides detailed information on Maryland occupations.¹⁸³ Figure 88 below details Maryland employment by major standard occupation classification (SOC) code, the state's employment compared to the rest of the nation in each category (by location quotient), and the annual average wage for each occupational category.¹⁸⁴

Figure 88 shows that in Maryland, the occupational category with the largest employment is Office and Administration Support Occupations with over 400,000 workers. Occupations in this group include secretaries and administrative assistants, customer service representatives, and office clerks. The next-largest occupation group is Sales and Related Occupations, employing over 260,000 individuals in relevant professions. Food Preparation and Serving Related Occupations is the third-largest occupation category with more than 210,000 workers.

¹⁸³ "Occupational Employment Statistics – May 2015 State Occupational Employment and Wage Estimates Maryland," U.S. Bureau of Labor Statistics, accessed December 14, 2016, https://www.bls.gov/oes/current/oes_md.htm.

¹⁸⁴ Ibid.

Figure 88: Employment, LQ, and Wage Data by Occupational Category—Maryland, 2015

SOC	Occupation Category	Employment	Location Quotient	Annual Average Wage
43-0000	Office and Administrative Support	402,900	0.98	\$39,170
41-0000	Sales and Related	263,580	0.97	\$38,780
35-0000	Food Preparation and Serving Related	213,120	0.90	\$23,910
25-0000	Education, Training, and Library	172,650	1.07	\$60,940
29-0000	Healthcare Practitioners and Technical	164,160	1.09	\$83,580
13-0000	Business and Financial Operations	162,980	1.23	\$78,840
53-0000	Transportation and Material Moving	156,230	0.87	\$37,030
11-0000	Management	146,970	1.13	\$122,800
15-0000	Computer and Mathematical	120,360	1.60	\$95,640
47-0000	Construction and Extraction	112,200	1.09	\$47,290
49-0000	Installation, Maintenance, and Repair	100,700	1.00	\$49,230
37-0000	Building and Grounds Cleaning and Maintenance	84,720	1.02	\$27,900
39-0000	Personal Care and Service	78,820	0.97	\$28,050
51-0000	Production	77,700	0.45	\$38,520
31-0000	Healthcare Support	72,180	0.96	\$31,870
33-0000	Protective Service	71,850	1.14	\$46,860
17-0000	Architecture and Engineering	56,800	1.22	\$93,680
21-0000	Community and Social Service	40,970	1.10	\$49,070
19-0000	Life, Physical, and Social Science	40,520	1.88	\$85,730
27-0000	Arts, Design, Entertainment, Sports, and Media	30,670	0.88	\$58,940
23-0000	Legal	24,180	1.21	\$87,990
45-0000	Farming, Fishing, and Forestry	2,380	0.28	\$33,890
Total		2,596,640		\$54,630

Source: BLS OES

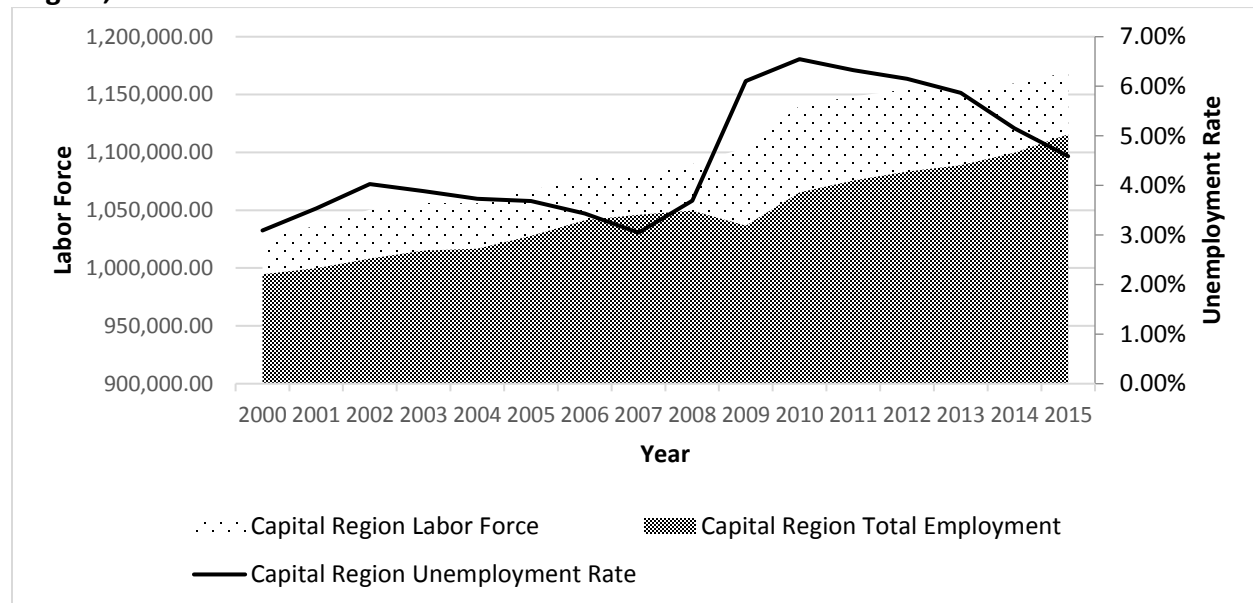
Location quotients indicate the occupations in which Maryland has relatively more employment, compared to the rest of the country. For example, a location quotient above 1.0 signals that Maryland has greater employment in that area, relative to national levels. As detailed in Figure 88, Maryland compares especially favorably for employment in the Life, Physical, and Social Sciences and Computer and Mathematical occupational categories, with location quotients of 1.88 and 1.60, respectively. These two occupational categories also have annual average wages well above the average for Maryland.

According to the BLS Occupation data detailed in Figure 88, the average annual wage in Maryland during 2015 exceeded \$52,402. Wages varied greatly by occupational category, ranging from \$24,000 annually for Food Preparation and Serving Related workers, to over \$122,500 annually for Management workers. Computer and Mathematical Occupations were the second-highest paid workers, with an average salary of approximately \$95,500. Architecture and Engineering Occupations followed with an average annual salary of nearly \$94,000.

D.2 Capital Region—Labor Market

Figure 89 shows the labor force trends for the Capital region. In 2000, the labor force in Maryland's capital region was just above 1.02 million and the number of people employed was nearly 1 million. The overall labor force has grown at a steady rate with the exception of 2004, where the labor force had a slight decrease. In 2015, the labor force in the area was approximately 1.17 million, and employment is nearly 1.12 million.¹⁸⁵ Before 2009, the unemployment rate for the region was between 3.09 and 4.03 percent. During the recession, the unemployment rate peaked at 6.55 percent for the region in 2010 and fell to 4.59 percent in 2015.

Figure 89: Labor Force, Total Employment, and Historical Unemployment Rate—Capital Region, 2000-2015



Source: BLS LAUS

¹⁸⁵ Note that the number employed in a region is not the same number of private sector jobs in a region. This means that LAUS employment numbers will be different from the CBP employment estimate.

The estimation method for employment and average wage by cluster also allows for the estimation of employment by occupational categories for each region and cluster in Maryland.¹⁸⁶ In order to understand the impact of individual clusters on Maryland's employees, it is helpful to know the distribution of the overall employment in Maryland by occupational category for each region. For the Capital region in Maryland, Figure 90 provides top-level occupation category employment estimates ordered by average wage. Collectively, RESI estimates that the average annual wage for the Capital Region is approximately \$54,200. The Office and Administrative Support Occupations category had the largest number of workers employed in the region with 131,900 employees at an average wage of approximately \$36,000. Note that CBP is the primary source of this information, and excludes agricultural production employees, so agricultural occupations are underestimated by this method.¹⁸⁷

¹⁸⁶ For details on the procedure for estimating employment and occupational categories, numbers see Appendix A.

¹⁸⁷ "County Business Patterns (CBP): Universe of County Business Patterns," U.S. Census Bureau, accessed October 10, 2016, <http://census.gov/programs-surveys/cbp/technical-documentation/methodology/universe-of-cbp.html>.

Figure 90: Estimated Major Occupation Categories—Capital Region¹⁸⁸

SOC	Occupation Category	Estimated Employment, 2014	Average Wage, 2015
11-0000	Management Occupations	55,113	\$122,640
23-0000	Legal Occupations	6,821	\$109,384
15-0000	Computer and Mathematical Occupations	78,029	\$89,242
17-0000	Architecture and Engineering Occupations	23,559	\$84,970
29-0000	Healthcare Practitioners and Technical Occupations	46,904	\$80,955
19-0000	Life, Physical, and Social Science Occupations	19,315	\$78,654
13-0000	Business and Financial Operations Occupations	65,195	\$76,228
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	12,025	\$58,912
47-0000	Construction and Extraction Occupations	51,456	\$47,359
25-0000	Education, Training, and Library Occupations	19,793	\$45,053
49-0000	Installation, Maintenance, and Repair Occupations	34,367	\$44,514
21-0000	Community and Social Service Occupations	13,381	\$42,148
41-0000	Sales and Related Occupations	93,459	\$39,789
43-0000	Office and Administrative Support Occupations	131,861	\$36,023
51-0000	Production Occupations	11,392	\$34,577
53-0000	Transportation and Material Moving Occupations	38,058	\$31,878
33-0000	Protective Service Occupations	17,489	\$29,562
31-0000	Healthcare Support Occupations	23,501	\$29,544
45-0000	Farming, Fishing, and Forestry Occupations	177	\$28,186
37-0000	Building and Grounds Cleaning and Maintenance Occupations	39,886	\$26,438
39-0000	Personal Care and Service Occupations	27,154	\$25,569
35-0000	Food Preparation and Serving Related Occupations	66,230	\$22,717
Total		875,165	\$54,199

Sources: BLS OES, RESI, U.S. Census CBP

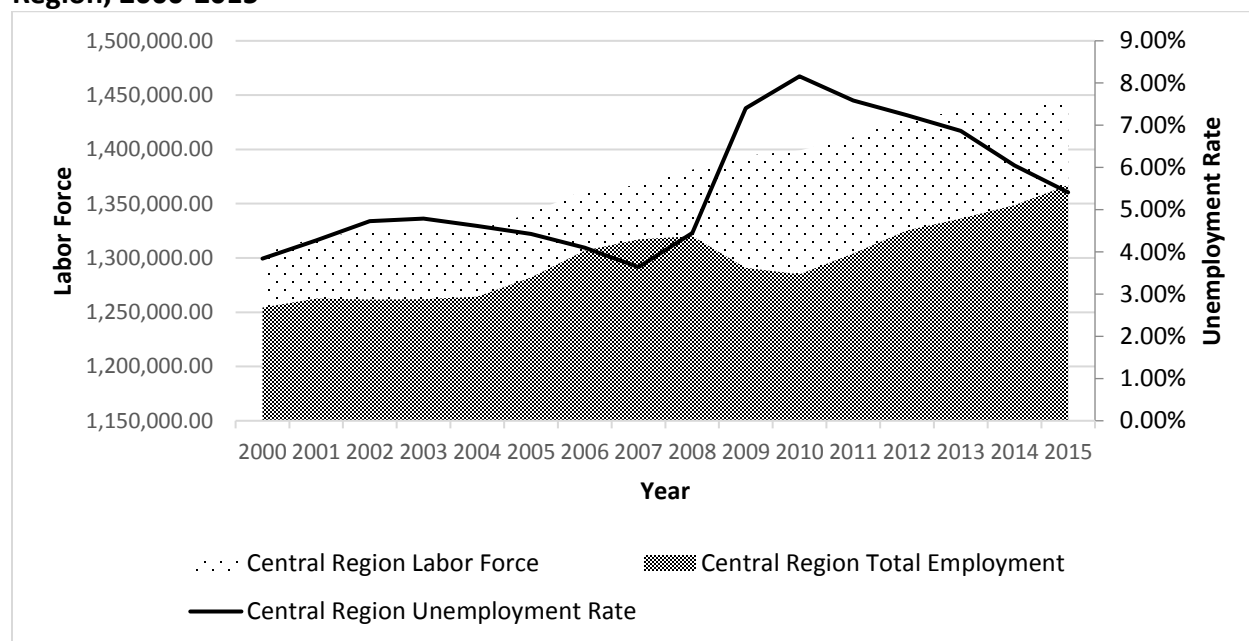
D.3 Central Region—Labor Market

Figure 91 shows the labor force trends for the Central region. The labor force for Central Maryland has grown to over 1.4 million workers in 2015 from its 2000 level of just over 1.3 million. The total employment in 2015 was approximately 1.37 million, and the unemployment

¹⁸⁸ Major occupational categories represent the highest-level occupational groupings of employees on private non-farm payrolls. The employment data is from 2014 CBP and wage estimates are from 2015 OES.

rate in Central Maryland was 5.41 percent in 2015 after peaking at 8.16 percent in 2010. Before 2009 and the Great Recession, the unemployment rate was between 3.64 percent and 4.79 percent.

Figure 91: Labor Force, Total Employment, and Historical Unemployment Rate—Central Region, 2000-2015



Source: BLS LAUS

The estimation method for employment and average wage by cluster also allows for the estimation of employment by occupational categories for each region and cluster in Maryland.¹⁸⁹ In order to understand the impact of individual clusters on Maryland's employees, it is helpful to know the distribution of the overall employment in Maryland by occupational category for each region. For the Central region in Maryland, Figure 92 provides top-level occupation category employment estimates. Collectively, RESI estimates that the average annual wage for the Central region is over \$52,600. The Office and Administrative Support Occupations category had the largest number of workers employed in the region with nearly 190,100 employed at an average wage of approximately \$36,000. Note that County Business Patterns (CBP) is the primary source of this information, and excludes agricultural production employees, so agricultural occupations are underestimated by this method.¹⁹⁰

¹⁸⁹ For details on the procedure for estimating employment and occupational categories, numbers see Appendix A.

¹⁹⁰ "County Business Patterns (CBP): Universe of County Business Patterns," U.S. Census Bureau.

