Annual Industrial Capabilities

Report to Congress for

2013

September 2016

Office of the Under Secretary of Defense
for Acquisition, Technology, and Logistics

Office of the Deputy Assistant Secretary of Defense
for Manufacturing and Industrial Base Policy

The estimated cost of this report or study for the Department of Defense is approximately $67,000 in Fiscal Years 2013-2015. This includes $0 in expenses and $67,000 in DoD labor. Cost estimate generated on July 23, 2015 Reference: B-7A12708

Table of Contents

Requirement:

This report is being provided to the Committee on Armed Services of the Senate and the Committee on Armed Services of the House of Representatives. This report simultaneously satisfies the requirements pursuant to Title 10, U.S.C., section 2504, which requires the Department of Defense (DoD) to submit an annual report summarizing DoD industrial capabilities-related guidance, assessments, and actions and Senate Report 112-26, which accompanied the National Defense Authorization Act (NDAA) for Fiscal Year 2012, and requires a report containing a prioritized list of investments to be funded in the future under the authorities of Title III of the Defense Production Act**.** This report summarizes DoD industrial capabilities-related guidance, assessments, and actions initiated during 2013 and as they existed at the close of that year. It is important to note that the status of some of the programs described herein has changed in the intervening time.

1. Defense Industry Outlook

The defense industrial base is a diverse and dynamic set of companies and DoD organic facilities that provide both products and services, directly and indirectly, to the Department of Defense and national security agencies to support national security objectives. It includes companies of all shapes and sizes, from some of the world's largest public companies to small businesses. It is no secret that the current defense industrial base (DIB) faces a challenging environment. The impact of potential budget reductions – particularly sequestration – places substantial pressure on firms in the DIB. It complicates efforts to conduct long-term planning as firms must plan and realign business activities to compete for capital in already competitive markets. Yet even in this atmosphere, today's financial metrics for our larger defense firms indicate that they are profitable and that the defense industry is carefully managing shareholder value. The positive financial data reflects savvy business decisions for equity buybacks, debt reduction, reduced capital expenditures, and reductions in the labor force. However, as budgetary pressure on research and development (R&D) and production spending increases stress on our industrial base will intensify.

While our defense industry is currently viable and competitive, the Department is concerned about the impact that defense budget instability will have on the ability of industry to provide the broad range of products and services needed by the Department and the Nation. In addition, sequestration and prolonged uncertainty could limit capital market confidence in the defense industry, undermining companies' willingness or ability to continue to invest in their defense portfolios. This would hit smaller, innovative, and niche product companies particularly hard, as they lack the capital resources to withstand such turmoil and uncertainty. While only a fraction of our industrial base capabilities are truly at risk, the United States is in danger of losing some key industrial capabilities vital for our future national security.

Trends in Defense Sectors

The FY 2013 President's Budget reflects a continuing trend that first started more than two decades ago. Since the 1990s, the DIB has seen erosion in multiple sectors, including fixed-wing aircraft, missiles, electronics, ground vehicles and materials, with associated

decreases in design engineering and manufacturing capability. While we produce the best weapons systems in the world, we both require and produce fewer of them in many cases. Typically, our large defense firms are more diverse and able to manage downturns in spending. However, substantial stress exists in the lower sub-tiers of the DIB as smaller firms, with limited access to capital, deal with the downturn in the defense budget. The impact of the budget cuts is intensified by a smaller industrial base due to the consolidation of the 1990s. Fewer companies translate to increased significance of each firm to the Department, and thus any loss of additional firms makes it more difficult to obtain required supplies and services, which in turn causes further price increases.

Further, the procurement increases that the Department experienced in FYs 2004-2008 were heavily weighted in Global War on Terrorism and Overseas Contingency Operations (OCO) distributions toward sustainment, rather than on the next generation of platforms. Because future spending levels are still unclear, the Department is reluctant to draw down its force structure any further than is already planned, and operations and maintenance accounts can only be trimmed slightly without hurting troop readiness levels. That means that, in the short term, the bulk of the cuts have fallen disproportionately on R&D and procurement accounts (and thus, on our industrial base). In fact, from 2008 to 2015, the non-Science & Technology R&D accounts (specifically 6.4, 6.5, and 6.7), which are used to transition basic science and technology to warfighter application, are planned to drop 36 percent. Over the same period, procurement in that area dropped 42 percent (both in constant dollars).

The Department is concerned about the impact that further budget cuts, on top of the drawdown from the conflicts, will have on the ability of the DIB to provide the broad range of products and services needed to support the Warfighter and national security. Many capabilities that are used by the Department also have commercial uses. When there is sufficient commercial demand for a capability, a decrease (or increase) in demand by defense has a typical and predictable impact: namely, the equilibration of supply and demand wherein companies enter when it is profitable and exit when it is not. But in some cases, the capabilities required by the Department are more sensitive to defense funding swings, especially when there is little commercial requirement for the product or skill, or for capabilities that are largely defense-unique. Both the lack of new defense programs and budget uncertainty restrict the DIB's ability to compete with commercial markets for engineering talent. In these cases, firms must balance wide swings in demand via decisions on capital investments and the employment of specialized labor.

Firms do not necessarily need to shut down to have a negative impact on defense capabilities. It is equally challenging when a company devotes a line of business to directly support defense. Faced with decreasing revenues in the defense sector, the company may exit the line of business with minimal negative (and possibly a positive) impact to its own bottom line and shareholders, but the operational risk to DoD may increase.

Technological Superiority

A healthy commercial market is vital to sustain the DIB in the long term. Although DoD recommends that industry develop commercial uses for military products, certain capabilities

will remain defense-unique to keep our technological and military advantage. The gap between the requested and appropriated budgets, compounded by sequestration, creates a planning challenge.

The Department is deeply concerned about the loss of technical expertise and design teams that are sustained through new program development. Over the past decade, many industrial sectors have had no or few new-start opportunities in defense-specific areas that are currently undergoing a decline in procurement, such as in the munitions and missile sector and ground combat vehicles. A sample of key areas in the DIB that require close monitoring include next-generation tactical aircraft design and integration skills, ground combat vehicle manufacturing and production capability, trusted micro-electronics, and sub-tier suppliers in space and tactical and strategic missile systems. The combination of loss of design (lack of new-starts) and production (lack of procurement) capability could result in costly delays, unanticipated expense, and a significant impact on many current and future programs and damaging the readiness of the Department.

Data-Driven Assessments

Cycles in budgets are not new to the Department. In order to understand and mitigate the impacts to programs from changes in the industrial base and vice versa, the Department published a Directive and handbook in 1996 that formalized the assessment of defense industrial capabilities on a case-by-case basis (DoD Directive 5000.60H, 1996). Once an area of concern is identified, the handbook provides a framework to determine the need for government action to preserve industrial capabilities vital to national security. The framework is useful, but, as written in 1996, it was also reactive and program-centric. While primes manage their individual supply chains effectively, the cumulative effect of multiple program procurement decisions can have unintended consequences on vital capabilities. Accordingly, DoD requires proactive insight into the impacts of acquisition decisions made today on the industrial capabilities that it requires now and in the future.

In late 2012 and through 2013, the Office of the Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy (MIBP) built on the existing 1996 framework to develop a methodology that could be used proactively across Services and industrial sectors and was designed to be rigorous, repeatable, and transparent. This methodology has become known as the Fragility and Criticality (FaC) assessment process, or FaC for short. Chapters 4 and 5 of the revised DoD Instruction (DoDI) 5000.60 guidebook provide the assessment framework. In 2013, the Department completed ten FaC pilot assessments that identified important risks in the industrial base and provided actionable mitigation strategies to DoD leadership. The pilots also offered lessons on how to improve the overall FaC process and provided empirical and statistical evidence to improve the constructs for Criticality and Fragility. From the data explorations and statistical analysis, MIBP confirmed Criticality as a construct in measuring those capabilities that are difficult to replace if lost, while Fragility serves as an indicator of the robustness of current suppliers' capabilities and the availability of potential firms in the current marketplace to support the Warfighter.

Globalization

In general, industry is becoming more integrated with global commercial markets. Even without the budget pressures, the simple fact is that the U.S. no longer has the luxury of assuming that we are, or will be, the leader in new technology breakthroughs. Indeed, international collaboration and cooperation have reduced the time from technology breakthrough to product development. This single change requires that our acquisition process be able to take advantage of emerging capabilities regardless of where they originate.

Effective global supply chain integration and management are even more critical to DoD program success now than in the past. Although globalization brings many benefits to both defense firms and the Department, such as the ability to leverage the R&D efforts of commercial industry that would be impossible to replicate on a defense-unique basis, it also brings increased cross-border flows of information and technology, thus reducing our technological advantage. As a consequence, in technology and capability areas that are globally competitive, our goal is to obtain the best product to support the Warfighter at the best price from the international marketplace. However, for those enabling technologies that are critical to maintaining superiority over our adversaries, we seek to invest in domestic or allied partner firms to retain the enablers or to regain the advantage. As part of the long-term globalization strategy, we should review policies and practices that address the need for Government data rights and management of delivered technical data.

Looking to the Future: DoD and the DIB

DoD faces a tough budget environment. Government and industry stakeholders are keenly aware that there have been significant pressures on the industrial base, and the prospect of more sequestration limits, which impact investment accounts and the readiness of the Department, affecting our innovation processes and our future. The good news is that defense markets are cyclical, and there will be an upturn eventually – and DoD must be ready for it. The firms that will succeed will need to make strategic investments now. Companies in the DIB have shown a remarkable ability to continue to generate significant profits, even as defense revenue slips, with a continued shareholder-friendly capital deployment strategy. In contrast, there is continued stress on important priorities like industry's company-sponsored R&D investments for sustained tech-superiority. Industry's investment in enabling technologies is key to the next-generation force structure.

2. Strategic Guidance

The Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy (DASD(MIBP)) was established by section 896 of the Ike Skelton NDAA for Fiscal Year 2011 (P.L. 111-383). MIBP supports the Office of the Secretary of Defense and Service Acquisition Executives by: (1) providing detailed analyses and in-depth understanding of the increasingly global, commercial, and financially-complex industrial supply chain essential to our national defense; and (2) recommending or taking appropriate actions to maintain the health, integrity, and technical superiority of that supply chain. In addition to MIBP's core mission to broadly

assess and address the health and resiliency of the DIB (Title 10, U.S.C., sections 2501, 2503, 2505, and 2506), it oversees important program and policy functions, including:

- The title 50, U.S.C., Defense Production Act (DPA) of 1950, Title I, Defense Priorities and Allocations System;
- The title 50, U.S.C., DPA Title III program, Expanding Production Capability and Supply;
- The title 10, U.S.C., section 2521 Manufacturing Technology (ManTech) program;
- The title 50, U.S.C., DPA Title VII, Section 721, Committee on Foreign Investment in the United States (CFIUS);
- The title 50, U.S.C., DPA Title VII, Section 722 of the DPA, Defense Production Act Committee (DPAC); and
- The title 10, U.S.C., section 2372, Independent Research and Development.

This extensive and diverse portfolio enables MIBP's holistic focus on defense manufacturing, production, and industrial base issues.

2.1 Presidential Commitment to Advanced Manufacturing Initiatives

Throughout 2013, both the Administration's and the Department's leadership placed the highest priority on advancing manufacturing capabilities within DoD and throughout the nation. One example is MIBP's ManTech program, which led an interagency effort to launch two new $140 million public-private partnerships for Advanced Manufacturing on behalf of the Department: the Digital Manufacturing and Design Innovation (DMDI) Institute and the Lightweight and Modern Metals Manufacturing Innovation (LM3I) Institute. These efforts, build on the successful launch of "America Makes," a $69 million "pilot" institute. America Makes opened on September 27, 2012 and will serve as a training and collaboration center to bridge the gap between basic research and technology adoption for additive manufacturing. More commonly known as "3D Printing," additive manufacturing is an enabling manufacturing technology for military platforms. Participants include DoD, the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and the Department of Commerce's (DOC) National Institute of Standards and Technology (NIST). The interagency investment of $30 million was matched by a $39 million cost-share from non-federal sources, and America Makes will endeavor to become self-sufficient in three years.

Together, the three institutes discussed above (DMDI, LM3I, and America Makes) have formed an initial National Network for Manufacturing Innovation (NNMI) focused on successful scale-up of emerging, world-leading advanced manufacturing capabilities, enabling U.S. industry to maintain its edge in a hypercompetitive global environment and meet vital economic and national security needs.