Figure 92: Estimated Major Occupational Category—Central Region

SOC	Occupation Category	Estimated Employment, 2014	Average Wage, 2015
43-0000	Office and Administrative Support Occupations	190,073	\$35,953
41-0000	Sales and Related Occupations	134,988	\$39,527
35-0000	Food Preparation and Serving Related Occupations	103,492	\$22,779
29-0000	Healthcare Practitioners and Technical Occupations	86,749	\$77,736
13-0000	Business and Financial Operations Occupations	84,632	\$76,701
15-0000	Computer and Mathematical Occupations	83,176	\$87,755
11-0000	Management Occupations	72,118	\$120,755
53-0000	Transportation and Material Moving Occupations	69,173	\$34,255
47-0000	Construction and Extraction Occupations	56,774	\$47,143
49-0000	Installation, Maintenance, and Repair Occupations	45,997	\$45,313
39-0000	Personal Care and Service Occupations	40,447	\$25,895
37-0000	Building and Grounds Cleaning and Maintenance Occupations	39,984	\$26,440
31-0000	Healthcare Support Occupations	38,724	\$29,617
25-0000	Education, Training, and Library Occupations	32,708	\$52,127
17-0000	Architecture and Engineering Occupations	29,422	\$82,770
51-0000	Production Occupations	22,417	\$35,042
21-0000	Community and Social Service Occupations	19,689	\$42,514
33-0000	Protective Service Occupations	19,050	\$29,649
19-0000	Life, Physical, and Social Science Occupations	18,378	\$73,709
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	14,911	\$56,464
23-0000	Legal Occupations	11,558	\$108,206
45-0000	Farming, Fishing, and Forestry Occupations	347	\$26,642
Total		1,214,807	\$52,630

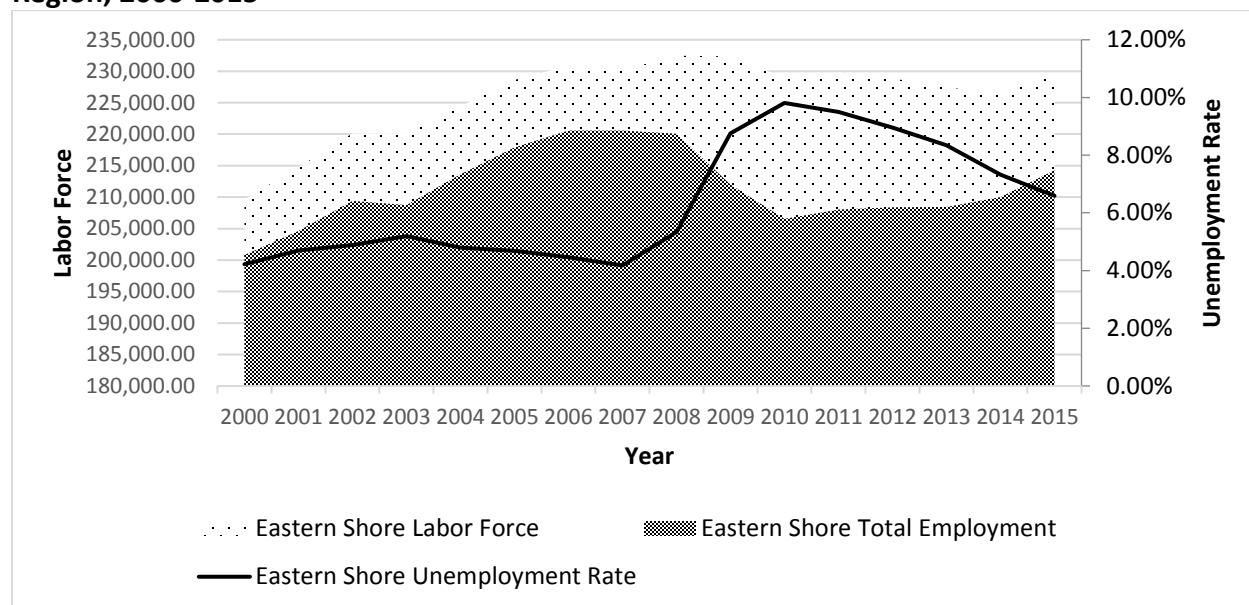
Sources: BLS OES, RESI, U.S. Census CBP

D.4 Eastern Shore—Labor Market

Figure 93 shows the labor force trends for the Eastern Shore. The labor force on the Eastern Shore has increased from approximately 210,000 people in 2000 to over 232,000 at the peak in 2008. Since that time, the labor force has been relatively flat and currently is just over 229,000 people. Between 2000 and 2008, the unemployment rate for the region ranged between 4.18

percent and 5.34 percent. The highest rate of unemployment occurred in 2010, and hit 9.81 percent. Since the peak, the unemployment rate has diminished and in 2015 was 6.60 percent.

Figure 93: Labor Force, Total Employment, and Historical Unemployment Rate—Eastern Shore Region, 2000-2015



Source: BLS LAUS

The estimation procedure for employment and average wage by cluster also allows for the estimation of occupations by cluster for each region in Maryland. In order to understand the importance of individual clusters on Maryland's employees, it is helpful to know the distribution of the overall employment in Maryland by occupational category for each region. For the Eastern Shore, Figure 94 provides top-level major occupation category employment estimates. Collectively, RESI estimates that the average annual wage for the Eastern Shore is approximately \$45,200. The Office and Administrative Support Occupations category had the largest number of workers employed in the region with 21,800 employed at an average wage of nearly \$34,500. Note that County Business Patterns is the primary source of this information, and excludes agricultural production employees, so agricultural occupations are underestimated by this method.¹⁹¹

¹⁹¹ "County Business Patterns (CBP): Universe of County Business Patterns," U.S. Census Bureau.

Figure 94: Estimated Major Occupations Categories—Eastern Shore Region

SOC	Occupation Category	Estimated Employment, 2014	Average Wage, 2015
11-0000	Management Occupations	7,448	\$108,496
13-0000	Business and Financial Operations Occupations	6,737	\$71,282
15-0000	Computer and Mathematical Occupations	3,540	\$84,249
17-0000	Architecture and Engineering Occupations	2,364	\$82,400
19-0000	Life, Physical, and Social Science Occupations	1,245	\$70,657
21-0000	Community and Social Service Occupations	2,774	\$42,126
23-0000	Legal Occupations	681	\$107,102
25-0000	Education, Training, and Library Occupations	3,439	\$47,988
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	1,567	\$52,601
29-0000	Healthcare Practitioners and Technical Occupations	11,630	\$77,365
31-0000	Healthcare Support Occupations	5,593	\$29,328
33-0000	Protective Service Occupations	1,538	\$30,235
35-0000	Food Preparation and Serving Related Occupations	17,269	\$22,778
37-0000	Building and Grounds Cleaning and Maintenance Occupations	5,630	\$26,017
39-0000	Personal Care and Service Occupations	5,898	\$25,924
41-0000	Sales and Related Occupations	20,012	\$33,620
43-0000	Office and Administrative Support Occupations	21,753	\$34,468
45-0000	Farming, Fishing, and Forestry Occupations	135	\$28,028
47-0000	Construction and Extraction Occupations	6,533	\$47,126
49-0000	Installation, Maintenance, and Repair Occupations	6,416	\$44,434
51-0000	Production Occupations	4,812	\$35,128
53-0000	Transportation and Material Moving Occupations	9,600	\$33,613
Total		146,615	\$45,157

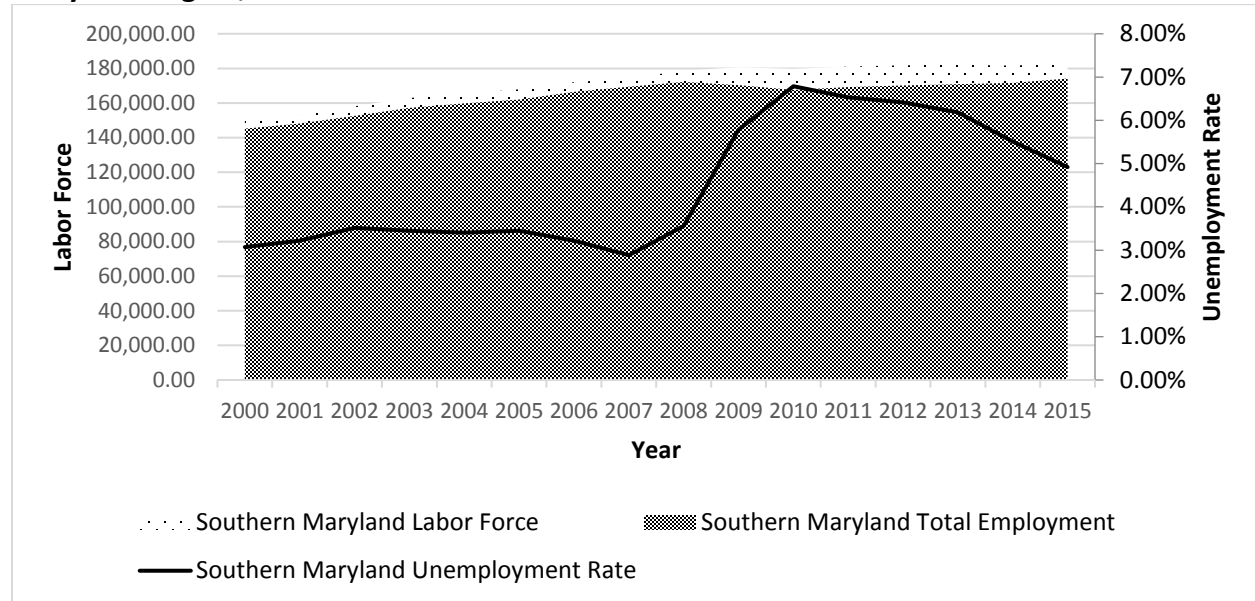
Sources: BLS OES, RESI, U.S. Census CBP

D.5 Southern Maryland—Labor Market

Southern Maryland's labor force grew from just under 150,000 people to over 183,000 people between 2000 and 2015. As can be seen in Figure 95, the labor force grew steadily until 2008, when it slowed down and became relatively stable. The unemployment rate in Southern Maryland has generally been lower than in other parts of the state. Before the recession, the

unemployment rate ranged from a low of 2.88 percent, to a high 3.56 percent. It peaked at 6.19 percent in 2010. In 2015, the unemployment rate was 4.92 percent for the region.

Figure 95: Labor Force, Total Employment, and Historical Unemployment Rate—Southern Maryland Region, 2000-2015



Source: BLS LAUS

The estimation procedure for employment and average wage by cluster also allows for the estimation of occupations by cluster for each region in Maryland. In order to understand the importance of individual clusters on Maryland's employees, it is helpful to know the distribution of the overall employment in Maryland by occupational category for each region.

For Southern Maryland, Figure 96 provides top-level occupation category employment estimates. Collectively, RESI estimates that the average annual wage for Southern Maryland is approximately \$49,000. The Sales and Related Occupations category had the largest number of workers employed in the region with 12,200 employed at an average wage of approximately \$32,700. Note that County Business Patterns is the primary source of this information, and excludes agricultural production employees, so agricultural occupations are underestimated by this method.¹⁹²

¹⁹² "County Business Patterns (CBP): Universe of County Business Patterns," U.S. Census Bureau.

Figure 96: Estimated Major Occupational Categories—Southern Maryland Region

SOC	Occupation Category	Estimated Employment, 2014	Average Wage, 2015
11-0000	Management Occupations	4,534	\$115,015
13-0000	Business and Financial Operations Occupations	4,364	\$74,984
15-0000	Computer and Mathematical Occupations	5,085	\$88,149
17-0000	Architecture and Engineering Occupations	3,921	\$79,754
19-0000	Life, Physical, and Social Science Occupations	1,363	\$72,060
21-0000	Community and Social Service Occupations	1,127	\$42,153
23-0000	Legal Occupations	390	\$108,899
25-0000	Education, Training, and Library Occupations	1,776	\$42,168
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	874	\$54,585
29-0000	Healthcare Practitioners and Technical Occupations	5,761	\$82,035
31-0000	Healthcare Support Occupations	2,786	\$30,592
33-0000	Protective Service Occupations	1,009	\$32,102
35-0000	Food Preparation and Serving Related Occupations	11,168	\$22,428
37-0000	Building and Grounds Cleaning and Maintenance Occupations	2,732	\$26,087
39-0000	Personal Care and Service Occupations	2,689	\$26,220
41-0000	Sales and Related Occupations	12,200	\$32,716
43-0000	Office and Administrative Support Occupations	12,053	\$34,692
45-0000	Farming, Fishing, and Forestry Occupations	23	\$30,098
47-0000	Construction and Extraction Occupations	6,026	\$47,687
49-0000	Installation, Maintenance, and Repair Occupations	3,879	\$46,468
51-0000	Production Occupations	1,019	\$38,972
53-0000	Transportation and Material Moving Occupations	4,242	\$31,899
Total		89,020	\$49,017

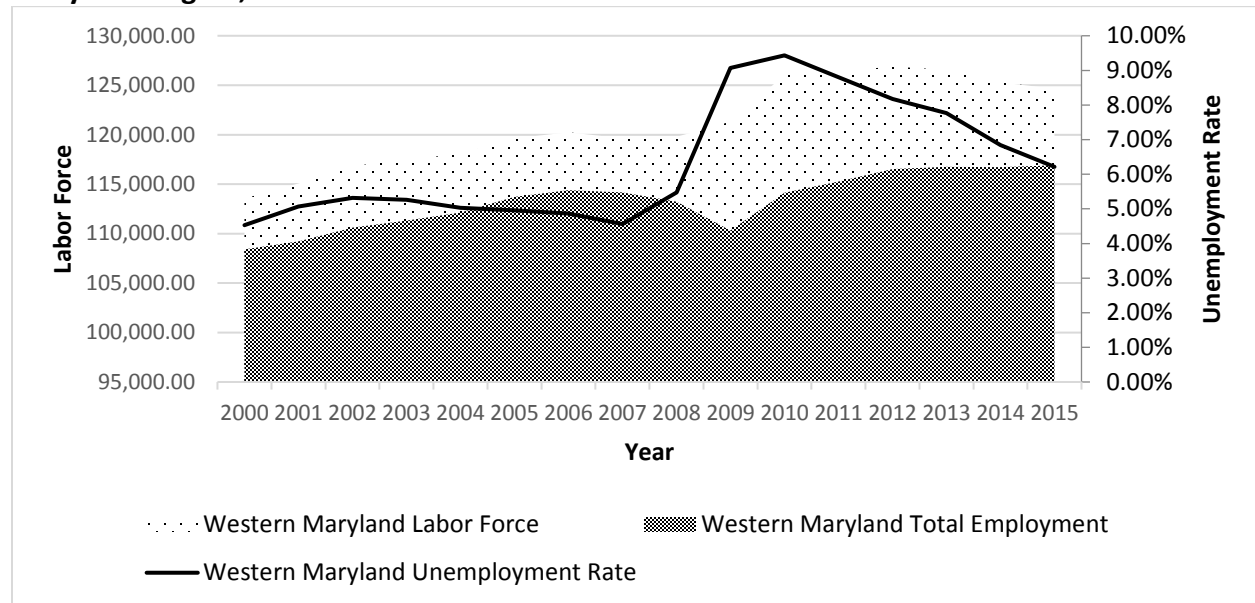
Sources: BLS OES, RESI, U.S. Census CBP

D.6 Western Maryland—Labor Market

Figure 97 shows the labor force trends for Western Maryland. Western Maryland's labor force grew from under 114,000 people in 2000 to a peak of just under 127,000 people in 2012. In 2015, the labor force was just under 125,000. Right around the recession the region saw a relatively large increase in the labor force, and it has seen a slight decrease since that time. The unemployment rate in the region, before the recession, ranged from a low of 4.53 percent in

2000 to a high of 5.48 percent in 2008. The unemployment rate peaked in 2010 at 9.43 percent, and then recovered to 6.21 percent in 2015.

Figure 97: Labor Force, Total Employment, and Historical Unemployment Rate—Western Maryland Region, 2000-2015



Source: BLS LAUS

The estimation procedure for employment and average wage by cluster also allows for the estimation of occupations by cluster for each region in Maryland. In order to understand the importance of individual clusters on Maryland's employees, it is helpful to know the distribution of the overall employment in Maryland by occupational category for each region.

For Western Maryland, Figure 98 provides top-level occupation category employment estimates. Collectively, RESI estimates that the average annual wage for Western Maryland is approximately \$47,700. The Office and Administrative Support Occupations category had the largest number of workers employed in the region with 18,100 employed at an average wage of approximately \$35,200. Note that County Business Patterns is the primary source of this information, and excludes agricultural production employees, so agricultural occupations are underestimated by this method.¹⁹³

¹⁹³ "County Business Patterns (CBP): Universe of County Business Patterns," U.S. Census Bureau.

Figure 98: Estimated Major Occupational Categories—Western Maryland Region

SOC	Occupation Category	Estimated Employment, 2014	Average Wage, 2015
11-0000	Management Occupations	5,459	\$113,748
13-0000	Business and Financial Operations Occupations	6,661	\$73,216
15-0000	Computer and Mathematical Occupations	4,560	\$85,735
17-0000	Architecture and Engineering Occupations	1,381	\$79,414
19-0000	Life, Physical, and Social Science Occupations	543	\$72,252
21-0000	Community and Social Service Occupations	1,735	\$41,576
23-0000	Legal Occupations	399	\$107,210
25-0000	Education, Training, and Library Occupations	1,299	\$41,626
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	1,175	\$55,157
29-0000	Healthcare Practitioners and Technical Occupations	7,391	\$77,171
31-0000	Healthcare Support Occupations	3,725	\$29,148
33-0000	Protective Service Occupations	743	\$29,949
35-0000	Food Preparation and Serving Related Occupations	9,469	\$22,674
37-0000	Building and Grounds Cleaning and Maintenance Occupations	2,899	\$26,081
39-0000	Personal Care and Service Occupations	3,440	\$25,506
41-0000	Sales and Related Occupations	13,603	\$35,653
43-0000	Office and Administrative Support Occupations	18,075	\$35,161
45-0000	Farming, Fishing, and Forestry Occupations	32	\$31,608
47-0000	Construction and Extraction Occupations	3,925	\$47,557
49-0000	Installation, Maintenance, and Repair Occupations	4,575	\$45,324
51-0000	Production Occupations	3,306	\$36,527
53-0000	Transportation and Material Moving Occupations	7,911	\$35,176
Total		102,308	\$47,662

Sources: BLS OES, RESI, U.S. Census CBP

Appendix E: DoD Spending By Cluster

This section presents the total job estimates, average annual DoD funding, DoD spending impacts, and average wages associated with each cluster. The first subsection presents this information for the state level, and the other subsections present the corresponding information for each region.

E.1 Maryland—DoD Spending by Cluster

Figure 99 presents the statewide job estimates, average annual DoD Dollars obligated, the estimated impact on jobs of the DoD funding obligations, and the average wages associated with the cluster at the state level for all clusters in Maryland.

Figure 99: Estimated Average Jobs, Average Annual Wages, Annual Funding, and Impact by Cluster—Maryland¹⁹⁴

Cluster Name	Statewide Job Estimate, 2014	Average Wages, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Business Services	315,659	\$76,688	\$7,299,282,121	35,446
Education and Knowledge Creation	78,237	\$75,859	\$1,864,276,683	9,152
Local Real Estate, Construction, and Development	233,818	\$49,519	\$1,487,297,165	11,185
Aerospace Vehicles and Defense	10,881	\$85,290	\$1,240,767,978	5,418
Communications Equipment and Services	10,725	\$73,561	\$1,103,423,851	5,586
Water Transportation	4,469	\$60,708	\$871,676,614	5,347
Local Utilities	29,055	\$67,836	\$659,778,570	3,622
Local Health Services	346,345	\$54,877	\$500,422,212	3,396
Information Technology and Analytical Instruments	12,456	\$94,160	\$438,013,070	1,732

¹⁹⁴ This estimated employment supported by DoD funding by cluster (in the fourth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for a more detailed methodology.

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Cluster Name	Statewide Job Estimate, 2014	Average Wages, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Local Commercial Services	178,526	\$47,021	\$396,081,575	3,137
Transportation and Logistics	17,892	\$51,069	\$322,011,737	2,348
Local Hospitality Establishments	245,109	\$24,730	\$258,745,083	3,896
Construction Products and Services	10,897	\$53,052	\$242,413,679	1,702
Insurance Services	22,890	\$70,133	\$147,976,576	786
Downstream Metal Products	2,968	\$51,180	\$146,059,007	1,063
Distribution and Electronic Commerce	91,013	\$55,178	\$140,233,696	946
Local Entertainment and Media	26,129	\$40,998	\$100,912,817	917
Production Technology and Heavy Machinery	8,379	\$59,478	\$87,262,129	546
Medical Devices	1,680	\$61,828	\$77,720,144	468
Marketing, Design, and Publishing	28,034	\$71,949	\$58,467,512	303
Local Household Goods and Services	37,946	\$32,400	\$53,551,728	616
Metalworking Technology	2,343	\$54,538	\$47,302,205	323
Furniture	2,550	\$42,161	\$41,560,213	367
Biopharmaceuticals	5,529	\$75,051	\$35,802,625	178
Local Industrial Products and Services	8,019	\$47,465	\$35,179,074	276
Food Processing and Manufacturing	9,793	\$44,665	\$32,061,032	267
Lighting and Electrical Equipment	1,810	\$60,138	\$31,350,370	194

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Cluster Name	Statewide Job Estimate, 2014	Average Wages, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Oil and Gas Production and Transportation	227	\$73,487	\$28,829,734	146
Recreational and Small Electric Goods	2,095	\$46,884	\$25,540,603	203
Leather and Related Products	378	\$39,826	\$23,805,225	223
Local Logistical Services	44,164	\$41,231	\$21,522,622	194
Apparel	1,040	\$41,677	\$19,348,879	173
Local Food and Beverage Processing and Distribution	101,456	\$31,209	\$18,228,933	218
Automotive	1,051	\$50,516	\$15,894,014	117
Local Community and Civic Organizations	89,891	\$42,344	\$12,919,191	114
Video Production and Distribution	1,831	\$58,255	\$12,497,275	80
Environmental Services	2,043	\$49,273	\$8,604,071	65
Hospitality and Tourism	44,515	\$33,128	\$8,237,749	93
Local Personal Services (Non- Medical)	66,781	\$33,123	\$8,197,254	92
Electric Power Generation and Transmission	2,277	\$76,555	\$5,954,661	29
Upstream Chemical Products	1,643	\$68,382	\$4,932,780	27
Downstream Chemical Products	3,419	\$57,810	\$4,862,392	31
Trailers, Motor Homes, and Appliances	135	\$43,289	\$4,752,727	41
Wood Products	2,567	\$39,432	\$3,662,936	35

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Cluster Name	Statewide Job Estimate, 2014	Average Wages, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Plastics	6,342	\$47,725	\$3,043,386	24
Local Education and Training	39,070	\$44,827	\$2,517,955	21
Upstream Metal Manufacturing	1,490	\$51,150	\$2,325,146	17
Vulcanized and Fired Materials	1,662	\$47,422	\$2,140,219	17
Textile Manufacturing	1,046	\$41,718	\$2,024,933	18
Local Motor Vehicle Products and Services	85,078	\$38,536	\$1,252,315	12
Coal Mining	471	\$58,177	\$1,245,966	8
Printing Services	8,312	\$47,054	\$1,126,905	9
Forestry	148	\$40,314	\$1,077,607	10
Performing Arts	6,110	\$50,898	\$1,069,023	8
Nonmetal Mining	702	\$48,015	\$897,315	7
Financial Services	45,755	\$82,323	\$555,954	3
Paper and Packaging	3,333	\$52,283	\$545,911	4
Livestock Processing	1,853	\$32,880	\$439,161	5
Footwear	177	\$49,437	\$256,335	2
Local Retailing of Clothing and General Merchandise	97,452	\$26,520	\$167,928	2
Music and Sound Recording	268	\$65,593	\$71,239	0
Agricultural Inputs and Services	1,286	\$37,143	\$58,248	1
Jewelry and Precious Metals	98	\$50,780	\$7,263	0
All Clusters	2,409,318	\$50,451	\$17,968,243,321	101,263

Sources: BLS OES, REMI, RESI, USA Spending, U.S. Census CBP

E.2 Capital Region—DoD Spending by Cluster

Figure 100 presents the statewide job estimates, average annual DoD Dollars obligated, the estimated impact on jobs of the DoD funding obligations, and the average wages associated with the cluster at the state level for all clusters in the Capital region.

Figure 100: Estimated Average Jobs, Average Annual Wages, Annual Funding, and Impact by Cluster—Capital Region¹⁹⁵

Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Business Services	155,491	\$80,110	\$3,764,580,776	16,239
Communications Equipment and Services	6,222	\$74,272	\$714,155,402	3,323
Local Real Estate, Construction, and Development	100,882	\$49,865	\$614,306,587	4,257
Education and Knowledge Creation	44,360	\$83,165	\$516,905,370	2,148
Local Health Services	103,770	\$55,397	\$264,504,721	1,650
Local Hospitality Establishments	70,588	\$24,958	\$244,051,349	3,379
Local Commercial Services	72,833	\$45,386	\$237,011,702	1,805
Local Utilities	9,757	\$68,227	\$236,757,638	1,199
Information Technology and Analytical Instruments	6,662	\$96,168	\$230,345,663	828
Aerospace Vehicles and Defense	1,321	\$84,977	\$142,844,325	581
Transportation and Logistics	3,066	\$45,823	\$131,488,471	992
Distribution and Electronic Commerce	23,030	\$57,971	\$86,877,798	518
Construction Products and Services	3,897	\$52,893	\$80,687,497	527

¹⁹⁵ This estimated employment supported by DoD funding by cluster (in the fourth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for a more detailed methodology.

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Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Local Entertainment and Media	8,043	\$40,519	\$77,395,978	660
Medical Devices	181	\$61,959	\$62,014,395	346
Marketing, Design, and Publishing	10,001	\$74,060	\$36,372,261	170
Production Technology and Heavy Machinery	683	\$56,764	\$32,142,093	196
Biopharmaceuticals	2,539	\$75,051	\$22,979,995	106
Water Transportation	86	\$63,746	\$20,288,113	110
Lighting and Electrical Equipment	225	\$57,713	\$19,817,803	119
Furniture	261	\$42,721	\$19,660,190	159
Local Household Goods and Services	14,123	\$32,044	\$17,198,578	185
Local Industrial Products and Services	1,898	\$46,879	\$14,338,057	106
Downstream Metal Products	635	\$49,618	\$13,930,074	97
Recreational and Small Electric Goods	34	\$50,780	\$13,614,145	93
Oil and Gas Production and Transportation	46	\$66,689	\$11,388,132	59
Food Processing and Manufacturing	1,001	\$44,799	\$8,798,498	68
Local Community and Civic Organizations	36,110	\$43,825	\$7,656,111	60
Automotive	8	\$50,640	\$7,424,568	51
Local Personal Services (Non-Medical)	23,434	\$32,869	\$6,851,392	72
Hospitality and Tourism	12,409	\$33,272	\$5,708,019	59
Local Logistical Services	11,021	\$41,446	\$5,507,602	46
Video Production and Distribution	1,027	\$58,255	\$2,859,181	17
Metalworking Technology	257	\$56,477	\$2,003,722	12
Downstream Chemical Products	167	\$60,726	\$1,740,883	10

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Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Environmental Services	665	\$47,668	\$1,289,058	9
Electric Power Generation and Transmission	399	\$76,555	\$1,232,085	6
Apparel	65	\$40,502	\$1,143,587	10
Upstream Chemical Products	10	\$68,603	\$1,118,551	6
Performing Arts	1,976	\$53,763	\$907,167	6
Upstream Metal Manufacturing	43	\$51,830	\$877,665	6
Textile Manufacturing	62	\$39,826	\$862,671	7
Plastics	165	\$46,877	\$848,417	6
Vulcanized and Fired Materials	199	\$47,374	\$415,050	3
Printing Services	2,511	\$47,024	\$395,257	3
Nonmetal Mining	183	\$47,819	\$368,344	3
Local Food and Beverage Processing and Distribution	31,517	\$30,842	\$269,523	3
Trailers, Motor Homes, and Appliances	2	\$43,289	\$247,159	2
Leather and Related Products	78	\$39,867	\$189,421	2
Local Retailing of Clothing and General Merchandise	29,215	\$26,224	\$178,902	2
Paper and Packaging	60	\$50,473	\$172,987	1
Footwear	1	\$49,437	\$126,098	1
Local Education and Training	15,192	\$45,189	\$124,472	1
Insurance Services	8,602	\$70,256	\$117,958	1
Financial Services	14,299	\$82,125	\$67,589	0
Agricultural Inputs and Services	103	\$45,178	\$48,519	0
Livestock Processing	8	\$37,509	\$41,562	0
Wood Products	391	\$39,632	\$29,471	0

Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Forestry	3	\$40,314	\$26,942	0
Music and Sound Recording	149	\$65,593	\$18,340	0
Jewelry and Precious Metals	2	\$50,780	\$9,425	0
All Clusters	831,966	\$54,547	\$7,685,333,309	40,324

Sources: BLS OES, REMI, RESI, USA Spending, U.S. Census CBP

E.3 Central Region—DoD Spending by Cluster

Figure 101 presents the statewide job estimates, average annual DoD Dollars obligated, the estimated impact on jobs of the DoD funding obligations, and the average wages associated with the cluster at the state level for all clusters in the Capital region.

Figure 101: Estimated Average Jobs, Average Annual Wages, Annual Funding, and Impact by Cluster—Central Region¹⁹⁶

Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Business Services	166,779	\$79,025	\$2,153,631,370	11,657
Education and Knowledge Creation	44,933	\$72,797	\$1,259,500,038	7,401
Aerospace Vehicles and Defense	7,601	\$85,419	\$995,080,987	4,983
Water Transportation	3,263	\$60,955	\$845,277,435	5,932
Local Real Estate, Construction, and Development	105,131	\$49,708	\$778,528,515	6,699
Local Utilities	15,065	\$68,679	\$401,596,981	2,501
Communications Equipment and Services	4,391	\$72,385	\$323,817,737	1,914
Local Health Services	187,184	\$55,307	\$230,706,971	1,784

¹⁹⁶ This estimated employment supported by DoD funding by cluster (in the fourth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for a more detailed methodology.