2.2 Expanded Efforts to Incorporate Industrial Base Impacts in the Department's Budget Deliberations

The Department has continued efforts initiated in the FY 2013 budget cycle to explicitly consider the effects of program adjustments on the industrial base. In 2012, the USD(AT&L) created a process to work with the Military Departments (MILDEPs) to identify critical and fragile industrial base niches involved in the supply chains for major defense acquisition programs. The DASD(MIBP) spearheaded these FaC assessments in order to analyze the portfolio of critical and fragile niches across the defense enterprise and inform DoD budget discussions. The information derived from these analyses may be used, for example, to make adjustments to ensure a smooth workflow, especially by considering the impact of spending across different programs that have a common sub-tier supplier that is considered at risk. This effort is described in more detail in section 3.0, "Sector-by-Sector, Tier-by-Tier Evaluations of the Defense Industrial Base."

There is a broad spectrum of programs, processes, and executive and congressional leadership options to address industrial base risks. Nevertheless, with a focus on specific programs rather than the industrial base as a whole, a gap has existed in addressing vulnerabilities in the "industrial commons," particularly at lower tiers of the supply chain. . . To address this gap, the FY 2011 NDAA established an industrial base fund in conjunction with the establishment of the DASD(MIBP). The fund is codified in 10 CFR 2508 and named by the Department as the Industrial Base Analysis and Sustainment (IBAS) program.

IBAS-funded projects addressing critical issues and supply chain vulnerabilities are identified by three basic methods: 1) existing knowledge, 2) new fragility and criticality industrial base assessments, and 3) nominations from the Services and DoD agencies. The positioning of IBAS among the spectrum of risk reduction programs is found in its name: "sustainment." Preservation includes design teams as well as capabilities to produce existing products. While innovation is not the primary objective, it is certainly compatible, and is frequently an indispensable partner to preserving both design teams and production capabilities.

Defense industrial capabilities without a strong companion market for commercial sales are frequently the most vulnerable. Because of the vulnerability of defense-specific capabilities in today's budget environment, IBAS is currently broken out and managed in the three broad categories of "Missiles," "Space," and "Other." Cross-program and cross-service leadership and partnership are essential to identification of vulnerabilities and effective risk reduction projects. For that reason, IBAS collaborates closely with the Critical Energetics Working Group (CEWG) and Fuze Integrated Product Team (IPT) for missiles and the Critical Technologies Working Group (CTWG) for space. In the future, as IBAS adapts to a continuously changing industrial base environment, collaboration with cross-program and cross-service entities like the CEWG, the Fuze IPT, and the CTWG will remain essential.

2.3 Continuation of the Better Buying Power Initiative

Better Buying Power (BBP) is based on the principle of continuous improvement to improve the performance of the defense acquisition enterprise. BBP 2.0 was introduced in late

2012, and implementation guidance was issued in April 2013. The rollout continues the initiative started in 2010, when then USD(AT&L) Ashton Carter issued guidance to the acquisition community to ensure affordability and increase productivity in defense spending to deliver better value to the taxpayer and the Warfighter.

On April 24, 2013, USD(AT&L) Frank Kendall issued a memorandum providing implementation guidance to acquisition professionals for BBP 2.0 aimed at achieving greater efficiency and productivity in defense spending. The progression from BBP 1.0 to 2.0 reflects a change in emphasis from specific "best practices" to an increased emphasis on helping acquisition professionals think critically and make better decisions as they confront the myriad, complex situations encountered in defense acquisition. Based on continuous improvement, BBP 2.0 reinforces much of the content from BBP 1.0, but it also includes new initiatives and modifies some of the previous guidance. Adjustments to BBP 1.0 were made based on experience during its implementation and feedback from industry and government. BBP 2.0 emphasizes professionalism and the provision of better tools to help DoD acquisition professionals make sound decisions.

BBP 2.0 continues efforts in seven areas to achieve greater efficiency and productivity in defense spending:

1. Achieve affordable programs;

2. Control costs throughout the product lifecycle;

3. Incentivize productivity and innovation in industry and Government;

4. Eliminate unproductive processes and bureaucracy;

5. Promote effective competition;

6. Improve tradecraft in acquisition of services; and

7. Improve the professionalism of the total acquisition workforce.

Along with BBP 1.0, BBP 2.0 focuses on cost consciousness and professionalism as critical elements of our culture. Cost consciousness is emphasized in part because the government system tends to emphasize spending over control. BBP 2.0 implementation reinforces professionalism for three reasons: first, because we all can and should be working to improve our abilities; second, because it is important that the communities we work with understand the importance of professionalism to success in defense acquisition; and third, because nothing is more important to our success than our professional ability to understand, think critically, and make sound decisions about the complex and often highly technical matters defense acquisition confronts.

The Department remains committed to the BBP initiative. It seeks to achieve greater efficiency in the acquisition process in conjunction with lowering the burden of non-value-added

requirements on the defense industry. The Department also recognizes that industry is driven by profits and cash flow and thus those are the primary incentives that we can offer to businesses to respond to our requirements. BBP is one of the mechanisms through which the Department seeks to reinvigorate its partnership with industry to develop, produce, and sustain the systems that offer American Warfighters a technological edge.

2.4 Increased Cooperation on Materials Industrial Base Assessments

Section 901 of the National Defense Authorization Act for Fiscal Year 2013 (P.L. 112-239) addresses a specific facet of the industrial base: the availability of materials critical to national security. The DASD(MIBP) shares with the office of the Defense Logistics Agency Strategic Materials (DLA SM) the responsibility for assessing the material needs of the defense industrial base, assessing the robustness of the associated material supply chains, and, as appropriate, developing, implementing, and monitoring policies to ensure the availability of required materials. The legislation also reconfigures the Strategic Materials Protection Board (SMPB) such that it will now be chaired by the DASD(MIBP), while the Administrator of DLA SM serves as vice-chair. In the past, the SMPB was chaired by the USD(AT&L). The DASD(MIBP) recognizes the goal of Congress and the synergies to be gained from a strategy that emphasizes a more centralized approach by the Department to issues concerning the supply of materials critical to the DIB.

3. Sector-by-Sector, Tier-by-Tier (S2T2) Evaluations of the Defense Industrial Base

In 2013, the USD (AT&L) directed MIBP to conduct pilot sector-by-sector, tier-by-tier FaC assessments of eleven discrete sectors, niches and programs: Space, Missiles, Military Satellite Communications Systems Terminals, Focal Plane Arrays, Warfighter Information Network – Tactical (WIN-T) Inc. 1, F-18, F-22, Gray Eagle, Tobyhanna Army Depot Skills, Vertical Lift Skills, and Ground Vehicles. The results are addressed in the appropriate industrial base sections of this report.

The S2T2 assessments confirmed with supporting data that the space and missiles sectors are under particular stress. General factors leading to this situation are the highly specialized and military-specific requirements in some sub-sectors, declining procurement, and fewer new program starts. In these two sectors, formal industrial base risk mitigation planning is underway. Specifically, CTWG is addressing space sector risk and a Fuze Integrated Product Team and the Critical Energetic Materials Working group are both addressing specific missile sector risks. S2T2 FaC assessment results are important inputs to these planning groups.

In addition, the S2T2 FaC assessment results were critical inputs to a late 2013 industrial base Deputy's Management Action Group (DMAG) seeking to find balance in the budget – balance in short-term and long-term risks, and balance in cuts to troops and to the military and contractor organizations that support them. A particular example of DMAG action was increasing the President's budget request for the Industrial Base Analysis and Sustainment

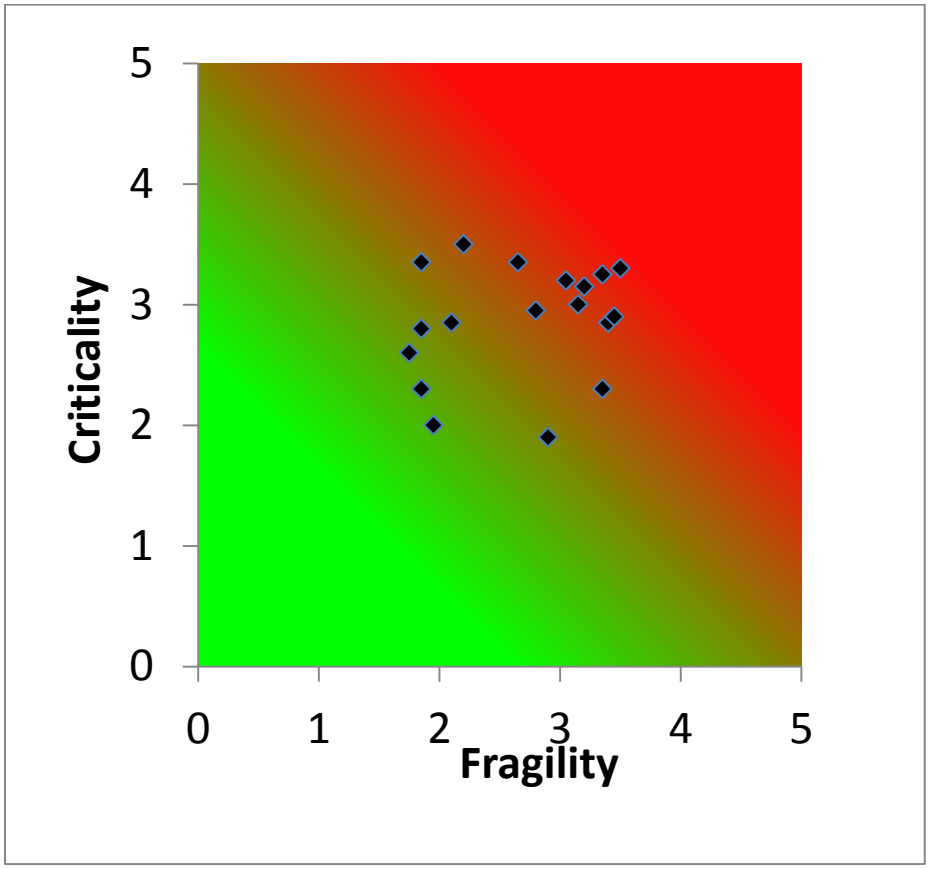
program (see section 4.5.4) to address weaknesses in the missile industrial base for fuzes and thermal batteries.

The S2T2 FaC assessments are performed using prescribed FaC criteria to render them repeatable and fact-based. Fragility characteristics are those that make a specific product or service likely to be disrupted. Criticality characteristics are those that make it difficult to replace if disrupted. These characteristics are evaluated by subject matter experts who assign numeric values to each of the criteria. Analysis from the 2013 FaC assessments resulted in the number of FaC criteria being reduced from fourteen to ten to eliminate analytical overlap. The remaining ten criteria are listed in the following tables.

FRAGILITY:	
Financial Outlook (current provider)	**Firms in Sector (existing market)**
DoD Sales (current provider)	**Foreign Dependency (existing market)**

CRITICALITY:	
Defense-unique	**Facility & Equipment requirements**
Skilled labor requirement	**Reconstitution time**
Defense design requirements	**Availability of alternatives**

The FaC results can be plotted on a chart for visual effect as illustrated below.



One of the lessons learned in 2013 is that evaluating programs individually is very inefficient. The best results were obtained by convening subject matter experts across program boundaries and examining the common industrial base as a whole. The net result is that the department will not perform FaC assessments individually on all Major Defense Acquisition Programs (MDAPs). Another lesson learned is that most areas of the industrial base are not fragile or critical and that quickly identifying and removing those sectors without further examination is a tremendous efficiency.

4. Industrial Sector Assessments

The following sections examine the industrial base sectors based on assessments and analyses conducted by the Office of the DASD(MIBP). Each section encompasses an overview of the health of the sector, financial performance of industries supporting the sector, at-risk areas or critical issues important to the defense industrial base, and potential impacts of MDAP terminations in the previous fiscal year (FY 2013 for this report), as required by section 2505(b) of title 10, U.S.C.