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Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Information Technology and Analytical Instruments	6,223	\$95,482	\$179,139,792	803
Insurance Services	14,005	\$70,072	\$147,926,423	903
Construction Products and Services	5,110	\$53,028	\$134,022,607	1,081
Local Commercial Services	87,613	\$49,797	\$117,681,957	1,011
Downstream Metal Products	900	\$51,207	\$109,786,828	917
Metalworking Technology	937	\$53,318	\$44,222,122	355
Distribution and Electronic Commerce	50,254	\$55,200	\$38,312,471	297
Leather and Related Products	132	\$39,809	\$23,520,245	253
Food Processing and Manufacturing	5,116	\$44,751	\$23,065,220	220
Production Technology and Heavy Machinery	3,203	\$59,058	\$23,028,367	167
Local Household Goods and Services	16,247	\$32,606	\$20,776,609	273
Local Entertainment and Media	12,368	\$40,552	\$20,387,041	215
Local Industrial Products and Services	3,954	\$47,745	\$19,360,378	173
Furniture	684	\$42,896	\$18,828,650	188
Transportation and Logistics	10,586	\$53,160	\$17,943,828	144
Local Logistical Services	20,401	\$41,083	\$14,744,210	154
Local Hospitality Establishments	109,583	\$24,940	\$13,988,918	240

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Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Local Food and Beverage Processing and Distribution	44,613	\$31,086	\$13,295,617	183
Biopharmaceuticals	2,304	\$75,051	\$12,673,976	72
Apparel	468	\$41,937	\$11,573,981	118
Lighting and Electrical Equipment	877	\$60,402	\$9,949,866	70
Video Production and Distribution	633	\$58,255	\$9,584,226	70
Marketing, Design, and Publishing	16,855	\$72,699	\$9,187,232	54
Recreational and Small Electric Goods	618	\$47,775	\$7,507,805	67
Automotive	547	\$50,766	\$6,810,370	57
Oil and Gas Production and Transportation	129	\$75,510	\$6,503,101	37
Environmental Services	1,100	\$50,390	\$5,419,226	46
Local Community and Civic Organizations	42,013	\$42,361	\$5,225,250	53
Electric Power Generation and Transmission	737	\$76,555	\$4,722,576	26
Upstream Chemical Products	1,117	\$68,537	\$3,759,892	23
Medical Devices	377	\$62,002	\$3,251,730	22
Local Education and Training	19,624	\$44,830	\$2,189,045	21
Hospitality and Tourism	20,667	\$33,701	\$2,069,719	26
Wood Products	526	\$39,461	\$1,764,784	19
Downstream Chemical Products	2,206	\$57,529	\$1,577,063	12
Trailers, Motor Homes, and Appliances	52	\$43,289	\$1,247,623	12

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Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Forestry	1	\$40,314	\$1,056,421	11
Upstream Metal Manufacturing	586	\$51,599	\$1,042,426	9
Local Motor Vehicle Products and Services	38,109	\$38,860	\$990,048	11
Local Personal Services (Non-Medical)	31,442	\$33,315	\$952,435	12
Textile Manufacturing	129	\$40,526	\$912,834	10
Vulcanized and Fired Materials	491	\$47,373	\$731,890	7
Printing Services	2,131	\$47,116	\$650,261	6
Plastics	1,869	\$48,651	\$644,006	6
Nonmetal Mining	236	\$48,112	\$509,735	5
Livestock Processing	347	\$33,522	\$496,999	6
Financial Services	26,980	\$87,980	\$487,244	2
Paper and Packaging	865	\$51,102	\$349,389	3
Performing Arts	3,508	\$49,095	\$127,218	1
Footwear	104	\$49,437	\$100,160	1
Music and Sound Recording	102	\$65,593	\$58,410	0
Local Retailing of Clothing and General Merchandise	44,105	\$26,589	\$25,677	0
Jewelry and Precious Metals	33	\$50,780	\$15,729	0
Agricultural Inputs and Services	288	\$36,311	\$10,827	0
All Clusters	1,188,453	\$52,491	\$8,082,350,494	51,344

Sources: BLS OES, REMI, RESI, USA Spending, U.S. Census CBP

E.4 Eastern Shore—DoD Spending by Cluster

Figure 102 presents the statewide job estimates, average annual DoD Dollars obligated, the estimated impact on jobs of the DoD funding obligations, and the average wages associated with the cluster at the state level for all clusters on the Eastern Shore.

Figure 102: Estimated Average Jobs, Average Annual Wages, Annual Funding, and Impact by Cluster—Eastern Shore¹⁹⁷

Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Education and Knowledge Creation	1,980	\$62,875	\$24,841,118	153
Production Technology and Heavy Machinery	623	\$55,179	\$21,036,679	147
Construction Products and Services	586	\$53,561	\$19,690,751	142
Aerospace Vehicles and Defense	1,398	\$84,929	\$14,769,258	67
Downstream Metal Products	175	\$53,263	\$14,756,795	107
Distribution and Electronic Commerce	5,130	\$50,880	\$12,003,283	91
Medical Devices	652	\$61,649	\$11,728,084	74
Business Services	5,914	\$71,651	\$9,053,887	49
Information Technology and Analytical Instruments	564	\$83,467	\$8,515,272	39
Local Food and Beverage Processing and Distribution	6,254	\$32,779	\$5,673,377	67
Water Transportation	500	\$59,653	\$5,603,929	36
Trailers, Motor Homes, and Appliances	22	\$43,289	\$5,408,874	48
Wood Products	514	\$39,284	\$3,008,474	30
Local Real Estate, Construction, and Development	12,941	\$48,931	\$2,985,576	24
Furniture	30	\$43,644	\$2,833,518	25
Local Commercial Services	6,325	\$52,127	\$1,749,312	13
Apparel	14	\$41,981	\$1,143,410	11
Automotive	40	\$51,110	\$1,137,564	9

¹⁹⁷ This estimated employment supported by DoD funding by cluster (in the fourth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for a more detailed methodology.

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Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Transportation and Logistics	1,459	\$51,969	\$987,068	7
Local Household Goods and Services	2,557	\$31,493	\$915,472	11
Downstream Chemical Products	170	\$56,944	\$795,128	5
Vulcanized and Fired Materials	52	\$47,704	\$763,989	6
Plastics	1,767	\$47,251	\$669,290	5
Lighting and Electrical Equipment	249	\$61,400	\$576,104	4
Oil and Gas Production and Transportation	6	\$85,154	\$363,070	2
Hospitality and Tourism	6,205	\$32,067	\$334,980	4
Upstream Metal Manufacturing	367	\$50,373	\$325,173	2
Local Industrial Products and Services	425	\$45,355	\$234,651	2
Recreational and Small Electric Goods	261	\$50,736	\$219,501	2
Environmental Services	52	\$46,799	\$206,424	2
Food Processing and Manufacturing	867	\$43,830	\$195,630	2
Metalworking Technology	96	\$56,159	\$179,060	1
Local Motor Vehicle Products and Services	7,025	\$34,816	\$170,219	2
Textile Manufacturing	250	\$42,128	\$148,269	1
Marketing, Design, and Publishing	769	\$75,362	\$113,408	1
Communications Equipment and Services	182	\$74,175	\$99,051	1
Biopharmaceuticals	651	\$75,051	\$98,304	1
Local Health Services	26,955	\$54,052	\$80,537	1
Agricultural Inputs and Services	282	\$39,552	\$56,601	1
Nonmetal Mining	110	\$47,819	\$48,090	0

Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Local Education and Training	2,417	\$45,776	\$48,000	0
Local Utilities	2,167	\$64,787	\$40,536	0
Paper and Packaging	661	\$50,473	\$37,336	0
Performing Arts	112	\$49,070	\$31,600	0
Local Logistical Services	2,282	\$41,657	\$25,908	0
Printing Services	317	\$47,024	\$24,663	0
Local Hospitality Establishments	17,316	\$24,374	\$19,831	0
Leather and Related Products	24	\$39,700	\$9,344	0
Local Personal Services (Non-Medical)	4,040	\$33,865	\$4,617	0
Local Retailing of Clothing and General Merchandise	8,484	\$26,813	\$2,517	0
Upstream Chemical Products	226	\$67,498	\$1,219	0
All Clusters	132,464	\$44,751	\$173,764,748	1,195

Sources: BLS OES, REMI, RESI, USA Spending, U.S. Census CBP

E.5 Southern Maryland—DoD Spending by Cluster

Figure 103 presents the statewide job estimates, average annual DoD Dollars obligated, the estimated impact on jobs of the DoD funding obligations, and the average wages associated with the cluster at the state level for all clusters in Southern Maryland.

Figure 103: Estimated Average Jobs, Average Annual Wages, Annual Funding, Annual Funding and Impact by Cluster—Southern Maryland¹⁹⁸

Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Business Services	15,089	\$78,107	\$1,352,852,319	4,824
Transportation and Logistics	413	\$49,046	\$171,556,232	974

¹⁹⁸ This estimated employment supported by DoD funding by cluster (in the fourth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for a more detailed methodology.

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Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Local Real Estate, Construction, and Development	10,733	\$49,757	\$89,871,809	503
Aerospace Vehicles and Defense	107	\$85,309	\$79,666,649	260
Communications Equipment and Services	189	\$71,246	\$65,191,487	255
Education and Knowledge Creation	1,419	\$81,056	\$51,880,144	178
Local Utilities	1,492	\$65,550	\$21,252,455	90
Information Technology and Analytical Instruments	16	\$86,074	\$18,567,286	60
Local Commercial Services	2,922	\$51,765	\$13,957,844	75
Local Household Goods and Services	1,641	\$33,738	\$13,748,242	113
Marketing, Design, and Publishing	493	\$68,073	\$11,579,953	47
Oil and Gas Production and Transportation	5	\$63,723	\$10,491,702	46
Production Technology and Heavy Machinery	39	\$56,079	\$9,710,942	48
Construction Products and Services	55	\$55,944	\$7,636,058	38
Local Health Services	13,024	\$56,049	\$5,141,694	26
Downstream Metal Products	65	\$49,955	\$4,734,436	26
Local Entertainment and Media	1,107	\$35,961	\$3,116,358	24
Distribution and Electronic Commerce	744	\$55,637	\$2,023,006	10
Environmental Services	49	\$47,872	\$1,688,062	10
Apparel	12	\$39,700	\$1,465,330	10

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Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Local Logistical Services	1,768	\$38,312	\$1,120,565	8
Water Transportation	78	\$60,814	\$747,230	3
Furniture	76	\$40,605	\$730,251	5
Local Hospitality Establishments	11,751	\$24,072	\$674,414	8
Metalworking Technology	19	\$49,669	\$640,297	4
Downstream Chemical Products	2	\$60,314	\$605,278	3
Local Industrial Products and Services	108	\$43,400	\$352,508	2
Automotive	5	\$52,215	\$298,858	2
Local Personal Services (Non-Medical)	3,386	\$33,386	\$217,667	2
Local Education and Training	1,488	\$43,910	\$194,839	1
Plastics	37	\$46,877	\$193,308	1
Recreational and Small Electric Goods	14	\$50,780	\$150,073	1
Local Motor Vehicle Products and Services	4,273	\$36,629	\$118,633	1
Hospitality and Tourism	1,333	\$31,895	\$98,526	1
Printing Services	240	\$47,024	\$89,403	1
Leather and Related Products	4	\$39,700	\$70,303	0
Vulcanized and Fired Materials	3	\$47,193	\$66,201	0
Local Food and Beverage Processing and Distribution	4,256	\$29,352	\$51,838	0
Food Processing and Manufacturing	24	\$43,472	\$41,246	0
Local Community and Civic Organizations	2,317	\$43,349	\$38,550	0

Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Upstream Metal Manufacturing	7	\$54,095	\$35,737	0
Performing Arts	61	\$56,620	\$35,398	0
Biopharmaceuticals	2	\$75,051	\$34,569	0
Local Retailing of Clothing and General Merchandise	4,882	\$26,707	\$32,102	0
Music and Sound Recording	5	\$65,593	\$22,904	0
Wood Products	109	\$38,702	\$20,471	0
Insurance Services	67	\$69,772	\$14,850	0
Financial Services	326	\$77,857	\$5,606	0
Video Production and Distribution	14	\$58,255	\$750	0
All Clusters	86,273	\$48,508	1,942,834,383	7,664

Sources: BLS OES, REMI, RESI, USA Spending, U.S. Census CBP

E.6 Western Maryland—DoD Spending by Cluster

Figure 104 presents the statewide job estimates, average annual DoD Dollars obligated, the estimated impact on jobs of the DoD funding obligations, and the average wages associated with the cluster at the state level for all clusters in Western Maryland.

Figure 104: Estimated Average Jobs, Average Annual Wages, Annual Funding and Impact by Cluster—Western Maryland¹⁹⁹

Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Local Commercial Services	5,668	\$52,743	\$25,187,985	262
Business Services	5,340	\$78,478	\$18,801,435	131
Education and Knowledge Creation	193	\$67,707	\$13,499,037	109
Recreational and Small Electric Goods	501	\$43,850	\$4,068,317	51

¹⁹⁹ This estimated employment supported by DoD funding by cluster (in the fourth column) was calculated utilizing the employment and wage data presented in the second and third columns. Please see Appendix C.4 for a more detailed methodology.

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Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Apparel	88	\$41,253	\$4,022,570	53
Downstream Metal Products	289	\$53,582	\$2,850,041	29
Local Real Estate, Construction, and Development	7,401	\$48,512	\$1,124,574	13
Distribution and Electronic Commerce	4,396	\$46,827	\$969,943	11
Local Household Goods and Services	1,840	\$32,579	\$862,574	15
Local Industrial Products and Services	350	\$45,409	\$848,057	10
Plastics	421	\$47,499	\$687,548	8
Production Technology and Heavy Machinery	1,666	\$64,193	\$573,016	5
Medical Devices	41	\$63,009	\$529,535	5
Information Technology and Analytical Instruments	795	\$95,013	\$396,170	2
Construction Products and Services	490	\$53,460	\$376,766	4
Automotive	83	\$48,912	\$276,516	3
Metalworking Technology	243	\$58,695	\$253,044	2
Downstream Chemical Products	147	\$60,876	\$237,421	2
Local Utilities	1,421	\$64,571	\$224,436	2
Local Personal Services (Non-Medical)	2,291	\$34,987	\$218,546	3
Vulcanized and Fired Materials	348	\$47,444	\$176,329	2
Oil and Gas Production and Transportation	31	\$71,245	\$139,545	1
Communications Equipment and Services	182	\$72,230	\$129,087	1
Water Transportation	19	\$56,661	\$101,997	1
Lighting and Electrical Equipment	11	\$62,199	\$97,991	1

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Cluster Name	Statewide Job Estimate, 2014	Average Wage, 2015	Average Annual Dollars Obligated, 2011-2015	Jobs Supported by DoD Spending
Upstream Chemical Products	40	\$69,196	\$91,518	1
Wood Products	176	\$39,822	\$88,524	1
Transportation and Logistics	784	\$45,648	\$60,230	1
Local Motor Vehicle Products and Services	4,427	\$36,769	\$59,006	1
Local Entertainment and Media	1,488	\$45,564	\$56,470	1
Local Logistical Services	3,926	\$42,767	\$51,264	1
Furniture	577	\$41,378	\$46,521	1
Marketing, Design, and Publishing	1,037	\$71,390	\$44,767	0
Leather and Related Products	2	\$40,792	\$37,447	1
Textile Manufacturing	225	\$42,572	\$35,958	0
Food Processing and Manufacturing	222	\$46,159	\$29,861	0
Hospitality and Tourism	1,955	\$31,729	\$26,505	0
Forestry	27	\$40,314	\$25,100	0
Local Hospitality Establishments	9,568	\$24,271	\$22,469	1
Video Production and Distribution	7	\$58,255	\$20,000	0
Local Retailing of Clothing and General Merchandise	5,135	\$26,745	\$9,868	0
Environmental Services	36	\$50,541	\$1,455	0
Local Food and Beverage Processing and Distribution	3,976	\$32,841	\$498	0
All Clusters	67,860	\$44,270	\$77,359,941	736

Sources: BLS OES, REMI, RESI, USA Spending, U.S. Census CBP

Appendix F: Top Vendors by DoD Funding for each Cluster

This section presents the top vendor for each cluster. The first subsection presents this information for the state level, and the other subsections present the corresponding information for each region.

F.1 Maryland—Top Vendors by DoD Funding for each Cluster

Figure 105 below shows the company receiving the largest average yearly DoD funding commitments for each cluster in Maryland. Ordered from the largest to smallest.

Figure 105: Highest-Funded Company per Maryland Cluster

Cluster Name	Company Name	Average Annual Dollars Obligated, 2011-2015
Water Transportation	Lockheed Martin Corporation	\$820,918,132
Education and Knowledge Creation	The Johns Hopkins University Applied Physics Laboratory LLC	\$715,023,269
Business Services	BAE Systems Technology Solutions & Services Inc.	\$600,429,936
Aerospace Vehicles and Defense	AAI Corporation	\$472,522,668
Insurance Services	Johns Hopkins Medical Services Corporation	\$367,505,000
Communications Equipment and Services	Lockheed Martin Corporation	\$336,163,172
Local Hospitality Establishments	Sodexo Management Inc.	\$239,268,456
Local Health Services	Johns Hopkins Medical Services Corporation	\$233,027,453
Local Real Estate, Construction, and Development	Walsh/Gilbane JV	\$206,445,000
Local Utilities	Lockheed Martin Corporation	\$181,973,845
Transportation and Logistics	DynCorp International LLC	\$143,562,931
Downstream Metal Products	Lockheed Martin Corporation	\$76,891,281
Information Technology and Analytical Instruments	Hewlett-Packard Company	\$46,907,424
Food Processing and Manufacturing	McCormick & Company, Incorporated	\$43,160,510
Metalworking Technology	Lockheed Martin Aeronautics Service-International	\$40,146,363
Local Commercial Services	International Business Machine	\$39,869,235

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Cluster Name	Company Name	Average Annual Dollars Obligated, 2011-2015
Local Household Goods and Services	Neany, Inc.	\$31,088,426
Distribution and Electronic Commerce	URS Federal Services, Inc.	\$31,045,654
Local Industrial Products and Services	Raytheon Company	\$28,931,547
Construction Products and Services	American Water Operations And Maintenance Inc.	\$26,912,089
Marketing, Design, and Publishing	Engility Corporation	\$26,195,279
Local Entertainment and Media	International Business Machine	\$24,496,411
Medical Devices	Medical Center Orthotics And Prosthetics, LLC	\$24,176,000
Leather and Related Products	Smiths Detection Edgewood Incorporated	\$23,125,367
Automotive	Textron Inc.	\$19,861,704
Oil and Gas Production and Transportation	Washington Gas Energy Services Inc.	\$17,863,882
Production Technology and Heavy Machinery	Global Strategies Group (North America) Inc.	\$15,606,091
Local Motor Vehicle Products and Services	URS Federal Services, Inc.	\$15,090,010
Biopharmaceuticals	AcelRx Pharmaceuticals, Inc.	\$12,647,049
Furniture	Federal Resources Supply Company	\$10,939,173
Recreational and Small Electric Goods	Digital Receiver Technology, Inc.	\$10,507,818
Local Food and Beverage Processing and Distribution	US Foodservice Incorporated (2294)	\$9,289,304
Lighting and Electrical Equipment	Automated Business Power, LLC	\$7,936,592
Local Community and Civic Organizations	Rehabplus Staffing Group, Inc.	\$6,653,124
Trailers, Motor Homes, and Appliances	Global Strategies Group (North America) Inc.	\$5,402,368
Apparel	Blind Industries And Services Of Maryland	\$5,313,040
Video Production and Distribution	Towne Group Inc.	\$5,284,236

Cluster Name	Company Name	Average Annual Dollars Obligated, 2011-2015
Local Education and Training	Northrop Grumman Systems Corporation	\$5,233,683
Local Logistical Services	L B & B Associates Inc.	\$4,705,630
Local Personal Services (Non-Medical)	TVI Corporation	\$4,315,613
Wood Products	Global Strategies Group (North America) Inc.	\$4,209,122
Electric Power Generation and Transmission	Constellation Newenergy, Inc.	\$3,860,016
Coal Mining	J & J Energy Inc.	\$3,630,850
Upstream Chemical Products	Usalco, LLC	\$2,509,838
Downstream Chemical Products	Carleton Technologies Inc.	\$1,931,753
Environmental Services	Veolia ES Technical Solutions, L.L.C.	\$1,687,728
Hospitality and Tourism	Sodexo, Inc.	\$1,501,162
Performing Arts	Mid Atlantic Professionals, Inc.	\$1,168,929
Forestry	Mar-Len Environmental, Inc.	\$1,056,421
Livestock Processing	Henry W Stapf Incorporated	\$972,676
Vulcanized and Fired Materials	Marine Polymers Inc.	\$951,203
Plastics	Alliance Micro Incorporated	\$715,580
Nonmetal Mining	Gearhart Brothers Services, LLC	\$580,696
Printing Services	BAE Systems Technology Solutions & Services Inc.	\$544,967
Textile Manufacturing	Truetandem, LLC	\$531,128
Paper and Packaging	National Industries For The Blind	\$458,344
Upstream Metal Manufacturing	Alcan Rolled Products - Ravenswood, LLC	\$439,647
Financial Services	Kropp Holdings, Inc.	\$413,048
Local Retailing of Clothing and General Merchandise	EC Amrc/Bsness Objcts Americas	\$238,055
Footwear	Footmaxx Of Virginia, Inc.	\$228,120
Music and Sound Recording	Transformational Security, LLC	\$194,122
Agricultural Inputs and Services	Vetcorp, Inc.	\$137,318
Jewelry and Precious Metals	NAF Program Division	\$15,729

Sources: RESI, USA Spending

F.2 Capital Region—Top Vendors by DoD Funding for each Cluster

Figure 106 below shows the company receiving the largest average yearly DoD funding commitments for each cluster in the Capital region. Ordered from the largest to smallest.

Figure 106: Highest-Funded Company per Capitol Region Cluster

Cluster Name	Company Name	Average Annual Dollars Obligated, 2011-2015
Business Services	BAE Systems Technology Solutions & Services Inc.	\$600,429,936
Communications Equipment and Services	Lockheed Martin Corporation	\$346,379,176
Local Hospitality Establishments	Sodexo Management Inc.	\$239,268,456
Aerospace Vehicles and Defense	BAE Systems Technology Solutions & Services Inc.	\$91,826,258
Local Utilities	International Business Machines Corporation	\$90,744,101
Local Real Estate, Construction, and Development	Manhattan Hunt A Joint Venture	\$74,643,269
Education and Knowledge Creation	URS Federal Services, Inc.	\$50,271,994
Transportation and Logistics	DynCorp International LLC	\$48,251,775
Information Technology and Analytical Instruments	Hewlett-Packard Company	\$46,772,419
Local Commercial Services	International Business Machine	\$39,869,235
Distribution and Electronic Commerce	URS Federal Services, Inc.	\$31,045,654
Local Health Services	Aliron International, Inc.	\$25,673,783
Construction Products and Services	G-W Management Services, LLC	\$24,801,857
Local Entertainment and Media	International Business Machine	\$24,496,411
Medical Devices	Medical Center Orthotics And Prosthetics, LLC	\$24,176,000
Marketing, Design, and Publishing	Laughlin, Marinaccio & Owens, Inc.	\$23,153,490
Oil and Gas Production and Transportation	Washington Gas Energy Services Inc.	\$17,863,882
Local Motor Vehicle Products and Services	URS Federal Services, Inc.	\$15,090,010
Biopharmaceuticals	AcelRx Pharmaceuticals, Inc.	\$12,647,049
Local Household Goods and Services	URS Federal Technical Services, Inc.	\$11,372,833
Recreational and Small Electric Goods	Digital Receiver Technology, Inc.	\$10,507,818
Lighting and Electrical Equipment	Automated Business Power, LLC	\$7,936,592
Water Transportation	Phoenix International Holdings Inc.	\$7,749,264

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Cluster Name	Company Name	Average Annual Dollars Obligated, 2011-2015
Furniture	Cazador Apparel, LLC	\$7,305,087
Production Technology and Heavy Machinery	Phoenix Trading Inc.	\$6,703,070
Local Community and Civic Organizations	Rehabplus Staffing Group, Inc.	\$6,653,124
Food Processing and Manufacturing	Dairy Maid Dairy Inc.	\$5,418,944
Downstream Metal Products	Mistral, Inc.	\$5,047,732
Local Personal Services (Non-Medical)	TVI Corporation	\$4,315,613
Local Industrial Products and Services	Thales Communications, Inc.	\$4,104,150
Electric Power Generation and Transmission	Potomac Edison Company, The	\$3,272,079
Automotive	Z Systems Corporation	\$2,696,606
Video Production and Distribution	Lockheed Martin Services, Inc.	\$1,820,988
Local Logistical Services	Bates Trucking Company Incorporated	\$1,664,008
Hospitality and Tourism	Sodexo, Inc.	\$1,501,162
Performing Arts	Mid Atlantic Professionals, Inc.	\$1,168,929
Downstream Chemical Products	URS Federal Services, Inc.	\$1,124,255
Environmental Services	Prab, Inc.	\$780,031
Plastics	Alliance Micro Incorporated	\$715,580
Metalworking Technology	Phoenix Trading Inc.	\$569,046
Nonmetal Mining	Vetcorp, Inc.	\$566,934
Printing Services	BAE Systems Technology Solutions & Services Inc.	\$544,967
Paper and Packaging	National Industries For The Blind	\$458,344
Upstream Chemical Products	Cryo Express	\$450,163
Textile Manufacturing	Commercial Marketing Associates, Inc.	\$369,228
Apparel	Posterity Group LLC	\$362,196
Upstream Metal Manufacturing	Phoenix Trading Inc.	\$294,090
Vulcanized and Fired Materials	Phoenix Trading Inc.	\$279,938
Local Food and Beverage Processing and Distribution	Albert Uster Imports, Inc.	\$271,646
Local Retailing of Clothing and General Merchandise	EC Amrc/Bsness Objcts Americas	\$238,055

Cluster Name	Company Name	Average Annual Dollars Obligated, 2011-2015
Footwear	Footmaxx Of Virginia, Inc.	\$228,120
Insurance Services	Silicon Graphics Federal, Inc.	\$227,364
Financial Services	West Publishing Corporation	\$210,000
Local Education and Training	Lockheed Martin Services, Inc.	\$184,947
Trailers, Motor Homes, and Appliances	Sotera Engineered Solutions	\$180,210
Leather and Related Products	Galls, Inc.	\$180,063
Agricultural Inputs and Services	Vetcorp, Inc.	\$137,318
Forestry	Team Henry Enterprises, LLC	\$62,469
Livestock Processing	University Of Missouri System	\$40,000
Wood Products	Maven Engineering Corporation	\$29,600
Music and Sound Recording	Levin Professional Services, Inc.	\$18,340
Coal Mining	Phoenix Trading Inc.	\$12,180
Jewelry and Precious Metals	Commercial Emblem Company	\$9,425

Sources: RESI, USA Spending

F.3 Central Region—Top Vendors by DoD Funding for each Cluster

Figure 107 below shows the company receiving the largest average yearly DoD funding commitments for each cluster in the Central region. Ordered from the largest to smallest.

Figure 107: Highest-Funded Company per Central Region Cluster

Cluster Name	Company Name	Average Annual Dollars Obligated, 2011-2015
Water Transportation	Lockheed Martin Corporation	\$820,918,132
Education and Knowledge Creation	The Johns Hopkins University Applied Physics Laboratory LLC	\$715,023,269
Aerospace Vehicles and Defense	AAI Corporation	\$486,257,908
Insurance Services	Johns Hopkins Medical Services Corp	\$367,505,000
Business Services	Mantech Sensor Technologies, Inc.	\$317,955,839
Local Health Services	Johns Hopkins Medical Services Corp	\$233,027,453
Local Real Estate, Construction, and Development	Walsh/Gilbane JV	\$206,445,000
Local Utilities	Lockheed Martin Corporation	\$181,973,845
Communications Equipment and Services	Telecommunication Systems Incorporated	\$98,419,347

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Cluster Name	Company Name	Average Annual Dollars Obligated, 2011-2015
Downstream Metal Products	Lockheed Martin Corporation	\$78,358,575
Transportation and Logistics	Booz Allen Hamilton Engineering Services LLC	\$55,354,937
Food Processing and Manufacturing	McCormick & Company, Incorporated	\$43,160,510
Metalworking Technology	Lockheed Martin Aeronautics Service-International	\$40,146,363
Information Technology and Analytical Instruments	Force 3, Inc.	\$31,005,145
Local Industrial Products and Services	Raytheon Company	\$28,931,547
Construction Products and Services	American Water Operations And Maintenance Inc.	\$26,912,089
Leather and Related Products	Smiths Detection Edgewood Incorporated	\$23,125,367
Local Commercial Services	Chimes District Of Columbia, Inc.	\$20,322,558
Automotive	Textron Inc.	\$19,861,704
Local Entertainment and Media	CDW Government, Inc.	\$15,779,143
Local Household Goods and Services	Motorola Solutions, Inc.	\$12,457,496
Distribution and Electronic Commerce	L B & B Associates Inc.	\$11,888,004
Biopharmaceuticals	Meridian Medical Technologies, Inc.	\$10,776,152
Local Food and Beverage Processing and Distribution	US Foodservice Incorporated (2294)	\$9,289,304
Oil and Gas Production and Transportation	The Carroll Independent Fuel Company	\$6,042,469
Apparel	Blind Industries And Services Of Maryland	\$5,313,040
Video Production and Distribution	Towne Group Inc.	\$5,284,236
Local Hospitality Establishments	Maryland Department Of Education	\$5,265,141
Local Education and Training	Northrop Grumman Systems Corporation	\$5,233,683
Local Logistical Services	L B & B Associates Inc.	\$4,705,630

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Cluster Name	Company Name	Average Annual Dollars Obligated, 2011-2015
Local Community and Civic Organizations	Naval Academy Athletic Association	\$4,636,525
Production Technology and Heavy Machinery	AAI Corporation	\$4,104,514
Recreational and Small Electric Goods	Tero Tek International Inc.	\$3,393,782
Lighting and Electrical Equipment	L-3 Chesapeake Sciences Corporation	\$3,304,367
Marketing, Design, and Publishing	New River Systems Corporation	\$3,299,510
Furniture	Strategic Initial Outfitting Transition Solutions, LLC	\$3,281,990
Electric Power Generation and Transmission	Constellation Newenergy, Inc.	\$3,088,213
Upstream Chemical Products	Usalco, LLC	\$2,509,838
Medical Devices	Active Signal Technologies Inc.	\$1,910,500
Environmental Services	Veolia ES Technical Solutions, L.L.C.	\$1,687,728
Local Personal Services (Non-Medical)	Respira, Inc.	\$1,467,947
Wood Products	Mobilease Modular Space, Inc.	\$1,068,301
Forestry	Mar-Len Environmental, Inc.	\$1,056,421
Livestock Processing	Henry W Stapf Incorporated	\$972,676
Hospitality and Tourism	Blair, Inc.	\$844,221
Downstream Chemical Products	United Commercial Supply LLC	\$615,540
Nonmetal Mining	Gearhart Brothers Services, LLC	\$580,696
Trailers, Motor Homes, and Appliances	Piraeus International, Inc.	\$548,239
Textile Manufacturing	Truetandem, LLC	\$531,128
Vulcanized and Fired Materials	American Technology Corporation (6810)	\$443,300
Upstream Metal Manufacturing	Alcan Rolled Products - Ravenswood, LLC	\$439,647
Financial Services	Kropp Holdings, Inc.	\$413,048
Local Motor Vehicle Products and Services	Tero Tek International Inc.	\$326,289
Plastics	National Supply Network, LLC.	\$319,181

Cluster Name	Company Name	Average Annual Dollars Obligated, 2011-2015
Printing Services	General Dynamics Information Technology, Inc.	\$277,494
Music and Sound Recording	Transformational Security, LLC	\$194,122
Paper and Packaging	Royal Media Network, Inc.	\$149,796
Footwear	Onguard Industries, LLC	\$110,447
Local Retailing of Clothing and General Merchandise	Solomon & Associates	\$35,485
Performing Arts	Wright, David	\$30,365
Jewelry and Precious Metals	NAF Program Division	\$15,729
Agricultural Inputs and Services	Providence Center, Inc.	\$9,750

Sources: RESI, USA Spending

F.4 Eastern Shore—Top Vendors by DoD Funding for each Cluster

Figure 108 below shows the company receiving the largest average yearly DoD funding commitments for each cluster in the Central region. Ordered from the largest to smallest.