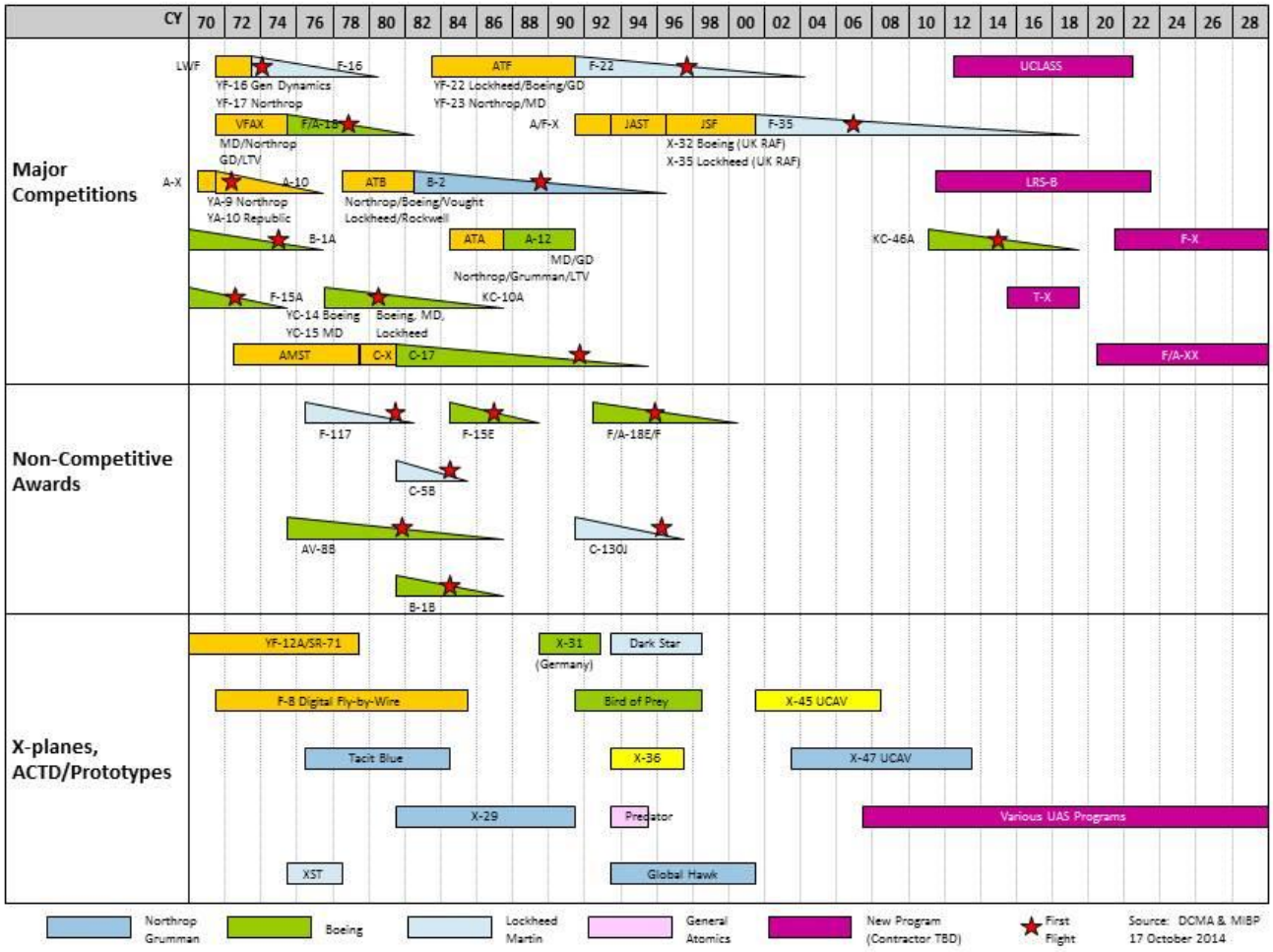
4.1 Aircraft Sector Industrial Summary

According to the Aerospace Industries Association's 2013 Year-End Review and Forecast, military aircraft sector sales dropped 6.3 percent from 2012. The decrease in military sales was mainly caused by budget reductions, including reductions to overseas contingency operations funding. The Center for Strategic & International Studies indicated in their Current Issues publication (May 2014) that Air Force contract obligations for aircraft declined 25 percent (from $21.5 billion in 2012 to $16.1 billion in 2013) as a consequence of funds reductions mandated by the Budget Control Act of 2011.

Considering the budget constraints, the Department is focusing on defense-unique aerospace capabilities that could be at risk and that are not sustained by the commercial market. In 2013, DoD completed aircraft fragility and criticality assessments for the F-22 and Gray Eagle programs, as well as the vertical lift sector. F-22 FaC assessment results did not indicate a need to do further investigations or take immediate actions to reduce IB risks for that program. The Grey Eagle FaC assessment identified Unmanned Aerial Vehicle (UAV) sensor payload and autonomous landing technologies as capabilities that need to be reviewed in more detail. MIBP is planning to complete a deep dive in those areas in FY 2015. The vertical lift sector assessment uncovered a design teams' sustainability issue that is common not only to rotary wing but to the whole aircraft sector. Since the 1970s (see Figure 4.1.1), there has been a steady decline in the number of defense development programs for fixed-wing aircraft. Currently, the F-35 and MQ-4 Triton are the only aircraft programs in the Engineering and Manufacturing Development (EMD) phase of the acquisition. This situation has created concerns about the industry's ability to sustain the skills and capabilities needed for future aircraft design and development. Although modernization programs for C130 AMP, F-15, B-2, and F-22 will help sustain important capabilities such as avionics, electronic warfare, limited structural changes, software development and weapons integration, they will not provide opportunities for major design, development and integration work.

With the approaching end of F-35 development and an absence of new fighter requirements in the next five to seven years, critical design capabilities are facing shortages. The Navy has initiated study efforts related to potential follow-on fighter/attack (FA-XX); however, any development effort is not expected to begin in earnest until after 2020. The risk of losing design teams is increased by an aging aerospace workforce that, on average, is close to retirement, as well as by an apparent lack of interest from young engineers in the aerospace domain. Historically, the transfer of engineering know-how and critical classified knowledge was done from one generation of engineer to the next by hands-on, real-time execution of relevant work. Over the past 25 years or more, opportunities for this type of knowledge transfer have been very limited. Therefore, future technical challenges will be tackled by engineers with potentially significantly less experience than the generation before. The consequences may include longer and more expensive development and initial production costs.

Figure 4.1.1: Major Military Fixed-Wing Aircraft Design and Development Programs



(Sources: historical data, FY15 Presidential Budget, and estimated timeframes for next-gen aircrafts)

Most large fixed-wing platform airframes, as well as many of their high-value subsystems, are commercial off-the-shelf (COTS) or COTS-derivative items. These high-value subsystems include engines, avionics, auxiliary power units, environmental control systems, and ground proximity warning systems. Large airframes and subsystems rely heavily on commercial technologies, processes and products, and will be sustained by ongoing and planned military and commercial aerospace programs. New Air Force and Navy acquisition programs (see table 4.1.2) may increase EMD activities, but the current workload may not be enough to sustain prime contractor design teams until they are needed. In addition, the level of design that will be required for each of the programs is not clear. Prime contractors may propose modifications to current platforms to meet requirements, thus reducing the opportunities to sustain design and development teams.

Table 4.1.2: Future Aircraft programs (based on FY 2015 procurement plan)

Program	*Lead Service*
Long Range Strike–Bomber (LRS-B)	Air Force
UCLASS	Navy
Trainer (T-X)	Air Force
EA-18G Replacement Program	Navy

The Department's source selection decisions for these programs are crucial in determining the future competitive landscape of the aircraft industrial base.

The Navy is continuing to invest in Unmanned Aerial Systems (UAS) programs, such as the MQ-8C Fire Scout (with expanded range and payload relative to the MQ-8B), the MQ-4 Triton, and the Unmanned Carrier Launched Surveillance and Strike (UCLASS) system.

4.2 Electronics Sector Industrial Summary

Over the past twenty-five years, there has been an unprecedented globalization of the electronics industry, particularly for firms that engage in consumer communications and information technology. While globalization has many economic benefits, it also provides increased access and opportunity for malicious actors to manipulate information and communications technology products and services to gain unauthorized access to otherwise closed-off technologies and services. Threats to the supply chain can affect both software and hardware products. Software is growing exponentially in size and complexity, creating assurance challenges. Software design, development, testing, distribution, and maintenance can be done more inexpensively offshore in easy reach of malicious actors. This situation creates a major challenge for the Department and the U.S. Government.

Security of the supply chain can be compromised by untrustworthy or counterfeit microelectronic components. The semiconductor industry has increasingly moved toward offshore or foreign-owned semiconductor component production. This trend creates a threat to the United States as the potential increases for unauthorized design inclusions to appear on integrated circuits used in military applications.

Microcircuits and related leading-edge technologies are strongly influenced by global commercial interests that are not the same as defense and aerospace interests. Devices used in defense and aerospace applications are subject to environmental effects not usually found in the consumer market, including long-life and storage periods, as well as environmental factors such as shock, vibration, nuclear radiation hardening, electromagnetic environmental effects, and wide temperature ranges. Atmospheric radiation is also a concern to the aerospace industry. Aircraft, and especially spacecraft, are vulnerable to cosmic ray and solar particle radiation total dose and single event upsets, while future electronic systems are even more vulnerable due their higher sensitivity. Consumer products are not designed for these kinds of conditions.

Compounding the challenge for U.S. defense and aerospace companies is the fact that, with the migration of electronics manufacturing offshore, issues of counterfeiting, trust (intellectual property theft and anti-tampering), product reliability, and assured sources of supply

become increasingly more difficult to manage. While consumer markets, manufacturing costs, and industrial policies have affected the global semiconductor industry, the need for "trust" in systems and components is complicating matters for the defense and aerospace community.

At the tier below actual manufacturing, there exists an industry supplying electronics manufacturing equipment that is also global, with the major suppliers domiciled in the United States, Japan, and the Netherlands. To some degree, manufacturing processes are standardized. For example the standard size for silicon substrates from which most integrated circuits are manufactured is 300mm. To increase efficiencies by manufacturing more product from a single substrate, the industry is planning a transition to a larger 450mm size. One of the Department's primary concerns with manufacturing is the security and integrity of the product. The part of a fabrication facility that has the best potential access to design information is the section that fabricates and verifies the lithographic masks used to define the patterns on a wafer. Mask technology does not change in the transition to 450 mm. Nevertheless, the Department plans to continue monitoring the evolution of 450 mm manufacturing equipment technology to ensure the United States has reliable, secure, and trusted access to leading edge semiconductor manufacturing capability. A report to Congress on this topic, "450 mm Semiconductor Fabrication Equipment Manufacturing Technology," was submitted on November 22, 2013.

Potential adversaries could tamper with electronic devices used in defense and aerospace systems in ways that are undetectable, steal intellectual property from designs, and thereby defeat key defense systems. A counterfeit electronic component is one where material, performance, or characteristics are knowingly misrepresented by the vendor, supplier, distributor, or manufacturer. The objective of malicious tampering is to engage in espionage or sabotage, while the motivation for counterfeiting is economic, but the effect of both is the same: intentionally compromised devices may be impossible to detect and can jeopardize both mission and life.

The Department is working with Congress and industry to address the above concerns. Mission-critical functions and critical components are being managed based on system criticality. The Department is developing policy and standards and using source intelligence to select reliable suppliers of critical components in managing risk to trust in covered systems throughout the entire system lifecycle. The application of risk management practices begins during the design of covered systems and prior to the acquisition of critical components or their integration within covered systems, whether acquired through a commodity purchase, system acquisition, or sustainment process. In May 2013 the Department published a proposed Defense Federal Acquisition Regulation Supplement (DFARS) rule on **"**Detection and Avoidance of Counterfeit Electronic Parts**"** as required by Section 818 of the FY 2012 NDAA.

4.2.1 Radar and Electronic Warfare Sector Industrial Summary

Background

The DoD focus on radar technology in 2013 continued to be on Active Electronically Scanned Array (AESA) technologies. Several surface AESA programs have undergone an industrial downselect, such as the Navy Air and Missile Defense Radar (AMDR), while the Air

Force Space Fence and 3-Dimensional Expeditionary Long-range Radar (3DELRR) programs were preparing for Milestone B decisions. The U. S. Marine Corps (USMC) AN/TPS-80 program is preparing to enter Low-Rate Initial Production (LRIP). These decisions are being made against the backdrop of an overall environment of fiscal austerity, including that imposed by the Budget Control Act of 2011 and a drawdown from two wars since 2010. The assessments presented here are drawn from an Office of the Secretary of Defense (OSD) analysis[1] of the future AESA market from the perspectives of the market composition (surface versus airborne), competitors, and the global context in which they compete.

Domestic AESA Assessment

The industrial base supporting AESA radars is assessed to be viable and stable based on the current projections of global and U.S. demand and the adoption of key power amplifier technologies in the commercial telecommunications market. The U.S. market is dominated by three major U.S. defense corporations – Raytheon, Northrop Grumman and Lockeed Martin. These vendors account for $18.0 billion, or two-thirds of the projected $27.5 billion worldwide AESA market from 2013 to 2022. Large and complex systems, such as the Navy's AMDR, have provided the opportunity to develop a versatile acquisition strategy drawing from the strengths of all three companies.

The predominant strength is in the airborne AESA systems used on the current retrofit of F/A-18, F-16, and F-22 aircraft and the projected number of AN/APG-81 systems for the F-35. In the U.S. airborne segment Raytheon and Northrop Grumman workload is approximately $13.4 billion making up 97 percent of the market.