Figure 108: Highest-Funded Company per Eastern Shore Region Cluster

Cluster Name	Company Name	Annual Average Dollars Obligated, 2011-2015
Construction Products and Services	Sealaska Constructors, LLC	\$18,900,000
Education and Knowledge Creation	Alliant Techsystems Operations LLC	\$17,791,861
Production Technology and Heavy Machinery	Global Strategies Group (North America) Inc.	\$15,606,091
Aerospace Vehicles and Defense	Federal Resources Supply Company	\$13,222,947
Downstream Metal Products	Alliant Techsystems Operations LLC	\$12,259,745
Distribution and Electronic Commerce	Federal Resources Supply Company	\$11,479,651
Medical Devices	Federal Resources Supply Company	\$11,427,692
Furniture	Federal Resources Supply Company	\$10,939,173
Information Technology and Analytical Instruments	Federal Resources Supply Company	\$7,498,863
Business Services	Global Strategies Group (North America) Inc.	\$6,939,537

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Cluster Name	Company Name	Annual Average Dollars Obligated, 2011-2015
Local Real Estate, Construction, and Development	Corcon, Inc.	\$6,839,260
Local Food and Beverage Processing and Distribution	Sysco Eastern Maryland, LLC	\$5,616,150
Trailers, Motor Homes, and Appliances	Global Strategies Group (North America) Inc.	\$5,402,368
Water Transportation	Zodiac Of North America, Inc.	\$4,776,405
Wood Products	Global Strategies Group (North America) Inc.	\$4,209,122
Apparel	Inova Geosynthetics, LLC	\$3,994,628
Local Commercial Services	Inquiries, Inc.	\$3,244,220
Automotive	Hardwire, LLC	\$1,085,462
Vulcanized and Fired Materials	Marine Polymers Inc.	\$951,203
Downstream Chemical Products	Alliant Techsystems Operations LLC	\$946,918
Transportation and Logistics	East Coast Flight Services, Inc.	\$909,279
Local Household Goods and Services	Custom Lawn Service Inc.	\$903,207
Local Industrial Products and Services	Manufacturing Support Industries	\$625,948
Plastics	Chesapeake Center Inc.	\$488,099
Upstream Metal Manufacturing	Manufacturing Support Industries	\$429,106
Oil and Gas Production and Transportation	Tri-Gas & Oil Co., Inc.	\$357,729
Local Motor Vehicle Products and Services	Centreville Manufacturing, Inc.	\$290,967
Lighting and Electrical Equipment	Federal Resources Supply Company	\$259,894
Food Processing and Manufacturing	Pepsi Bottling Ventures Of Salisbury Maryland Limited Liability Company	\$234,508
Hospitality and Tourism	Americana Stowaway Motel, Inc.	\$226,226
Textile Manufacturing	Marine Polymers Inc.	\$160,300
Marketing, Design, and Publishing	Thomas Associates, Inc.	\$153,281
Local Health Services	Operative Experience, Inc.	\$149,625

Cluster Name	Company Name	Annual Average Dollars Obligated, 2011-2015
Recreational and Small Electric Goods	Federal Resources Supply Company	\$135,218
Local Utilities	Agviq, LLC	\$130,786
Environmental Services	Advant-Edge Solutions Of Middle Atlantic, Inc.	\$117,325
Biopharmaceuticals	U S Dept Of Health And Human Services	\$98,304
Agricultural Inputs and Services	Jester E Lawrence	\$97,342
Communications Equipment and Services	Dynamic Performance Technologies	\$89,750
Local Logistical Services	THC Enterprises, Inc.	\$84,600
Metalworking Technology	Integrity Tool & Fastener, Inc.	\$81,732
Paper and Packaging	Integrity Tool & Fastener, Inc.	\$55,832
Local Education and Training	Meba Training Plan	\$48,000
Upstream Chemical Products	Federal Resources Supply Company	\$44,623
Nonmetal Mining	Boart Longyear Company	\$37,540
Performing Arts	Talent Source	\$31,600
Printing Services	THC Enterprises, Inc.	\$24,750
Local Retailing of Clothing and General Merchandise	Chesapeake Center Inc.	\$24,000
Local Hospitality Establishments	Rem Aquatics, LLC	\$18,600
Leather and Related Products	Integrity Tool & Fastener, Inc.	\$9,344
Local Personal Services (Non-Medical)	Rice, Wesley, E	\$4,617
Coal Mining	Federal Resources Supply Company	\$765

Sources: RESI, USA Spending

F.5 Southern Maryland—Top Vendors by DoD Funding for each Cluster

Figure 109 below shows the company receiving the largest average yearly DoD funding commitments for each cluster in the Central region. Ordered from the largest to smallest.

Figure 109: Highest-Funded Company per Southern Maryland Region Cluster

Cluster Name	Company Name	Annual Average Dollars Obligated, 2011-2015
Business Services	Adams Communication & Engineering Technology, Inc.	\$112,753,173
Transportation and Logistics	DynCorp International LLC	\$95,311,156
Communications Equipment and Services	Neany, Inc.	\$69,791,072
Local Household Goods and Services	Neany, Inc.	\$31,088,426
Marketing, Design, and Publishing	Engility Corporation	\$26,195,279
Aerospace Vehicles and Defense	The Boeing Company	\$22,262,918
Local Real Estate, Construction, and Development	Sheffield Korte Joint Venture	\$21,427,802
Oil and Gas Production and Transportation	Airtec, Inc.	\$17,430,278
Education and Knowledge Creation	PAE Applied Technologies LLC	\$13,267,918
Local Utilities	General Dynamics Information Technology, Inc.	\$11,544,091
Information Technology and Analytical Instruments	Science Applications International Corporation	\$10,205,718
Production Technology and Heavy Machinery	J. F. Taylor, Inc.	\$8,302,069
Downstream Metal Products	Triton Metals, Inc.	\$5,065,283
Local Commercial Services	Qinetiq North America, Inc.	\$4,371,981
Construction Products and Services	Arriba Corporation	\$3,894,287
Coal Mining	J & J Energy Inc.	\$3,630,850
Apparel	Neany, Inc.	\$3,200,800
Local Health Services	MD Consulting LLC	\$2,624,294
Local Entertainment and Media	Advantaged Solutions, Inc.	\$2,494,668
Downstream Chemical Products	Carleton Technologies Inc.	\$1,931,753
Distribution and Electronic Commerce	MCB Lighting & Electrical, Inc.	\$1,631,340
Metalworking Technology	Bowhead Innovative Products And Solutions, Inc.	\$1,620,764
Environmental Services	Haztrain, Inc.	\$1,548,202
Water Transportation	Hawaii Resource Group LLC	\$1,038,796
Lighting and Electrical Equipment	Kelly Generator & Equipment, Inc.	\$844,065

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Cluster Name	Company Name	Annual Average Dollars Obligated, 2011-2015
Local Logistical Services	Patriot Construction, LLC	\$693,018
Local Hospitality Establishments	Gana-A' Yoo Services Corporation	\$673,596
Furniture	Patriot Construction, LLC	\$565,985
Local Industrial Products and Services	Acceletronics Incorporated	\$334,720
Plastics	Mesmo Inc.	\$299,643
Automotive	Haztrain, Inc.	\$218,855
Local Education and Training	Haztrain, Inc.	\$218,032
Printing Services	Vision Research, Inc.	\$208,400
Recreational and Small Electric Goods	Mesmo Inc.	\$149,047
Leather and Related Products	Mesmo Inc.	\$148,219
Vulcanized and Fired Materials	Sabreliner Aviation, LLC	\$143,940
Local Personal Services (Non-Medical)	MMD Alteration & Sewing	\$131,638
Medical Devices	DXE Medical, Inc.	\$110,210
Hospitality and Tourism	CP Marine Development LLC	\$70,514
Local Motor Vehicle Products and Services	American Trading Service Inc.	\$68,748
Local Community and Civic Organizations	Finley, James	\$60,000
Biopharmaceuticals	Ortho-Clinical Diagnostics, Inc.	\$51,952
Local Food and Beverage Processing and Distribution	American Trading Service Inc.	\$51,838
Upstream Chemical Products	Worldwide Aircraft Leasing Corporation	\$49,440
Food Processing and Manufacturing	Teton Avjet, LLC	\$41,246
Performing Arts	Egeli, Peter.	\$41,200
Textile Manufacturing	Tonoga Inc.	\$37,180
Upstream Metal Manufacturing	BMG Metals, Inc.	\$30,158
Trailers, Motor Homes, and Appliances	Hitch Man Inc., The	\$28,409
Wood Products	SFN Inc.	\$25,870
Music and Sound Recording	Recorded Books, LLC	\$22,904
Local Retailing of Clothing and General Merchandise	Malcha Inc.	\$18,162
Insurance Services	Biofire Defense, LLC	\$14,850

Cluster Name	Company Name	Annual Average Dollars Obligated, 2011-2015
Footwear	Tidewater Machine Company	\$7,584
Financial Services	Dun & Bradstreet, Inc.	\$5,606
Paper and Packaging	Unistar-Sparco Computers, Inc.	\$4,389
Jewelry and Precious Metals	Alexander Designs, L.L.C.	\$3,899
Video Production and Distribution	Phocus Video Communications	\$750

Sources: RESI, USA Spending

F.6 Western Maryland—Top Vendors by DoD Funding for each Cluster

Figure 110 below shows the company receiving the largest average yearly DoD funding commitments for each cluster in the Central region. Ordered from the largest to smallest.

Figure 110: Highest-Funded Company per Western Maryland Region Cluster

Cluster Name	Company Name	Annual Average Dollars Obligated 2011-2015
Business Services	Aaski Technology Inc.	\$47,533,000
Local Commercial Services	Quantell, Inc.	\$21,981,115
Education and Knowledge Creation	Netconn Solutions	\$17,485,221
Aerospace Vehicles and Defense	Sierra Nevada Corporation	\$14,258,590
Recreational and Small Electric Goods	Garrett Container Systems, Inc.	\$4,043,413
Apparel	Garrett Container Systems, Inc.	\$3,985,997
Distribution and Electronic Commerce	EPIC Aviation, LLC	\$3,505,187
Downstream Metal Products	Garrett Container Systems, Inc.	\$2,528,681
Medical Devices	Garrett Container Systems, Inc.	\$1,272,538
Local Industrial Products and Services	Garrett Container Systems, Inc.	\$961,622
Local Household Goods and Services	King-Bryant, Inc.	\$844,095
Local Utilities	The Potomac Edison Company	\$758,485
Plastics	Garrett Container Systems, Inc.	\$684,014
Construction Products and Services	Webco Maryland, LLC	\$604,771
Automotive	Jerr-Dan Corporation	\$524,728
Local Real Estate, Construction, and Development	King-Bryant, Inc.	\$420,883

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Cluster Name	Company Name	Annual Average Dollars Obligated 2011-2015
Metalworking Technology	Pangborn Corporation	\$411,772
Communications Equipment and Services	Americom Government Services Incorporated	\$357,588
Production Technology and Heavy Machinery	Garrett Container Systems, Inc.	\$300,215
Local Personal Services (Non-Medical)	Dycon Government Solutions, Inc.	\$265,184
Downstream Chemical Products	Fireball, LLC	\$237,421
Vulcanized and Fired Materials	Greater Maryland Tool & Mfg. Corp.	\$203,346
Information Technology and Analytical Instruments	Network Spectrum, Inc.	\$200,448
Lighting and Electrical Equipment	Biaera Technologies, LLC	\$149,900
Footwear	Garrett Container Systems, Inc.	\$142,800
Oil and Gas Production and Transportation	A C & T Co Inc.	\$139,545
Wood Products	Garrett Container Systems, Inc.	\$129,434
Furniture	Peter Pepper Products Inc.	\$128,627
Water Transportation	Demaree Inflatable Boats, Inc.	\$98,634
Upstream Chemical Products	Fireball, LLC	\$91,518
Transportation and Logistics	DS Technologies LLC	\$57,286
Local Entertainment and Media	Garrett Container Systems, Inc.	\$56,470
Textile Manufacturing	Textile Preservation Associates Incorporated At Antietam	\$52,248
Upstream Metal Manufacturing	Garrett Container Systems, Inc.	\$50,797
Local Motor Vehicle Products and Services	Emergency Vehicle Specialist, Inc.	\$49,915
Marketing, Design, and Publishing	Wolters Kluwer Health, Inc.	\$44,767
Leather and Related Products	Garrett Container Systems, Inc.	\$37,964
Local Logistical Services	Bowman Sales And Equipment, Inc.	\$36,481
Food Processing and Manufacturing	Royal Crown Bottling Company Of Winchester Inc.	\$27,989
Forestry	Jernigan's Environmental Services, Inc.	\$25,100
Local Hospitality Establishments	Leiter's Fine Catering Inc.	\$22,469
Video Production and Distribution	Carl Anderson Production Services, LLC	\$20,000
Hospitality and Tourism	Wiland, Diana K	\$16,802

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Cluster Name	Company Name	Annual Average Dollars Obligated 2011-2015
Local Retailing of Clothing and General Merchandise	Garrett Container Systems, Inc.	\$9,868
Environmental Services	Tradebe Treatment And Recycling, LLC	\$1,455
Local Food and Beverage Processing and Distribution	Garrett Container Systems, Inc.	\$498

Sources: RESI, USA Spending

Appendix G: Economic Impacts with DoD Budget Increase and Decrease

RESI also performed economic impact analysis forecasts for spending levels under budget increases and decreases for Maryland. Under both assumptions the overall patterns of the model were similar, and the impacts were mostly proportional. Three scenarios were developed and a forecast was completed for each situation:

- Scenario 1: Assuming that the average DoD funding from 2011-2015 remains constant, what will the economic impact of this funding be on industry clusters in Maryland over the next ten years?
- Scenario 2: Assuming that the average DoD funding from 2011- 2015 is reduced by 10 percent, what will the economic impact of this funding reduction be on industry clusters in Maryland over the next ten years?
- Scenario 3: Assuming that the average DoD funding from 2011- 2015 is increased by 10 percent, what will the economic impact of this funding addition be on industry clusters in Maryland over the next ten years?

Figure 111, which was originally presented in Section 4.1.6, shows the status quo, Scenario 1 of spending in Maryland. The average employment from DoD spending in Maryland over this time is estimated to be 101,263.

Figure 111: Forecasted Total Economic Impacts for Maryland for all Defense Spending, Scenario 1—Maryland, 2017-2026

Year	Employment	Output	Wages
2017	115,708	\$15,043,690,976	\$5,475,544,544
2018	117,991	\$15,421,023,822	\$5,673,405,693
2019	115,786	\$15,407,858,658	\$5,742,593,305
2020	111,237	\$15,035,879,503	\$5,724,345,205
2021	105,618	\$14,493,863,934	\$5,654,222,553
2022	99,683	\$13,872,695,438	\$5,553,067,291
2023	94,015	\$13,252,256,471	\$5,451,533,677
2024	88,765	\$12,660,950,181	\$5,357,276,104
2025	84,022	\$12,116,757,711	\$5,276,177,177
2026	79,807	\$11,667,482,185	\$5,218,638,703
Average	101,263.2	\$13,897,245,887.90	\$5,512,680,425.20

Sources: REMI PI+, RESI

Figure 112 shows the forecast for the economic impact of DoD spending between 2017 and 2026, assuming a 10 percent decrease in average DoD funding, based on the average from the 2011 to 2015. From analyzing the scenario and comparing the results to the data presented Scenario 1 in Figure 111, RESI found that a 10 percent decrease in DoD funding had an almost

one-to-one impact. Scenario 2 found that with a reduction in funding there was a 9.973 percent average decrease in employment over the next ten years.

Figure 112: Forecasted Total Economic Impacts for Maryland for all Defense Spending, Scenario 2—Maryland, 2017-2026

Year	Employment	Output	Wages
2017	127,220	\$16,542,616,229	\$6,018,751,178
2018	129,731	\$16,957,456,930	\$6,234,565,805
2019	127,318	\$16,943,500,909	\$6,309,725,531
2020	122,317	\$16,534,582,839	\$6,289,152,388
2021	116,145	\$15,939,529,464	\$6,212,233,878
2022	109,631	\$15,258,215,883	\$6,101,747,528
2023	103,406	\$14,577,103,411	\$5,990,818,773
2024	97,635	\$13,927,348,879	\$5,887,756,872
2025	92,418	\$13,328,802,565	\$5,798,979,908
2026	87,781	\$12,834,630,110	\$5,736,100,349
Average	111,360.2	\$15,284,378,721.90	\$6,057,983,221.00

Sources: REMI PI+, RESI

Figure 113 shows the forecast for the economic impact of DoD spending between 2017 and 2026, assuming a 10 percent increase in average DoD funding, based on the average from the 2011 to 2015. Similarly, Scenario 3 found that with an increase in funding there was a 9.971 percent average increase in employment over ten years. This indicates that the model predicts diminishing returns, as there is a slightly larger gain to employment from moving from the ten percent decrease to current spending, than there is from moving from current spending to the ten percent increase, but otherwise provides limited insight. Section 7 of "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape" presents detailed analyses that are based on specific policy changes determined as likely through the SWOT analysis.²⁰⁰

²⁰⁰ Regional Economic Studies Institute of Towson University, "A SWOT Analysis of Maryland's Department of Defense Intensive Landscape."

Figure 113: Forecasted Total Economic Impacts for Maryland for all Defense Spending, Scenario 3—Maryland, 2017-2026

Year	Employment	Output	Wages
2017	104,159	\$13,541,406,738	\$4,930,796,428
2018	106,221	\$13,881,844,571	\$5,110,574,238
2019	104,252	\$13,871,934,672	\$5,174,417,078
2020	100,158	\$13,537,117,775	\$5,158,465,100
2021	95,095	\$13,048,655,834	\$5,095,278,468
2022	89,742	\$12,487,992,901	\$5,003,607,826
2023	84,632	\$11,928,401,920	\$4,911,589,408
2024	79,904	\$11,395,767,310	\$4,826,297,404
2025	75,636	\$10,906,006,107	\$4,752,993,440
2026	71,842	\$10,501,657,414	\$4,700,894,122
Average	91,164.1	\$12,510,078,524.20	\$4,966,491,351.20

Sources: REMI PI+, RESI

Appendix H: Cluster Level Occupational Economic Impacts

RESI used the economic impact analysis forecasts for spending levels under status quo and a decreases for Maryland to estimate cluster level impacts for employment. The occupational category impacts for the top three clusters for the state, and top cluster for each region are presented below.

The cluster level jobs and impact estimates were made using the number of direct jobs created for each cluster, as reported by REMI, multiplied by the percentage of jobs in the occupational category, which is described in Appendix C.4. To estimate the loss of jobs with a 10 percent DoD budget decrease to the cluster, RESI multiplied the overall job estimate by the 9.971 percent marginal job rate decrease RESI estimated using the 10 percent decrease in overall DoD funding forecast.

H.1 Maryland–Top Three Clusters Occupational Economic Impacts

Figure 114 shows the estimated impact of a 10 percent decrease in DoD funding by occupational category for the Business Services Cluster in Maryland.

Figure 114: Direct Employment and Estimated Losses by Occupational Category for Business Services Cluster in Maryland

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
15-0000	Computer and Mathematical Occupations	5,720	570	\$50,634,615
43-0000	Office and Administrative Support Occupations	2,989	298	\$11,673,016
13-0000	Business and Financial Operations Occupations	2,787	278	\$22,355,551
17-0000	Architecture and Engineering Occupations	2,106	210	\$16,899,918
11-0000	Management Occupations	1,974	197	\$28,349,345
41-0000	Sales and Related Occupations	796	79	\$5,711,043
53-0000	Transportation and Material Moving Occupations	633	63	\$1,818,459
19-0000	Life, Physical, and Social Science Occupations	602	60	\$4,125,521
49-0000	Installation, Maintenance, and Repair Occupations	304	30	\$1,458,657
37-0000	Building and Grounds Cleaning and Maintenance Occupations	302	30	\$759,710
33-0000	Protective Service Occupations	282	28	\$1,000,846
51-0000	Production Occupations	260	26	\$848,231
29-0000	Healthcare Practitioners and Technical Occupations	256	26	\$1,651,302
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	252	25	\$1,625,573
47-0000	Construction and Extraction Occupations	226	23	\$1,136,283
23-0000	Legal Occupations	96	10	\$1,213,549
31-0000	Healthcare Support Occupations	82	8	\$237,400
35-0000	Food Preparation and Serving Related Occupations	77	8	\$204,660
25-0000	Education, Training, and Library Occupations	64	6	\$259,183
39-0000	Personal Care and Service Occupations	61	6	\$151,780

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SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
21-0000	Community and Social Service Occupations	58	6	\$252,605
45-0000	Farming, Fishing, and Forestry Occupations	3	0	\$8,703
Total		19,927	1,987	\$152,375,950

Sources: BLS OES, REMI, RESI, U.S. Census CBP

Figure 115 shows the estimated impact of a 10 percent decrease in DoD funding by occupational category for the Education and Knowledge Creation Cluster in Maryland.

Figure 115: Direct Employment and Estimated Losses by Occupational Category for the Education and Knowledge Creation Cluster in Maryland

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
19-0000	Life, Physical, and Social Science Occupations	1,003	100	\$8,035,867
25-0000	Education, Training, and Library Occupations	962	96	\$6,540,417
43-0000	Office and Administrative Support Occupations	625	62	\$2,552,438
13-0000	Business and Financial Operations Occupations	503	50	\$3,638,340
11-0000	Management Occupations	484	48	\$6,517,687
15-0000	Computer and Mathematical Occupations	479	48	\$4,423,904
17-0000	Architecture and Engineering Occupations	335	33	\$3,275,165
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	125	12	\$711,824

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SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
29-0000	Healthcare Practitioners and Technical Occupations	114	11	\$814,278
37-0000	Building and Grounds Cleaning and Maintenance Occupations	83	8	\$251,329
49-0000	Installation, Maintenance, and Repair Occupations	72	7	\$338,819
21-0000	Community and Social Service Occupations	71	7	\$352,418
41-0000	Sales and Related Occupations	59	6	\$418,459
33-0000	Protective Service Occupations	55	5	\$213,648
39-0000	Personal Care and Service Occupations	47	5	\$141,685
35-0000	Food Preparation and Serving Related Occupations	24	2	\$66,365
31-0000	Healthcare Support Occupations	23	2	\$79,401
53-0000	Transportation and Material Moving Occupations	20	2	\$83,740
47-0000	Construction and Extraction Occupations	20	2	\$110,416
51-0000	Production Occupations	20	2	\$101,221
23-0000	Legal Occupations	18	2	\$249,219
45-0000	Farming, Fishing, and Forestry Occupations	1	0	\$4,938
Total		5145	513	\$38,921,576

Sources: BLS OES, REMI, RESI, U.S. Census CBP

Figure 116 shows the estimated impact of a 10 percent decrease in DoD funding by occupational category for the Local Real Estate, Construction, and Development cluster in Maryland.

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Figure 116: Direct Employment and Estimated Losses by Occupational Category for Local Real Estate, Construction, and Development Cluster in Maryland

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
47-0000	Construction and Extraction Occupations	2,820	281	\$13,263,334
43-0000	Office and Administrative Support Occupations	827	82	\$2,946,419
41-0000	Sales and Related Occupations	664	66	\$2,861,560
49-0000	Installation, Maintenance, and Repair Occupations	574	57	\$2,448,862
11-0000	Management Occupations	474	47	\$4,735,061
13-0000	Business and Financial Operations Occupations	284	28	\$1,862,821
53-0000	Transportation and Material Moving Occupations	227	23	\$817,043
37-0000	Building and Grounds Cleaning and Maintenance Occupations	132	13	\$375,557
17-0000	Architecture and Engineering Occupations	75	7	\$545,159
51-0000	Production Occupations	63	6	\$243,328
23-0000	Legal Occupations	45	4	\$458,190
15-0000	Computer and Mathematical Occupations	30	3	\$213,811
33-0000	Protective Service Occupations	27	3	\$91,383
39-0000	Personal Care and Service Occupations	16	2	\$47,622
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	12	1	\$56,737

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
35-0000	Food Preparation and Serving Related Occupations	10	1	\$24,446
29-0000	Healthcare Practitioners and Technical Occupations	4	0	\$26,318
19-0000	Life, Physical, and Social Science Occupations	4	0	\$22,275
21-0000	Community and Social Service Occupations	1	0	\$5,914
25-0000	Education, Training, and Library Occupations	0	0	\$1,478
45-0000	Farming, Fishing, and Forestry Occupations	0	0	\$711
31-0000	Healthcare Support Occupations	0	0	\$176
Total		6,288	627	\$31,048,207

Sources: BLS OES, REMI, RESI, U.S. Census CBP

H.2 Capital Region-Top Cluster Occupational Economic Impacts

Figure 117 shows the estimated impact of a 10 percent decrease in DoD funding by occupational category for the Business Services cluster in the Capital region.

Figure 117: Direct Employment and Estimated Losses by Occupational Category for the Business Services Cluster in the Capital Region

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment 10 Percent DoD Decrease	Total Lost Wages
15-0000	Computer and Mathematical Occupations	3,728	372	\$33,095,486
13-0000	Business and Financial Operations Occupations	1,540	154	\$12,543,862
43-0000	Office and Administrative Support Occupations	1,485	148	\$5,901,085
11-0000	Management Occupations	1,086	108	\$15,733,584
17-0000	Architecture and Engineering Occupations	951	95	\$7,742,250

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SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment 10 Percent DoD Decrease	Total Lost Wages
41-0000	Sales and Related Occupations	446	44	\$3,374,664
19-0000	Life, Physical, and Social Science Occupations	306	31	\$2,141,564
53-0000	Transportation and Material Moving Occupations	186	19	\$591,047
33-0000	Protective Service Occupations	175	17	\$622,820
37-0000	Building and Grounds Cleaning and Maintenance Occupations	164	16	\$412,715
49-0000	Installation, Maintenance, and Repair Occupations	156	16	\$757,481
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	142	14	\$923,576
29-0000	Healthcare Practitioners and Technical Occupations	116	12	\$736,902
47-0000	Construction and Extraction Occupations	89	9	\$478,743
51-0000	Production Occupations	68	7	\$257,899
23-0000	Legal Occupations	49	5	\$630,553
35-0000	Food Preparation and Serving Related Occupations	31	3	\$84,588
21-0000	Community and Social Service Occupations	29	3	\$126,842
31-0000	Healthcare Support Occupations	29	3	\$81,454
39-0000	Personal Care and Service Occupations	20	2	\$49,985
25-0000	Education, Training, and Library Occupations	19	2	\$93,361
45-0000	Farming, Fishing, and Forestry Occupations	1	0	\$3,838
Total		10,815	1,078	\$86,384,298

Sources: BLS OES, REMI, RESI, U.S. Census CBP

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H.3 Central Region-Top Cluster Occupational Economic Impacts

Figure 118 shows the estimated impact of a 10 percent decrease in DoD funding by occupational category for the Business Services cluster in the Central region.

Figure 118: Direct Employment and Estimated Loses by Occupational Category for Business Services Cluster in the Central Region

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
15-0000	Computer and Mathematical Occupations	1,795	179	\$15,893,819
43-0000	Office and Administrative Support Occupations	845	84	\$3,349,959
13-0000	Business and Financial Operations Occupations	817	81	\$6,544,595
11-0000	Management Occupations	603	60	\$8,706,769
17-0000	Architecture and Engineering Occupations	580	58	\$4,682,786
41-0000	Sales and Related Occupations	235	23	\$1,718,181
19-0000	Life, Physical, and Social Science Occupations	159	16	\$1,094,706
53-0000	Transportation and Material Moving Occupations	147	15	\$432,263
49-0000	Installation, Maintenance, and Repair Occupations	77	8	\$372,830
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	73	7	\$473,925
29-0000	Healthcare Practitioners and Technical Occupations	66	7	\$434,417
51-0000	Production Occupations	59	6	\$201,564
37-0000	Building and Grounds Cleaning and Maintenance Occupations	57	6	\$144,488
47-0000	Construction and Extraction Occupations	55	5	\$280,423
33-0000	Protective Service Occupations	50	5	\$183,059
23-0000	Legal Occupations	28	3	\$370,007

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
31-0000	Healthcare Support Occupations	20	2	\$59,256
35-0000	Food Preparation and Serving Related Occupations	17	2	\$47,839
21-0000	Community and Social Service Occupations	16	2	\$70,261
39-0000	Personal Care and Service Occupations	15	2	\$38,561
25-0000	Education, Training, and Library Occupations	15	2	\$64,087
45-0000	Farming, Fishing, and Forestry Occupations	1	0	\$2,096
Total		5,732	572	\$45,165,890

Sources: BLS OES, REMI, RESI, U.S. Census CBP

H.4 Eastern Shore-Top Cluster Occupational Economic Impacts

Figure 119 shows the impact of a 10 percent decrease in DoD funding by occupational category for the Education and Knowledge Creation cluster for the Eastern Shore.