In surface AESA, a $7.6 billion market is split between the major players; with Raytheon holding 62%, Lockheed Martin at 24%, and Northrup Grumman at 14%. The decision on AMDR, coupled with the alternative scenarios involving Space Fence and 3DELRR acquisition decisions, indicate a very competitive and tight surface AESA market. The AMDR, 3DELRR, and Space Fence competitions are relatively small procurements compared to airborne AESA systems. Companies with a strong presence in airborne systems are well-positioned to compete in these programs. For those companies specializing in surface AESA systems, these competitions are crucial in deciding whether to remain or exit the AESA product domain.

Three Technology Development (TD) contracts were awarded (one each to Lockheed Martin, Northrop Grumman, and Raytheon) in 2010-2012 that allowed vendors the flexibility in fielding a modular design that emphasized scalability over a broad range of aperture sizes, integrated packaging to minimize cable connections, dry cooling interfaces for the transmit/receive modules to eliminate liquid interface, and stiffening to maintain array flatness under ship motion. These three competing vendors all submitted EMD contract proposals, and Raytheon was selected as the winning bid based on best value criteria. The versatility of the

[1] "Surface AESA Radar Industrial Base Assessment" (October, 2013) jointly produced by the Office of the Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy and the Defense Contract Management Agency/Industrial Analysis Center.

AMDR acquisition strategy coupled with adherence to a consistent set of requirements allowed the Navy to obtain this new radar capability at best value.

Critical Suppliers

The critical physical elements for AESA radars are the design and development of monolithic microwave integrated circuits (MMIC) and the ceramic packaging for transmit/receive (T/R) modules. While there are six U.S. MMIC suppliers, the end quality and processes are very tightly coupled with the design of the RF circuitry of the power amplifiers and the T/R module. Consequently, MMIC vendors are likely not completely interchangeable. A switch to a new vendor would involve more than minimal risk to product quality and delivery. The broader commercial future for these suppliers appears stable. Similar MMICs are used in many commercial applications, mostly in the telecommunications business. The commercial applications dwarf the military uses; two of the surveyed vendors indicated that DoD makes up less than 1% of their business. There are three suppliers providing ceramic packaging for T/R modules. As with the MMIC suppliers, the commercial business for ceramic packaging significantly exceeds the DoD side. There appears to be only a slight risk that these suppliers are in danger of being lost to the Department in the foreseeable future.

Global Context

The global AESA market for the ten years from 2013 to 2022 is projected to be approximately $27.5 billion, with the U.S. share expected to be $18 billion. Over this timeframe, one radar out of every five produced in the world will be an AESA radar. Gross Domestic Product forecasts are mixed for countries that either produce or buy AESA radars. The strongest competition to the U.S. AESA vendors is from Western Europe, Israel, and Australia. Larger European companies often team with U.S. vendors on specific European and U.S. projects.

Airborne AESA systems are competitively priced with their European equivalents. European surface AESA radars tend to be less expensive, but also less capable than their U.S. counterparts. The level of technical expertise in Europe is quite high. Technology transfer and import/export regulations in the AESA domain are historically problematic barriers to effective cooperation and competition with non-U.S. companies.

Airborne AESA Domain

The U.S. has two AESA suppliers – Raytheon and Northrop Grumman - vigorously engaged in the airborne market. These companies will produce a large number of radar sets over the next 10 years for a variety of new production and retrofit programs. Both companies will be developing new systems for either retrofit on existing aircraft or installation on new production aircraft. One of the two U.S. companies has a minimal share of this market, consisting of an upgrade to a currently operational radar system. The total market value over the span 2013–2022 is anticipated to be $13.4 billion, which represents almost half of the $27.5 billion projected global AESA market for that time period.

Manufacturing and Advanced Technology Efforts

Advanced research in key areas of AESA technology continues both within DoD and commercially. System engineers are using advanced computing power and RF design techniques to improve performance at the system and physics level of AESA radars. The design community is increasingly using open systems architecture concepts to produce modular radar designs that are easier to upgrade as component technologies improve.

Advances in the materials science of solid-state amplifiers indicate increased producibility and commercial viability of gallium nitride (GaN) devices. Similar technologies that can be adapted to the current industrial base processes, such as the maturation of Aluminum Gallium Nitride (AlGaN)-based transistor production, point to a technology path appropriate for maintaining the current industrial base.

4.2.2 Command, Control, Communications, and Computers (C4) Sector Summary

A wide variety of vendors are qualified to design and build an array of defense products within the C4 industrial sector. A robust global commercial electronics industrial base supports these vendors. Second-tier suppliers of assembled components tend to serve both commercial and defense customers. Third-tier suppliers of individual components, such as integrated circuits, frequently supply identical products for both commercial and defense use. At the fourth-tier, such as design tools and reused intellectual property, there is frequently minimal awareness of the final end use in defense products. In essence, the C4 industrial base upon which the Department typically relies is largely global below the prime contractor tier.

An S2T2 FaC assessment was conducted on the WIN-T Inc 1 program. The results indicated the number of fragile and critical capabilities in the WIN-T Inc 1 program were rare. This was largely due to the fact that WIN-T is intentionally based upon commercial technology. The WIN-T study highlighted the fact that FaC capabilities cover more than just manufactured products or the industrial base companies, but they also include personnel skill sets. Accordingly, the MIBP S2T2 working group is implementing lessons learned from the WIN-T assessment by increasing focus on the skill set thread in its future S2T2 assessments. One of those follow-on assessments was conducted in 2013 at the Tobyhanna Army Depot (see Annex B, page B-23). In addition, it was noted that issues with Tungsten-Rhenium wire that have been previously identified elsewhere (see Annex B, page B-44) could have an impact on WIN-T Inc 1.

The global and commercial nature of this sector of the industrial base, coupled with the impracticality of thoroughly testing all elements of electronic hardware and software, makes supply chain management and anti-counterfeiting efforts particularly important to this defense sector. The Department is undertaking a number of risk-based initiatives to assure security of the C4 supply chain,including the implementation of a Supply Chain Risk Management (SCRM) methodology.

Another ongoing concern for the Department is the trustworthiness of software in information systems, communications systems, and embedded systems. The Department is undertaking an important initiative in this area in accordance with Section 925 of the FY 2013

NDAA that addresses "Improvements of Security, Quality, and Competition in Computer Software Procured by the Department of Defense."

4.3 Ground Vehicles Sector Industrial Summary

Over the last decade, the ground vehicle industrial base has responded extremely well to increased demand in support of the wars in Iraq and Afghanistan. However, as anticipated and forecast in last year's report, future demand for ground vehicles and funding within this sector has been reduced. The anticipated DoD budget for ground vehicles was reduced by approximately 15 percent for FY 2015-2019. Exacerbated by sequestration and declining DoD budgets, this trend is expected to continue. With these budget realities, the Services have focused investments on modernizing and upgrading the current proven vehicle fleets and delayed new development. This has resulted in no "new" development programs in the Combat Vehicle sector (Armored Multi-Purpose Vehicle and PALADIN Integrated Management acquisition strategies are to leverage demonstrated technology). This environment compels the Department to deliberately evaluate and resource the critical industrial base capabilities necessary to both maintain the legacy fleets and develop future generations of military ground vehicles.

"Sustaining U.S. Global Leadership Priorities for 21st Century Defense,"[2] published in 2012, anticipates continued reductions in defense spending and a smaller, leaner, and more agile military force. While declines in the military ground vehicles sector are expected, companies that service both the commercial and military markets (dual-use) are expected to fare better than those in military-unique niches. In contrast, companies whose portfolios have no commercial applicability or lack an ability to diversify will likely have to close or consolidate facilities or face a complete shutdown. Some suppliers for combat tracked vehicles potentially manifest more risk based on their defense unique characteristics. S2T2/supplier risk data-collection and analysis will help to target industrial base assets/partners at critical and fragile sub-tier niches to mitigate the risks of single-points of failure that would be costly to reconstitute.

As future budgets are increasingly constrained, investments in ground vehicle acquisitions and research and development (R&D) are likely to be reduced. The military vehicle industrial sector faces a number of industrial base challenges, including retaining critical design and integration engineering talent and sustaining critical suppliers in the sub-tier industrial base. The Services, MIBP, and other stakeholders continue to monitor and assess these segments of the ground vehicle industrial base to identify at-risk capabilities.

In support of the Combat Vehicle industrial base, the Army commissioned a study to analyze the Combat Vehicle supply chain using a S2T2 approach to identify critical and fragile elements of the commercial industrial base through engagement across the public and private sectors. The comprehensive study of the supplier base and critical manufacturing skills within the overall combat vehicle industrial base network assessed critical manufacturing

[2] http://archive.defense.gov/news/Defense_Strategic_Guidance.pdf [Accessed March 2016]

capabilities and determined options to reduce manufacturing risk within the entire combat vehicle enterprise through responsible and targeted investment (Reference: Army's Industrial Base Baseline Assessment, Annex B, page B-17.) In summary, the report identified only a small number of suppliers and skills as a significant industrial base risk requiring DoD mitigation. Additionally, the Army will conduct an assessment of the Tactical/Wheeled Vehicle industrial base in mid/late FY 2014 to determine any potential mitigation necessary in this sub-sector of the military ground vehicle fleets and to mitigate the risks of losing critical industrial capabilities.

The wars in Iraq and Afghanistan created a significant surge in the development and production of military vehicles and related modification programs to add advanced technology to both tactical and combat vehicles. Additionally, the necessary post-combat overhaul and reset of military vehicles contributed to the sustainment of the unique manufacturing capabilities and supporting supply chains. These efforts and investments have resulted in a relatively good state of readiness for the established ground vehicle fleets. However, the current environment of reduced DoD budgets and the relatively good state of readiness for the legacy ground vehicle fleets will likely result in a continued trend of reduced investments. The probable result in the ground vehicle industrial base sector is a continuation of supplier consolidation or market exit and the unavoidable loss of some unaffordable, military-unique industrial capabilities. The Department will continue to monitor these potential at-risk areas through S2T2 industrial base assessments and will consider mitigation necessary to preserve critical suppliers and skills that may be adversely affected by the reduced demands.

4.4 Materials Sector Industrial Summary

Access to the basic materials required for producing finished products and intermediate products and components—including robust and diverse materials supply chains—is integral to the nation's manufacturing base and the nation's overall economic and national security. Typically, materials supply chains rely on considerable international trade, including basic raw material inputs through intermediate and fabricated materials products. However, there are a range of actions worldwide which distort supply chains, such as export controls that distort trade patterns and price structures as well as differing approaches to the regimes governing mining activities. Generally, the requirements of the defense industrial base represent a small percentage of overall U.S. demand for materials, such that U.S. consumption and supply chains are focused on serving the needs of the commercial sector. Therefore, maintaining a vibrant commercial manufacturing base is essential to the health of the defense industrial base. The Department closely monitors industries in which certain materials required by the defense industrial base there may not be a strong demand impetus from the commercial sector.

Among the many materials required by the defense industrial base, the availability of rare earth materials continues to garner considerable concern. Since the Department's initial rare earths report to the Congress in 2011, the Department observes that market supply and demand conditions overall have significantly improved in the United States and internationally.[3]

[3] Department of Defense, "Interim Report, Assessment and Plan for Critical Rare Earth Materials in Defense Applications," from USD (AT&L) to the Congress, August 2011.

However, with regard to U.S. capabilities, despite significant improvements over this time period, gaps remain in the domestic supply chain. For instance, facilities in China, Europe, Japan, the Philippines, and Vietnam maintain roles in the complex supply chain that provides intermediate and finished rare earth products to the U.S. market.

The overall demand and prices for rare earths have decreased significantly, coupled with increased supply available, including material surpluses and diversification in production.[4] The Department notes that the supply of rare earth materials for U.S. defense acquisition programs is not presently disrupted. Based on findings of the "Strategic and Critical Materials 2013 Report on Stockpile Requirements," submitted to Congress in January 2013, the Department also estimates no shortfalls of rare earth supplies of ores and concentrates for U.S. defense demand through 2015-2018. This report, however, did estimate a U.S. defense shortfall for a rare earth oxide used in lasers for certain weapons systems. To mitigate this estimated shortfall, the Department sought authorization to create a stockpile of the material, which Congress authorized per the FY 2014 NDAA. There also have been relative improvements in the availability of much less commonly used (albeit still very important) heavy rare earth elements, including those used in the production of phosphors for lighting products and displays, as well as those used as additives in specialized materials such as crystals for lasers, dopants in magnet alloys, and stabilizers for high temperature jet engine component coatings and ceramics for fuel cells.

Although rare earth materials are widely used within the DIB, such end uses represent a small fraction of total U.S. consumption. Therefore, as it does with most materials, the Department looks first to the market to mitigate rare earth supply risks. Indeed, the market has responded to mitigate the risks that were seen at the time of the Department's 2011 study, which outlined its rare earth risk mitigation strategy (e.g. developing new and diverse sources of supply and reducing demand by developing substitutes and product designs that use less or no rare earth material). However, when conditions warrant, the Department takes direct action to further mitigate such risks. Such actions may include investing in assured production or materials processing capabilities, establishing secure inventories of materials or parts, and/or establishing additional qualified defense material suppliers.

In addition to the developments previously noted, there have been other significant market changes on the supply side that have benefited consumers of rare earth materials since late 2010. For instance, U.S.-based Molycorp completed Phase I of the revitalization and expansion of its Mt. Pass rare earth mine and processing plant in California and is ramping up to full production with a total rare earth element oxide annual production capacity of 19,050 metric tons. The company has continued to expand and diversify its other rare earth production capabilities in the United States and internationally. Actions include acquisitions, joint ventures, and other key supplier arrangements throughout rare earth supply chains in Asia, Europe and North America.

Another very significant supply-side development for U.S. buyers and consumers of rare earths involves a recent rare earth magnet production plant owned by the Japanese-based firm Hitachi that is opening in the United States. This new manufacturing facility in North Carolina

[4] *The Global Rare Earths Industry: Poised for Growth*, by Dudley J. Kingsnorth, November 2012.

has production capacity and capabilities to produce large quantities (relative to the needs of the DIB) and diverse grades of high-performance, sintered Neodymium-Iron-Boron rare earth magnets.

Other positive rare earths supply-side developments underway in North America include the ongoing exploration and development of several new rare earth mining and processing ventures in the United States and Canada, including the Bear Lodge deposit in Wyoming, which may possess one of the highest-grade known europium (used in phosphors) deposits known worldwide. The Forest Service currently is reviewing the project's environmental impact statement, and the company, Rare Element Resources, has a goal of commissioning the project in late 2016.

On the demand side, there was a 11.8 percent decline in the overall global demand for rare earths from 2010 to 2013, and earlier forecasted growth in demand through 2016 has been revised downward.[5] The Department of Defense projects almost no growth in U.S. defense demand for rare earths between 2015 and 2018.[6]

The demand for rare earths has changed in a number of significant ways that has provided additional benefits to buyers and consumers of these materials. Specifically, important segments of the demand for rare earths have essentially been eliminated or greatly diminished, easing the overall demand for rare earths. Pressures on the demand for rare earths declined because of a number of factors, including private sector market responses to develop substitutes for rare earths as well as other efforts to reduce demand. Examples include designing products that are less dependent on rare earths, replacing the use of scarce heavy rare earths with more widely available light rare earths, re-using rare earth polishing materials, and, in certain cases, doing away with or minimizing the use of rare earths in products (e.g., increased use of light emmiting diode (LED) lighting means less demand for yttrium).

The Department actively assesses current and future rare earth supplies and DoD-wide demands (the next Report on Stockpile Requirements to the Congress will examine demand through 2020), supports R&D, and maintains authorities to address supply concerns as they develop.

In addition to DoD, DOE's Critical Materials Institute and the NSF support research programs into rare earths that will provide benefits to the market. DOE established the Critical Materials Institute to help the United States avoid the impact of supply availability concerns for certain materials—including rare earths—by developing technologies that will make better use of the materials as well as eliminate the need for materials that are subject to supply disruptions.

[5] Curtin-IMCOA, *Rare Earths Quarterly Bulletin #5*, by Dudley J. Kingsnorth, June 2013;*The Global Rare Earths Industry: Poised for Growth*, by Dudley J. Kingsnorth, November 2012.
[6] 2013 Report on Stockpile Requirements

4.5 Munitions and Missiles Sector Industrial Summary

The munitions and missile industrial sector is comprised of DoD's smart bombs, tactical (cruise missiles, air-to-air, air-to-ground), missile defense, and strategic missiles, as well as dumb bombs, ammunition, mortars, and tank rounds. The munitions and missiles industrial sector is primarily a defense-unique industrial sector. Since most/all of the major issues lie within the missile industrial base, dumb bombs, ammunition, mortars, and tank rounds, are not included in this report.

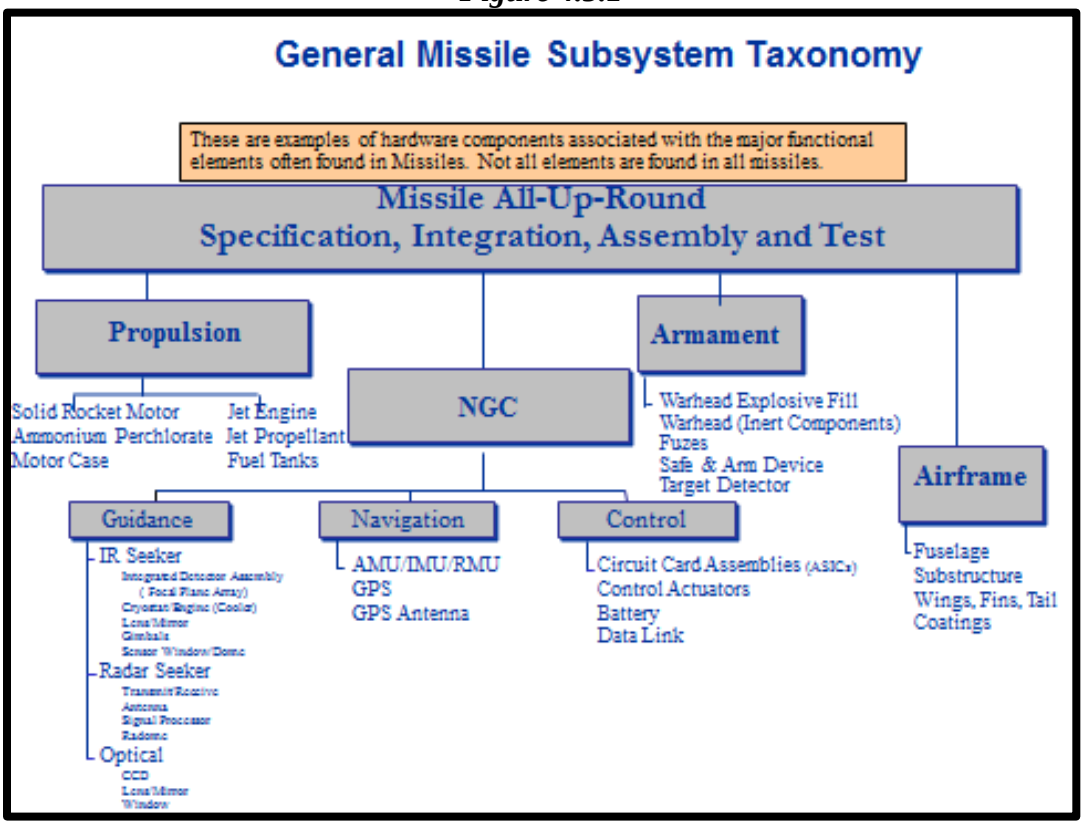
The Department provides the necessary resources to the industrial sector to ramp up production for munitions and missile systems to support Warfighter needs when the country is engaged in conflict, and it reduces the resources when the conflict ends. This cycle of rapid ramp-ups followed by precipitous declines of demand and production adds significant capacity management challenges to munitions and missile suppliers and their critical sub-tier suppliers. While all industrial sectors are challenged by rapid changes in DoD demand, this ramping up and down based on global conflicts increases risk for defense-unique industrial sectors at the sub-tier supplier level because many do not have the diversity of programs or products from other non-defense markets to support their design and production skills, and the sub-tier suppliers do not have the backlog of business.

Over the past decade, the munitions and missile sector has provided limited new-start missile opportunities and is currently undergoing a decline in procurement. Therefore, the design and production skills for critical components within the missile sector industrial base are at risk. The loss of this design and production capability could result in costly delays, unanticipated expense, and a significant impact to many current and future missile programs, damaging the readiness of the Department.

4.5.1 Background

The general missile taxonomy shown in Figure 4.5.1 breaks the missile into four functional areas: propulsion, armament, airframe, and navigation, guidance, and control (NGC). In the propulsion area, most missiles use a solid rocket motor (SRM). The size of these motors can range from 2.75 inches to as large as 83 inches for some strategic and ballistic missile defense systems. Some tactical missiles, like the Tactical Tomahawk, use a jet turbine fan engine. The major distinction for the warhead is either nuclear or conventional. The airframe area includes the fuselage, wings, fins, tail, and substructures. The airframe materials for these components range from aluminum to complex composites. The NGC area, in many cases, comprises the most expensive components of the system (mostly missile seekers).

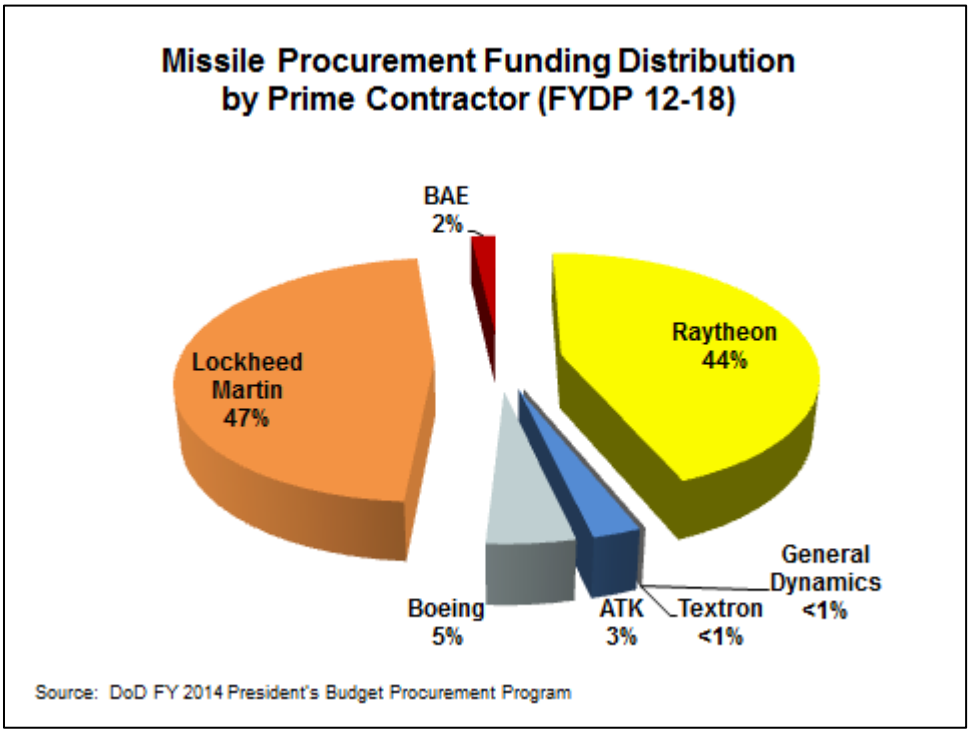
Figure 4.5.1



Prime Contractors

Since the end of the Cold War, the munitions and missiles development and production market has declined, resulting in aggressive competition for limited new program opportunities. Within the munitions and missile sector, two prime contractors, Raytheon Missile Systems (a division of Raytheon Company) and Lockheed Martin Corporation account for roughly 90 percent of the Department's munitions and missile procurement funding, as indicated in Figure 4.5.2. These prime contractors provide a full complement of missile types across the munitions and missiles sector and, for the most part, are able to meet defense-unique technical performance requirements, but not without concerns. Roughly half of the Department's munitions and missile production programs are operating at facility utilization rates equal to or less than fifty percent. DoD's prime contractors and their associated sub-tier supplier base must align company production capacities with expected DoD budget realities while ensuring the industrial capabilities needed for the next generation weapon systems are sustained.

Figure 4.5.2



4.5.2 Sustaining Design and Engineering Industrial Capabilities

Most current missile development activity consists of modifications to existing missile systems, such as the AIM-9X Block II, PAC 3 Missile System Enhancement (MSE), Advanced Anti-Radiation Guided Missile, and Standard Missile-6 (SM-6). Most of the research and development funding in the munitions and missile sector is associated with legacy program upgrades or modifications, which limit competitive opportunities. The limited number of new missile development programs inhibits the Department's ability to fully exercise the industrial capabilities necessary—from design concept, system development, and production—to meet current and future national security needs. The Long-Range Anti-Ship Missile (LRASM) and the Joint Air-to-Ground Missile (JAGM) are the only "new" missile development programs in competition. After being restructured as a technology development program, the JAGM program now reflects a front-end modernization for the Hellfire missile. The Navy is conducting a Capabilites Based Assessment for a follow-on to the Tactical Tomahawk Cruise Missile program and is updating an Analysis of Alternatives to inform a potential follow-on to LRASM (Navy Offensive Anti-Surface Warfare (OASuW)/Increment II). (Both programs may be combined into a single Next Generation Strike Capability development program.) The Air Force is studying options for a follow-on to the Air-Launch Crusie Missile in support of their next generation bomber program. Additionally, ship defense missiles are migrating to active seeker capability leveraging a common guidance section architecture from the Advanced Medium-Range Air-to-Air Missile (AMRAAM) C-7 to SM-6 Block 1 and Evolved SeaSparrow Missile (ESSM) Block 2. This family of missiles approach helps to mitigate the lower production quantities and leverages previous developments to reduce cost and efficiently utilize the missile design engineering capabilities.