Figure 119: Direct Employment and Estimated Losses by Occupational Category for Education and Knowledge Creation Cluster on the Eastern Shore

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
25-0000	Education, Training, and Library Occupations	12	1	\$83,493
43-0000	Office and Administrative Support Occupations	5	0	\$17,226
19-0000	Life, Physical, and Social Science Occupations	3	0	\$16,291
11-0000	Management Occupations	2	0	\$26,173
13-0000	Business and Financial Operations Occupations	2	0	\$13,251
15-0000	Computer and Mathematical Occupations	2	0	\$13,093
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	1	0	\$5,502

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
29-0000	Healthcare Practitioners and Technical Occupations	1	0	\$6,097
37-0000	Building and Grounds Cleaning and Maintenance Occupations	1	0	\$2,246
21-0000	Community and Social Service Occupations	1	0	\$3,432
39-0000	Personal Care and Service Occupations	1	0	\$1,575
17-0000	Architecture and Engineering Occupations	0	0	\$3,987
49-0000	Installation, Maintenance, and Repair Occupations	0	0	\$1,878
33-0000	Protective Service Occupations	0	0	\$1,524
41-0000	Sales and Related Occupations	0	0	\$1,626
35-0000	Food Preparation and Serving Related Occupations	0	0	\$671
47-0000	Construction and Extraction Occupations	0	0	\$877
31-0000	Healthcare Support Occupations	0	0	\$529
53-0000	Transportation and Material Moving Occupations	0	0	\$446
51-0000	Production Occupations	0	0	\$243
23-0000	Legal Occupations	0	0	\$516
45-0000	Farming, Fishing, and Forestry Occupations	0	0	\$19
Total		32	3	\$0

Sources: BLS OES, REMI, RESI, U.S. Census CBP

H.5 Southern Maryland-Top Cluster Occupational Economic Impacts

Figure 120 shows the impact of a 10 percent decrease in DoD funding by occupational category for the Business Services cluster in the Southern Maryland region.

Figure 120: Direct Employment and Estimated Losses by Occupational Category for Business Services Cluster in the Southern Maryland Region

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
15-0000	Computer and Mathematical Occupations	734	73	\$6,562,879
17-0000	Architecture and Engineering Occupations	582	58	\$4,565,567
13-0000	Business and Financial Operations Occupations	315	31	\$2,589,772
43-0000	Office and Administrative Support Occupations	298	30	\$1,213,281
11-0000	Management Occupations	238	24	\$3,400,665
19-0000	Life, Physical, and Social Science Occupations	132	13	\$851,203
41-0000	Sales and Related Occupations	80	8	\$641,506
37-0000	Building and Grounds Cleaning and Maintenance Occupations	77	8	\$193,725
33-0000	Protective Service Occupations	72	7	\$253,474
49-0000	Installation, Maintenance, and Repair Occupations	51	5	\$250,663
47-0000	Construction and Extraction Occupations	43	4	\$244,250
53-0000	Transportation and Material Moving Occupations	34	3	\$114,795
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	32	3	\$215,470
51-0000	Production Occupations	21	2	\$91,462
29-0000	Healthcare Practitioners and Technical Occupations	16	2	\$96,062
35-0000	Food Preparation and Serving Related Occupations	10	1	\$25,157
21-0000	Community and Social Service Occupations	7	1	\$27,886
23-0000	Legal Occupations	6	1	\$80,496
25-0000	Education, Training, and Library Occupations	4	0	\$20,599
31-0000	Healthcare Support Occupations	2	0	\$5,509

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
39-0000	Personal Care and Service Occupations	1	0	\$2,799
45-0000	Farming, Fishing, and Forestry Occupations	0	0	\$987
Total		2,754	275	\$0

Sources: BLS OES, REMI, RESI, U.S. Census CBP

H.6 Western Maryland-Top Cluster Occupational Economic Impacts

Figure 121 shows the impact of a 10 percent decrease in DoD funding by occupational category for the Local Commercial Services cluster in the Western Maryland region.

Figure 121: Occupational Category Direct Employment and Estimated Losses for Local Commercial Services Cluster in Western Maryland

SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
43-0000	Office and Administrative Support Occupations	19	2	\$69,064
49-0000	Installation, Maintenance, and Repair Occupations	9	1	\$43,611
13-0000	Business and Financial Operations Occupations	8	1	\$59,011
37-0000	Building and Grounds Cleaning and Maintenance Occupations	6	1	\$15,499
41-0000	Sales and Related Occupations	5	1	\$20,679
11-0000	Management Occupations	5	1	\$61,479
33-0000	Protective Service Occupations	3	0	\$9,553
15-0000	Computer and Mathematical Occupations	3	0	\$25,629
53-0000	Transportation and Material Moving Occupations	3	0	\$9,133
23-0000	Legal Occupations	3	0	\$32,060
51-0000	Production Occupations	3	0	\$9,430

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SOC	Occupational Category	Estimated Direct DOD Employment	Lost Employment, 10 Percent DoD Decrease	Total Lost Wages
17-0000	Architecture and Engineering Occupations	1	0	\$11,807
47-0000	Construction and Extraction Occupations	1	0	\$4,867
29-0000	Healthcare Practitioners and Technical Occupations	1	0	\$5,926
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	0	0	\$1,942
31-0000	Healthcare Support Occupations	0	0	\$1,032
19-0000	Life, Physical, and Social Science Occupations	0	0	\$1,547
25-0000	Education, Training, and Library Occupations	0	0	\$678
35-0000	Food Preparation and Serving Related Occupations	0	0	\$418
39-0000	Personal Care and Service Occupations	0	0	\$378
21-0000	Community and Social Service Occupations	0	0	\$145
45-0000	Farming, Fishing, and Forestry Occupations	0	0	\$27
Total		73	7	\$0

Sources: BLS OES, REMI, RESI, U.S. Census CBP

Appendix I: Cluster/Social Network Analysis Occupation Details

This appendix presents details of the occupation estimates for the network and cluster definition presented in Section 7. These cluster occupational estimates are presented in the order of the amount (highest to lowest) of average annual DoD spending obligations.

I.1 Business Services Cluster

The Business Services cluster received nearly \$7.3 billion in funding obligations on average between 2011 and 2015. Figure 122 shows the Business services cluster employs over 315,000 Maryland residents, with an average wage of over \$76,600 yearly. The cluster's highest occupation category is the Computer and Mathematical Occupations, which employs over 90,500 Marylanders, paying an average wage of nearly \$89,000 annually.

Figure 122: Estimated Employment and Average Annual Wage for Top-Level Occupations for Business Services Cluster in Maryland

SOC	Occupation Category	Estimated Jobs, 2014	Annual Average Wage, 2015
11-0000	Management Occupations	31,262	\$144,063
13-0000	Business and Financial Operations Occupations	44,141	\$80,459
15-0000	Computer and Mathematical Occupations	90,609	\$88,778
17-0000	Architecture and Engineering Occupations	33,352	\$80,499
19-0000	Life, Physical, and Social Science Occupations	9,544	\$68,674
21-0000	Community and Social Service Occupations	916	\$43,826
23-0000	Legal Occupations	1,516	\$127,167
25-0000	Education, Training, and Library Occupations	1,010	\$40,773
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	3,992	\$64,685
29-0000	Healthcare Practitioners and Technical Occupations	4,059	\$64,635
31-0000	Healthcare Support Occupations	1,303	\$28,944
33-0000	Protective Service Occupations	4,466	\$35,599
35-0000	Food Preparation and Serving Related Occupations	1,221	\$26,630
37-0000	Building and Grounds Cleaning and Maintenance Occupations	4,783	\$25,233
39-0000	Personal Care and Service Occupations	961	\$25,095
41-0000	Sales and Related Occupations	12,604	\$71,982
43-0000	Office and Administrative Support Occupations	47,339	\$39,173
45-0000	Farming, Fishing, and Forestry Occupations	46	\$29,759
47-0000	Construction and Extraction Occupations	3,585	\$50,350
49-0000	Installation, Maintenance, and Repair Occupations	4,814	\$48,141
51-0000	Production Occupations	4,115	\$32,751
53-0000	Transportation and Material Moving Occupations	10,021	\$28,828
Total		315,659	\$76,688

Sources: BLS OES; Delgado, Porter, and Stern; RESI; U.S. Census

I.2 Aerospace and Defense Cluster

The cluster received over \$1.2 billion in funding obligations on average between 2011 and 2015 and contributed significantly to Maryland's Economy. Figure 123 shows the Aerospace Vehicles and Defense cluster employs over 10,800 Marylanders, and pays an average wage of over \$85,200. The cluster's two highest occupation categories are the Architecture and Engineering and Computer and the Computer and Mathematical Occupations categories, which both pay high average wages, nearly \$92,000 annually, and over \$103,000 annually, respectively.

Figure 123: Estimated Employment and Average Annual Wage for Top-Level Occupations for Aerospace Vehicles and Defense Cluster in Maryland

SOC	Occupation Category	Estimated Jobs, 2014	Average Annual Wage, 2015
11-0000	Management Occupations	1,220	\$144,713
13-0000	Business and Financial Operations Occupations	1,290	\$81,632
15-0000	Computer and Mathematical Occupations	1,764	\$103,326
17-0000	Architecture and Engineering Occupations	2,881	\$91,938
19-0000	Life, Physical, and Social Science Occupations	122	\$87,608
23-0000	Legal Occupations	25	\$156,888
25-0000	Education, Training, and Library Occupations	2	\$65,395
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	66	\$74,433
29-0000	Healthcare Practitioners and Technical Occupations	22	\$76,295
33-0000	Protective Service Occupations	39	\$58,540
35-0000	Food Preparation and Serving Related Occupations	1	\$30,781
37-0000	Building and Grounds Cleaning and Maintenance Occupations	35	\$33,199
41-0000	Sales and Related Occupations	287	\$86,841
43-0000	Office and Administrative Support Occupations	960	\$47,330
45-0000	Farming, Fishing, and Forestry Occupations	0	\$0
47-0000	Construction and Extraction Occupations	57	\$57,197
49-0000	Installation, Maintenance, and Repair Occupations	526	\$59,848
51-0000	Production Occupations	1,451	\$43,519
53-0000	Transportation and Material Moving Occupations	131	\$44,615
Total		10,881	\$85,290

Sources: BLS OES; Delgado, Porter, and Stern; RESI; U.S. Census CBP

I.3 Communications Equipment and Services Cluster

The Communications Equipment and Services cluster received over \$1.1 billion in funding obligations on average between 2011 and 2015. Figure 124 shows the Communications Equipment and Services cluster employs over 10,700 people, and pays an average wage of over \$73,500. The cluster's two highest occupation categories are the Architecture and Engineering and Computer and the Computer and Mathematical Occupations categories, which both pay high average wages, nearly \$92,000 annually, and over \$103,000 annually, respectively.

Figure 124: Estimated Employment and Average Annual Wage for Top-Level Occupations for Communications Equipment and Services Cluster in Maryland

SOC	Occupation Category	Estimated Jobs, 2014	Average Annual Wage, 2015
11-0000	Management Occupations	891	\$145,880
13-0000	Business and Financial Operations Occupations	1,037	\$81,307
15-0000	Computer and Mathematical Occupations	2,108	\$89,609
17-0000	Architecture and Engineering Occupations	1,053	\$90,400
23-0000	Legal Occupations	30	\$141,428
25-0000	Education, Training, and Library Occupations	5	\$57,540
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	477	\$68,877
29-0000	Healthcare Practitioners and Technical Occupations	1	\$70,190
33-0000	Protective Service Occupations	10	\$44,748
37-0000	Building and Grounds Cleaning and Maintenance Occupations	10	\$29,111
41-0000	Sales and Related Occupations	1,672	\$57,955
43-0000	Office and Administrative Support Occupations	1,951	\$41,073
47-0000	Construction and Extraction Occupations	12	\$55,738
49-0000	Installation, Maintenance, and Repair Occupations	1,098	\$55,800
51-0000	Production Occupations	320	\$37,014
53-0000	Transportation and Material Moving Occupations	51	\$31,898
Total		10,725	\$73,561

Sources: BLS OES; Delgado, Porter, and Stern; RESI; U.S. Census CBP

I.4 Information Technology Cluster

The Information Technology cluster received over \$438 million in funding obligations on average between 2011 and 2015.

Figure 125 shows that the cluster employs nearly 12,500 people and pays an average wage of over \$94,100. The cluster's highest occupation category is the Computer and Mathematical Occupations, which employs over 5,400 people, over 44 percent of people in this cluster. The

Computer and Mathematical Occupations also receive high average wages, over \$101,000 annually.

Figure 125: Estimated Top-Level Occupations for Information Technology Cluster

SOC	Occupation Category	Estimated Jobs, 2014	Average Annual Wage, 2015
11-0000	Management Occupations	1,294	\$153,102
13-0000	Business and Financial Operations Occupations	1,297	\$89,078
15-0000	Computer and Mathematical Occupations	5,486	\$101,067
17-0000	Architecture and Engineering Occupations	1,522	\$90,367
19-0000	Life, Physical, and Social Science Occupations	57	\$87,626
23-0000	Legal Occupations	51	\$160,864
25-0000	Education, Training, and Library Occupations	7	\$68,565
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	190	\$77,248
29-0000	Healthcare Practitioners and Technical Occupations	8	\$78,796
33-0000	Protective Service Occupations	9	\$51,899
35-0000	Food Preparation and Serving Related Occupations	0	\$29,970
37-0000	Building and Grounds Cleaning and Maintenance Occupations	18	\$30,625
41-0000	Sales and Related Occupations	656	\$87,874
43-0000	Office and Administrative Support Occupations	924	\$45,230
45-0000	Farming, Fishing, and Forestry Occupations	0	\$0
47-0000	Construction and Extraction Occupations	8	\$56,626
49-0000	Installation, Maintenance, and Repair Occupations	154	\$54,934
51-0000	Production Occupations	716	\$37,709
53-0000	Transportation and Material Moving Occupations	59	\$32,950
Total		12,456	\$94,160

Sources: BLS OES; Delgado, Porter, and Stern; RESI; U.S. Census CBP

I.5 Biopharmaceuticals Cluster

The Biopharmaceuticals cluster received over \$35 million in funding obligations on average between 2011 and 2015. Figure 126 shows the Biopharmaceuticals cluster employs over 5,500 people, and pays an average wage of over \$75,000. The cluster's highest occupational category

is the Life, Physical, and Social Science Occupations category, which also pays an average wage of nearly \$75,000 annually.

Figure 126: Estimated Top-Level Occupations for Biopharmaceuticals Cluster

SOC	Occupation Category	Estimated Jobs, 2014	Average Annual Wage, 2015
11-0000	Management Occupations	737	\$140,740
13-0000	Business and Financial Operations Occupations	558	\$78,190
15-0000	Computer and Mathematical Occupations	307	\$89,900
17-0000	Architecture and Engineering Occupations	399	\$80,540
19-0000	Life, Physical, and Social Science Occupations	1,567	\$74,920
23-0000	Legal Occupations	20	\$154,180
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	28	\$67,150
29-0000	Healthcare Practitioners and Technical Occupations	53	\$75,310
31-0000	Healthcare Support Occupations	5	\$37,800
33-0000	Protective Service Occupations	15	\$36,750
35-0000	Food Preparation and Serving Related Occupations	3	\$32,890
37-0000	Building and Grounds Cleaning and Maintenance Occupations	45	\$29,100
39-0000	Personal Care and Service Occupations	0	\$0
41-0000	Sales and Related Occupations	85	\$82,230
43-0000	Office and Administrative Support Occupations	487	\$42,980
45-0000	Farming, Fishing, and Forestry Occupations	0	\$42,550
47-0000	Construction and Extraction Occupations	14	\$61,840
49-0000	Installation, Maintenance, and Repair Occupations	253	\$53,180
51-0000	Production Occupations	795	\$40,220

53-0000	Transportation and Material Moving Occupations	157	\$32,480
Total		5,528	\$75,051

Sources: BLS OES; Delgado, Porter, and Stern; RESI; U.S. Census CBP

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