An indication of the concern for strategic missile design engineering capabilities can be seen as the newest DoD strategic missile in the U.S. inventory, the Trident D5 missile, began its development in 1978, and the oldest, the Minuteman III, began its development in 1964. The Department remains concerned that the design engineering capabilities needed for tactical and nuclear weapon systems may not be readily available should the sector atrophy in the absence of a long-term demand signal. Table 4.5.3 provides a sampling of U.S. missile programs, their dates of development, and their current program variants.

Table 4.5.3

DoD Missile Program Updates			
Missile Program	Development Started	Production or Delivery Started	Current Variant
AIM-9 Sidewinder	1946	1953	AIM-9X
AMRAAM	1979	1988	AIM-120D
Hellfire	1974	1982	AGM-114R
TOW	1963	1968	TOW-2B
Patriot	1969	1981	PAC-3 MSE
Standard Missile	1963	1967	SM-6
Trident D5	1978	1987	D5
Minuteman III	1964	1968	MM III
Tomahawk	1970's	1983	Block IV
JASSM	1995	2001	JASSM-ER

Desite some improvements, there remains a contraction in the munitions and missile development and procurement market that has created a thinning of expertise in defense-unique technologies in both the contractor and federal government workforces. Declining munitions and missiles research and development funding, coupled with limited competitive opportunities projected in the near-term for new munitions and missile systems, may make it difficult for the missile sector industry to attract and retain a workforce with the industrial capabilities to design, develop, and produce future missile systems that will meet national security requirements.

4.5.3 Fragility and Criticality Missile Assessment: Sustaining our Sub-tier Suppliers

The munitions and missile industrial sector is routinely impacted by significant shifts in DoD demand as a result of various factors, but mostly due to the initiation or drawdown of conflicts. The Department is concerned with the ability of our munitions and missile prime contractors to manage and sustain critical sub-tier suppliers during these shifts in demand. Some of these critical sub-tier suppliers are single or sole-source providers, and some are foreign. As the Department draws down its operations overseas, it is monitoring the impact of reduced demand on the sub-tier supplier base through continuing S2T2 assessments of the DIB in close cooperation with the MILDEPs. The Department expects to identify a growing number of

industrial capability risk areas as sub-tier suppliers realign and adjust their industrial capacities to new DoD budget realities.

Due to the recent budget uncertainty, the USD(AT&L) asked MIBP to determine where the Department's acquisition decisions might damage the DIB. In response, MIBP performed a FaC assessment of the missile industrial sector. MIBP collaborated with the DoD Fuze IPT and the Critical Energetics Material Working Group for valuable industry and product information in their respective industrial sectors. The health of sub-tier suppliers in defense-unique fields is a serious and valid concern. Important defense unique sub-tier components in the munitions and missile industrial segment that continually face excess capacity challenges include thermal batteries, solid rocket motors, fuzes, jet engines, inertial measurement units (IMUs), global positioning system (GPS) receivers, seekers, and warheads. The suppliers that provide these components are used on multiple programs, and some of these components require 12 months or more to manufacture. Some of these sub-tier supplier products have broader utility and commercial applications that provide a more reliable and stable market base to sustain industrial design and production capabilities—such as the IMUs, GPS receivers, and seeker product sectors—while others are more unique to the munitions and missile industrial sector.

As DoD budgets become strained by continued budget uncertainty and higher priority needs like operational readiness, aircraft, and ship procurements, investments in munitions and missile R&D and procurement may be further reduced. The results of the Missile FaC assessment confirmed previously known industrial base challenges. These challenges fall into two broad categories; (1) sustaining our design and engineering teams and (2) sustaining the sub-tier supplier base.

The Missile FaC assessment identified the following areas as those with the highest risk:

- *SRMs*: SRMs are predominantly defense-unique items upon which the Department depends. The certainty of demand is at-risk because munitions and missiles are often used as bill-payers in fiscally constrained environments. The challenge is the high cost for reconstitution should the SRM industry encounter a significant production gap, particularly in the large (over 40-inch diameter) segment of the market. NASA's retirement of the Space Shuttle and the transition of the Constellation program to the Space Launch System have resulted in significant under-utilization of existing capacity.

- *Thermal Batteries*: All DoD missiles and Precision Guided Munitions use thermal batteries. Thermal batteries are predominantly defense-unique items and the domestic thermal battery industry has historically been dominated by one company with little participation by other firms. The other domestic companies that produce thermal batteries constitute less than 20 percent of the DoD thermal battery market. The dependency on a dominant supplier of thermal batteries makes this industry at-risk.

- *Missile Seekers*: Missile seekers are defense-unique systems that offer a technologically advanced capability. Mostly, missile prime contractors design and produce seekers in-house due to their complexity. Seeker design is regarded as a core competency. Advanced engineering design skills are needed for integration with host platforms,

missile guidance and control, integration of multiple seeker technologies on a single missile, as well as hardware and software to defeat countermeasures, reject clutter, and perform automatic target recognition. The FaC assessment team determined that the missile seeker industrial sector required additional information for further assessment. MIBP is performing a FaC assessment on this important sector.

- *Target Detectors*: Target detectors use active radio frequencies or laser technologies that are critical for anti-aircraft and anti-armor missiles. When used against aircraft, they calculate the closest point-of-intercept; against armored vehicles, they allow penetrators to fire through the thinner armor on top of the vehicles. Further study of the target detector industrial sector is needed to better assess fragility.

- *Small Turbine Fan Engines*: The Department relies on the viability of a small number of turbine fan engine providers to sustain propulsion technology and design engineering skills. Decreased Navy Tactical Tomahawk cruise missile production quantities (and the potential for future production quantity reductions), few new-start missile or upgrade programs that develop new propulsion systems, and constrained future R&D technology investments threaten the viability of the missile propulsion technology and engineering capabilities. Developments in foreign nations have led to higher speed, longer range weapons and advanced air defense capabilities abroad. These increased capabilities will compel the United States to pursue improved standoff, survivable and responsive missiles. Without sustainment of the existing missile propulsion industrial base, future development of missile programs could be delayed by 5 to 10 years or more while the propulsion design and engineering capabilities are reconstituted. Preserving the existing national missile propulsion capability, with an emphasis on the design engineering team, is of utmost importance.

As referenced earlier, MIBP collaborated with the DoD Fuze IPT to obtain fuze sector information and assess the fragility and criticality criteria. Fuzes are defense unique items. They are used on all munitions and missile programs. While funding for munitions has remained healthy over the last 10 years, continued improvements in guided systems significantly reduced the quantity of fuzes required for our current and future systems. This has contributed to an excess capacity in the fuze sector. Excess capacity limits manufacturers from being cost competitive and sustaining a viable design engineering cadre. The U.S. currently has three full-capability fuze design manufacturing suppliers. The fuze prime contractors are aggressively managing several defense-unique sub-tier component areas, such as electronic energy devices (e.g., bellows actuators), liquid and thermal reserve batteries, and certain obsolete electronic components to ensure their ability to design and produce fuzes in the future.

MIBP also collaborated with the newly-chartered Critical Energetics Materials Working Group to assess missile energetic materials. Examples of domestic and foreign source supplier issues are highlighted below:

- *Ammonium Perchlorate (AP)*: One U.S. supplier for AP remains for the SRM industry (both small and large diameter systems). The size and grain of the AP used in defense applications is unique to the SRM market. Demand for production of AP is well below

historic levels and approaching the minimum sustaining rate (MSR). Volumes have fallen so low that there is a risk that the vendor may not be able or willing to sustain its workforce skill levels and the supply chain while remaining competitive. The Department initiated an effort to explore mitigation options to reduce the industrial base concerns with the important ingredient for SRMs.

- *Butanetriol (BT)*: The Department has been dependent on a foreign source for BT since 2008. Butanetriol, identified on the U.S. Munitions List (USML), is a chemical precursor needed for production of butanetriol trinitrate (BTTN), a nitrate ester/plasticizer (part of the binder) used in the production of SRMs for the Army's Hellfire, TOW-2, Griffin, and Javelin missile systems. The previous BT source discontinued production of the chemical in 2004. At that time, the Department's BTTN provider acquired the remaining inventory and began looking for another supplier. In 2007, the Army conducted a global search for sources of BT. Only one source was identified that could produce the quantities and quality required. However, Section 1211 of the FY 2006 NDAA prohibits the acquisition of items listed on the USML from companies such as this producer. The Secretary of the Army signed a waiver in 2008 to prevent a production gap until the Department could develop a domestic source. The U.S. Army qualified a new domestic source for BT in FY 2013. In FY 2014, the Department used the IBAS Fund to fund the transition of the process for manufacturing BT from a developmental "Pilot Line" to a production-scale capability with the capacity to meet the Department's program requirements.

- *Triaminotrinitrobenzene (TATB)*: TATB is one of the least sensitive explosive materials known. This material is predominantly used in PBXN-7 (polymer-bonded explosive) and PBXW-14 for fuze applications. TATB has not been produced since 2006. The Department awarded the TATB Phase I Mod and Phase II Facilitization contracts in July and August of 2011. The TATB plant design completed earlier this year is based on the Benziger process and leverages existing infrastructure. Process prove-out, completion of consecutive specification compliant production runs and formulated production scale batches of PBXN-7/PBXW-14 have been completed. TATB and PBXN-7 have been qualified. The data package for the qualification PBXW-14 has been submitted to the Naval Surface Warfare Center, Indian Head Explosive (NSWC IHD) Ordnance Disposal Technology Division for approval.

- *Antimony Sulfide*: Antimony sulfide is a component of energetic compositions used in percussion primers and several fuze/detonator ignition trains that support over 200 DoD munitions. It is also an industrial commodity material used commercially to manufacture flame retardant plastics and textiles. Antimony sulfide is refined from stibnite ore that is mined underground. Large deposits of stibnite ore are rare in the earth's crust, and there are no known mines producing acceptable grade ore under United States or NATO partner control. China is the largest producer of antimony sulfide and controls its availability on the world market. The Army Research and Development Engineering Center (RDECOM) has ongoing efforts to identify and qualify alternative percussion primer compositions that do not contain antimony sulfide or other similar materials that are foreign-dependent or environmentally undesirable.

4.5.4 Deputy's Management Action Group

During the fall 2013 budget review process, the USD(AT&L) asked MIBP to lead a DMAG on the industrial base. The Department is concerned with the potential impacts of sequestration and the resulting budget realities on our defense industry. The results and information from the Missile FaC, the Fuze IPT, and the Critical Energetic Materials Working Group (CEMWG) provided the supporting data to identify the key missile industrial base areas of concern and the technical details necessary to develop mitigation plans to reduce the industrial base risks. During the DMAG review, the Department obtained a better understanding of the adverse impacts that the proposed budget acquisition decisions would have on the missile industrial base. Based on our analyses, we identified industrial base concerns in the fuze, thermal battery, and solid rocket motor industrial sectors. Two of the FY 2014 IBAS projects help mitigate SRM industrial base concerns: the BT production-scale capability and the solid divert and attitude control project. The President's FY 2015 budget submittal includes funding in the IBAS to support fuze and thermal battery industrial base mitigation projects.

4.5.5 Missile Sector Bottom Line

While many industrial sectors that support our national security requirements are supported by the commercial markets, the munitions and missile industrial sector is mostly defense-unique. As constrained DoD budgets become further strained by higher priority programs, investments in missile research and development and procurement may be more challenged. The munitions and missiles industrial sector already faces a number of challenges, which generally fall into two broad categories: (1) sustaining design and engineering teams and (2) sustaining sub-tier suppliers. Most of the R&D funding in the missile sector is associated with legacy program upgrades or modifications, which limits competitive opportunities and our ability to fully exercise the industrial capabilities necessary in the missile industrial base to meet current and future national security needs. The Department is concerned with the ability of our munitions and missile prime contractors to sustain critical sub-tier suppliers. The munitions and missile industrial sector is routinely impacted by significant shifts in DoD demand as a result of various factors, but mostly the initiation or drawdown of conflicts. As the DoD missiles budgets decline, the Department will continue to implement its S2T2 initiative and expects to identify a growing number of industrial capability risk areas as the sub-tier supplier base struggles to align its industrial capacities with DoD budget realities.

4.6 Shipbuilding Sector Industrial Summary

The shipbuilding DIB is comprised of five shipyards owned by two major prime contractors (General Dynamics (GD) and Huntington Ingalls Industries, Inc (HII)), a number of second-tier shipyards, and lower-tier suppliers (components and subcomponents).

The shipbuilding sector remained relatively stable in 2013. However, the potential impact of additional budget cuts to existing contracts and to future acquisition programs continues to be a concern. Given the dependence of this sector on defense contracts to maintain a skilled workforce and infrastructure, reductions in quantity and/or fleet composition may threaten the

viability of some of the shipyards and their suppliers and may reduce the benefits that could have been obtained through competition if quantities were higher.

Fortunately the combination of new Navy and other government agencies' procurement and maintenance programs, combined with commercial ship construction, will help support the shipbuilding sector. Per the Future-Years Defense Program, the Navy plans to begin the detailed design for the replacement of five aging ship classes. Two new amphibious programs [LHA 8 and L(X)-R], the fleet replenishment oiler program [T-AO(X)], the fleet ocean tug program [T-ATF(X)], and the Ohio Replacement (OR) program, will provide both design and production workload for the winning shipyards. Table 4.6.1 depicts the expected lead ship award dates and planned procurement quantities. Where practical and to the extent possible, competition is a key tenet of the acquisition strategy for these ships, as it translates into higher efficiency and cost savings for the Department.

Table 4.6.1: Future Navy Programs (based on FY 2015 procurement plan)

Program	*Lead Ship Expected Date*	*Planned Procurement Quantity*
Fleet Replenishment Oiler (T-AO(X))	FY16	17
Fleet Ocean Tug Replacement (T-ATF(X))	FY17	4
Landing Helicopter Dock (LHA 8)	FY17	3
Dock Landing Ship (LSD) 41/49 Class Replacement (LX-(R))	FY20 *	11
Ohio Replacement Program (OR)	FY21 *	12

* Advance procurement (AP) funds provided in earlier year(s) for detailed design and/or long lead material

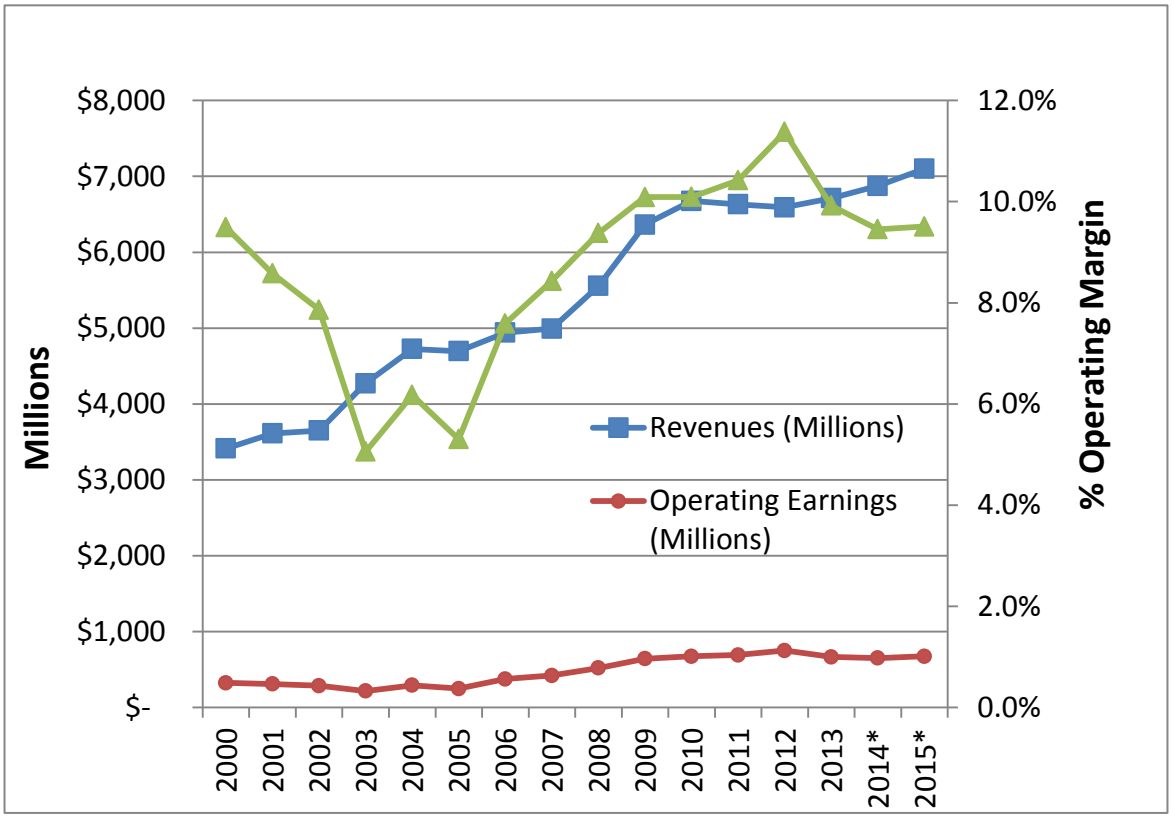
In addition, contracts for design and construction of ships for other government agencies and commercial customers are expected in the near future. For example, Bollinger Shipyards Lockport LLC, Eastern Shipbuilding Group Inc., and General Dynamics-Bath Iron Works (GD-BIW) were awarded an initial design contract for a new United States Coast Guard (USCG) program to build offshore patrol cutters (OPCs). After the initial design, the USCG will select one team to develop the detail design and build up to 11 ships out of the 25 ships planned. In September 2013, the USCG exercised a contract option with Bollinger Shipyards for production of six Sentinel-class Fast Response Cutters (FRCs). The six FRCs under this option will be delivered in 2016. On the commercial side, in February 2014, Seabulk Tankers, Inc., entered in a contract with DonJon Shipbuilding (barge construction) and BAE Systems (tug construction) for the construction of one 185,000 barrel coastal chemical and petroleum Articulated Tug and Barge unit. Delivery is expected in the first half of 2016.

General Dynamics – Marine Systems (comprised of Bath Iron Works, Electric Boat, and NASSCO (formerly National Steel and Shipbuilding Company)

General Dynamics Marine Systems reported a 1.8 percent increase in revenues and an 11 percent decrease in operating earnings compared to 2012. GD-Marine Systems leadership indicated that the earnings decline against the previous year's operating profit was due to the end of the Lewis and Clark Class dry cargo ship program in 2012. GD Marine Systems' operating margin was 9.9 percent in 2013, 0.9 percent higher than the company prediction. Long-lead material for Virginia Class Block IV submarines (SSN) and design work on the Ohio

Replacement Ballistic Missile Submarine were some of the main causes for backlogs in 2013. The GD-Marine Systems group is forecasting a revenue growth of 2.5 percent and a margin rate of 9.5 percent in 2014. Figure 4.6.2 shows GD-Marine Systems' financial results in the last 13 years and includes January 2014 projections for 2014 and 2015.

Figure 4.6.2: GD-Marine Systems Financial Results per Year (revenues,operating earnings, and operating margin).



*Source for 2014 and 2015 projections: Cowen and Company, January 2014
Annual Report / InfoBase

GD-Electric Boat (GD-EB) is the prime contractor for the Virginia Class submarines. GD-EB, in partnership with HII Newport News Shipbuilding had delivered ten of 18 Virginia Class submarines. The anticipated delivery date of the next ship of the class, SSN 785, is May 2015. There are six (SSN 786-791) boats still to be delivered as part of the Block III FY 2008-2013 multi-year procurement (MYP) contract with submarine deliveries scheduled through 2018. In FY 2014, the Navy awarded a MYP contract for ten VIRGINIA Class Block IV boats (SSN 792-801).

GD-EB is also the prime contractor for the OHIO Replacement submarine's design, and functions as a lead-design yard. HII-NNS supports the design process under contract as a subcontractor to GD-EB. The Navy's procurement strategy for the OHIO Replacement is still in development.

GD-NASSCO is constructing the Mobile Landing Platform (MLP) auxiliary support ships for the Navy and has contracts for nine commercial ships. MLP 1 was delivered in 2013, and MLP 2 will be delivered in 2014. MLP 3 is under construction and will be modified and built as an Afloat Forward Staging Base (AFSB), with delivery planned in summer 2015. The contract for MLP 4 (built as an AFSB) will be awarded in December 2014 with delivery planned in 2017. The President's Budget (PB) FY 2015 added a fifth MLP (built as an AFSB) in FY 2017. GD-NASSCO is also under contract to provide early industry support for the LHA 8, T-AO(X), and L(X)-R programs.

GD-NASSCO continued its partnership with a design firm in South Korea to design commercial containerships and tankers. GD-NASSCO re-entered the commercial shipbuilding construction business with contract awards in late 2012 and 2013. It was awarded a contract for the construction of two liquefied natural gas (LNG) powered containerships and seven LNG conversion-ready tankers. Construction of these commercial ships began in 2014 with deliveries scheduled from 2015 through mid-2017. GD-NASSCO's construction workload will drop off dramatically in 2017. Although this situation could be mitigated in the near future by additional commercial or government contracts (see table 4.6.3), the risk of a production disruption should be monitored.

GD-Bath Iron Workscontinues to build Arleigh Burke Class (DDG 51) and Zumwalt Class (DDG) destroyers. Seven DDG 51 Class ships have been awarded to GD-BIW. GD-BIW is also building three Zumwalt Class destroyers (DDG1000, 1001, and 1002). GD-BIW is also involved in the USCG OPC preliminary and contract design effort, along with two competitors, Bollinger Shipyards (Lockport, Louisiana) and Eastern Shipbuilding (Panama City, Florida).

Table 4.6.3.shows an Overview of GD-Marine Systems current workload (backlog).

Table 4.6.3: GD-Marine Systems workload overview

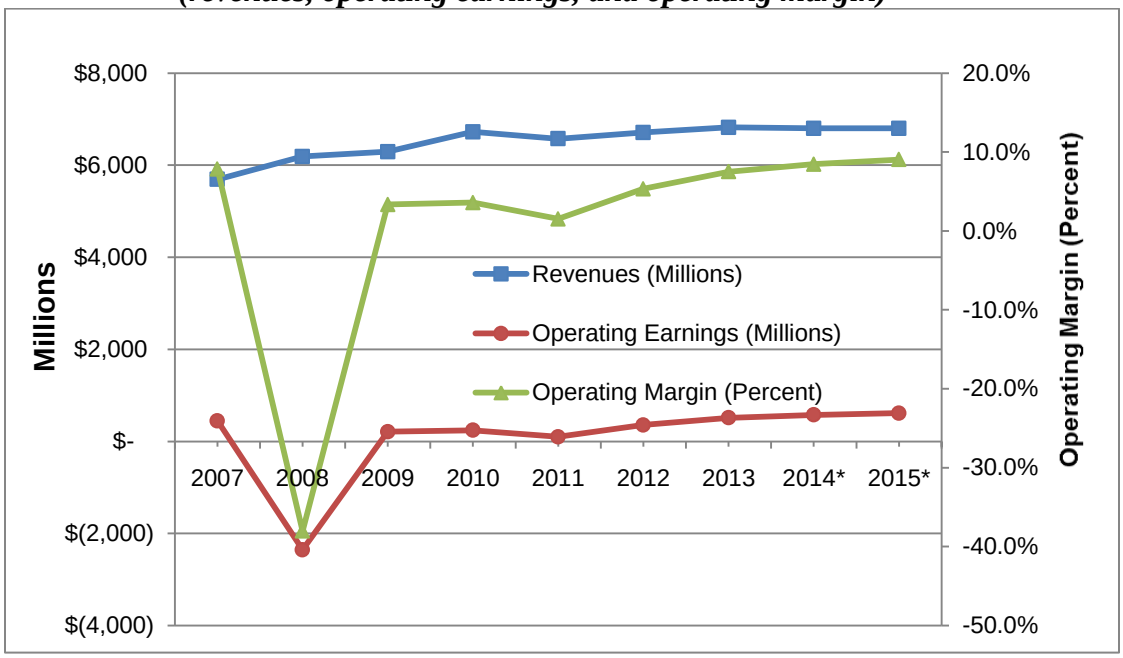
Program	*Customer*	*Ships awarded not delivered as of 12/31/2013*	*Additional Ships anticipated as 12/31/2013 (thru FY18) not yet awarded*	*Estimated Delivery Date of last awarded ship*
BIW				
Arleigh Burke Class Guided Missile Destroyer (DDG 51 Class)	Government: Navy	7	2	2022
Zumwalt Class Destroyer (DDG 1000, DDG 1001, DDG 1002)	Government: Navy	3	0	2018
Electric Boat				
Virginia Class Submarines (SSN 774 Class)	Government: Navy	16 in partnership with HII-NN (subcontractor)	2 in partnership with HII-NN	2018
NASSCO				
Mobile Landing Platform (MLP)	Government: Navy	2	2	2015
Liquefied Natural Gas (LNG) LNG Powered Container Ships	Commercial: TOTE	2	Unknown	2016
Liquefied Natural Gas (LNG) Conversion Ready Tankers	Commercial: American Petroleum Tankers (APT), Seabulk Tankers – SEACOR Holdings, Inc.	5 (APT) 3 (SEACOR – with option for 1 additional tanker)	Unknown	2017

(Data compiled with information from the FY 2013 Presidential Budget Submission and public websites)

Huntington Ingalls Industries, Inc. (compromised of Newport News and Ingalls Shipbuilding Divisions)

HII reported a 1.7 percent increase in revenues and 43 percent increase in operating earnings compared to 2012 (these numbers were calculated without adjustments related to hurricane insurance recoveries, impact of the Gulfport closure, or other factors). In the HII 2013 Results Report, the company's adjusted numbers showed a revenue increase of 1.6 percent and a total operating earnings increase of 29.9 percent when compared to the previous year. HII total operating margin was 7.5 percent without adjustments and 6.8 percent with adjustments for the year. According to HII 2013 earnings call, the operating margin increase was mainly attributable to the lower volume of underperforming contracts that they were working out of their portfolio and risk retirement on the the Coast Guard's National Security Cutter (NSC) program. Figure 4.6.4 shows HII financial results in the last 7 years (from 2007 through 2013) and includes projections for 2014 and 2015.

Figure 4.6.4: Huntington Ingalls Industries, Inc. Financial Results per Year (revenues, operating earnings, and operating margin)



**Source for 2014 and 2015 projections: Wells Fargo Securities, LLC estimates*
Annual Report / InfoBase

HII Newport News Shipbuilding (HII-NNS) is the sole shipbuilder of nuclear aircraft carriers (CVN) and teams with GD-EB in constructing the Virginia Class submarines. HII-NNS is currently constructing the lead FORD Class aircraft carrier, CVN 78, which is scheduled for delivery in March 2016. The detailed design and construction contract for CVN 79 is under negotiation and is expected to be awarded in FY 2015.

HII-NNS is the sole source maintenance provider for the aircraft carrier refueling complex overhauls (RCOH). The RCOH availability is performed once during a carrier's life cycle and includes refueling of the ship's nuclear reactors, as well as any significant repair, upgrade, and modernization work.

As described in the GD-EB section above, HII-NNS teams with GD-EB (the prime contractor) in constructing the VIRGINIA Class submarines and in providing design support for the OR program.

HII Ingalls Shipbuilding builds DDG-51 Class destroyers, LHA 6 Class, and LPD 17 Class Amphibious ships for the U.S. Navy, and National Security Cutters for the U.S. Coast Guard. The first ship of the U.S. Navy large-deck amphibious ships, LHA-6 America Class, is nearing completion, with delivery planned for April 2014. HII was awarded the follow-on ship construction contract for LHA-7, with delivery planned in 2018.

Along with GD-NASSCO, HII is also involved in design and affordability studies for the LHA 8, T-AO(X), and L(X)-R programs. HII Ingalls delivered LPD 24 and LPD 25 in December 2012 and October 2013, respectively; and is currently constructing the final two ships of the LPD

17 Class (LPD 26 and LPD 27) which are scheduled for delivery in 2016 and 2017. The restart of the DDG 51 program resulted in new awards for HII Ingalls, with construction underway of two destroyers scheduled for delivery in 2016 and 2017, and the award of five ships of the FY 2013-2017 multi-year procurement contract, which will provide workload to the shipyard through 2022. Having delivered the first three U.S. Coast Guard National Security Cutters, HII Ingalls is currently constructing the fourth, fifth and sixth ships and has been awarded a contract for the advanced procurement of long lead time material for the seventh and final ship of the Class.

HII's Ingalls Shipbuilding continues its planned consolidation of its shipbuilding activities from its Avondale, Louisiana, shipyard to its Pascagoula, Mississippi, facility. HII announced its intention to close its composite facility in Gulfport, Mississippi, after its composite work on DDG1001 and LPD 27 is completed.

Table 4.6.5: Huntington Ingalls Industries, Inc. workload overview as of December 31, 2013

Program	*Customer*	*Ships awarded not delivered as of 12/31/2013*	*Additional Ships anticipated as 12/31/2013 (thru FY18) not yet awarded*	*Estimated Delivery Date of last awarded ship*
Newport News				
Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78 Class)	Government: Navy	1	2	2016
Virginia Class Submarines (SSN 774)	Government: Navy	8 in partnership with HII-NN	10 in partnership with HII-NN	2018
Ingalls Shipbuilding				
Arleigh Burke Class Guided Missile Destroyer (DDG 51 Class)	Government: Navy	7	1	2022
America Class Amphibious Assault (LHA 6 & LHA 7)	Government: Navy	2	0	2018
San Antonio Class Amphibious Transport Dock (LPD 26 & 27)	Government: Navy	2	0	2017
National Security Cutters (WMSL 753 /754 /755 /756)	Government: US Coast Guard	4	0	

(Data compiled from the Presidential Budget Submissions and public websites.)

Second-tier Shipyards

The defense second-tier shipyards were stable in 2013. Second-tier shipyards are the primary shipbuilder of Littoral Combat Ships (LCS), the Joint High Speed Vessel (JHSV), and other support ships. The second-tier shipyards also construct and repair ships for other U.S. government agencies, as well as foreign governments via foreign military sales agreements. The Lockheed Martin-led industry team at Fincantieri's Marinette Marine Corporation and Austal USA are building the two LCS 1 and LCS 2 Classes, respectively. Both shipyards are building 10 ships each under the FY 2010-2015 Block Buy Award. The Navy is currently developing an acquisition strategy for procurement of the remaining eight ships (LCS 25-32) before

transitioning to a modified LCS, which will be designated as frigates for Hulls 33 and following. Austal USA is also building the JHSV Class, having delivered 2 of 10 ships under contract, with the third planned for delivery in March 2014. JHSV 4-6 are under construction.

VT Halter is constructing an oceanographic survey ship (T-AGS 66) with delivery planned for 2015. VT Halter is also supporting T-AO(X) affordability and trade study efforts. Dakota Creek Industries is constructing two oceanographic research ships, Auxiliary General Purpose Oceanographic Research Vessels (AGOR), AGOR 27 and AGOR 28. Both are expected to deliver in 2015.

Table 4.6.6: List of the defense sector second tier shipyards constructing ships for the U.S. Navy

Program	*Customer*	*Ships awarded not delivered as of 12/31/2013*	*Additional Ships anticipated as 12/31/2013 (thru FY18) not yet awarded*	*Estimated Delivery Date of last awarded ship*
Fincantieri - Marinette Marine Corporation				
Littoral Combat Ships (LCS 1 Class)	Government: Navy	10	FY16AF Acq Strategy is TBD	2019
Austal USA				
Littoral Combat Ships (LCS 2 Class)	Government: Navy	10	FY16AF Acq Strategy is TBD	2019
Joint High Speed Vessel (JHSV)	Government: Navy	8	0	2017
VT Halter Marine				
Oceanographic Survey Ships (T-AGS 66)	Government: Navy	1	0	2014
Dakota Creek Industries				
Oceanographic Research Ships (AGOR 27 & 28)	Government: Navy	2	0	2015
Table Reflects US Navy contracts only				

(Data compiled from various sources, including, but not limited to, public/government websites from January 2013 to January 2014.)

4.7 Space Sector Industrial Summary

The overall health of the U.S. space industrial base is good. The space industry continues to grow rapidly as space capabilities become pervasive in our everyday lives. However, the sector is primarily driven by the commercial market. This can be beneficial to the Department in that it can take advantage of commercial technology advancement, but it also can be detrimental for a number of reasons:

- As the space industry globalizes, companies continue to outsource certain capabilities that are produced more economically abroad.

- Budget declines or program cancellations force companies to reduce R&D spending, eliminate product lines, or go bankrupt.
- Industry shifts its product focus away from defense to commercial products where it can obtain better returns on invested capital.
- Environmental restrictions may prohibit production.

Therefore, the Department must remain vigilant to maintain critical capabilities that are specialized for military applications. This is particularly true for DoD space applications, which typically require cutting-edge technology and stringent requirements but often have very low production quantities when compared with commercial products.

4.7.1 Industry Health

According to the Space Foundation's annual 2013 Space Report, the global space economy grew by 7 percent in 2012 to $304 billion (a new record). The vast majority of this growth was in the commercial sector representing 75 percent of the space economy. Overall government investment rose by only slightly more than 1 percent, with U.S. growth at 1.4 percent. The U.S. space budget remained the largest in the world at $48 billion, although its global dominance is eroding as other countries are racing to catch up. As a percentage of global government spending, the United States was 74 percent in 2010, 67 percent in 2011, and 61 percent in 2012—a 14 percent reduction in just three years. After growing by more than 20 percent in 2011, the space budgets of Brazil, Russia, and India continued to grow at an accelerated pace in 2012: Brazil at 27 percent, Russia at 30 percent, and India at 51 percent. According to Futron's 2013 Space Competitiveness Index, the United States maintained its position as the highest-ranked country by a large margin. Japan, Russia, and Iran made the greatest advances, whereas other European countries and China lost ground to the United States in 2013.

The Satellite Industries Association's June 2013 *State of the Satellite Industry Report*, reported that global satellite industry revenues have nearly tripled since 2001 to $189 billion, with an average yearly growth rate of 10 percent. The global satellite industry is a subset of the $304 billion global space industry figures discussed previously. In 2012, there were over 1,000 satellites operated by more than 50 countries. More than half of the satellites are communications satellites, and more than a third are commercial communications satellites. Global satellite industry revenues grew at a rate of 7 percent in 2012, surpassing the 2011 growth rate of 6 percent. These revenues can be further divided into multiple sectors: Services, Manufacturing, Launch, and Ground Equipment. At $114 billion, Services account for 60 percent of industry revenues. Services revenues grew by 5 percent, primarily due to growth in satellite television and High-Definition Television (HDTV). The number of HDTV channels grew by 31 percent in 2012. Satellite manufacturing revenues overall grew by 23 percent despite a decrease in the number of launches (from 90 in 2011 to 81 in 2012). This was due to the launching of higher-value satellites. U.S. satellite manufacturers' revenues increased by 31 percent, with U.S. firms earning nearly 60 percent of global satellite manufacturing revenues. It should be noted that 61 percent of these revenues were from U.S. Government satellite purchases. However, there are indications that industry is having some degree of success in diversifying to commercial customers. In 2012, U.S. industry won 12 of the 18 commercial geosynchronous (GEO) satellite

orders—the largest share of orders won by U.S. manufacturers in over a decade. The satellite launch industry saw similar revenue growth numbers in 2012 with a 35 percent growth rate. The U.S. market share for this sector was derived almost entirely from U.S. Government launches. While there were fewer launches procured in 2012 than in 2011, launch revenues still increased substantially because the satellites that were launched were larger and more expensive.

4.7.2 Financial Performance

Within U.S. public markets, the Space Foundation Index (a weighted index that tracks the performance of space industry companies) recorded a fourth straight year of gains, completing 2012 with a 14 percent increase in value in line with the NASDAQ and S&P 500 gains of 16 percent and 13 percent, respectively. The index tracks the market performance of 28 publicly held companies that derive significant revenues from the sale of space-related infrastructure, including hardware, software, and integration services for space-related applications, such as the manufacture of satellites and launch vehicles or ground-based equipment such as terminals and chipsets.

MIBP performed a financial analysis of 30 U.S. companies that represent a broad cross section of the space industrial base, including: satellites, launch services, ground systems, satellite components and subsystems, networks, engineering services, payloads, propulsion, and electronics. These companies were all included in the same analysis for the 2012 and 2011 Congressional report, although seven companies were excluded due to mergers and acquisitions or lack of data. MIBP also looked at financial ratios for margin, profitability, short-term liquidity, and long-term solvency. While there are a few exceptions, the space sector, as a whole, is financially sound. All companies in the analysis had positive gross margins (total sales revenue minus cost of goods sold, divided by total sales revenue); one company had a negative earnings before interest, tax, depreciation, and amortization (EBITDA) margin (EBITDA divided by total revenue, (operating profitability); two had a negative earnings before interest and tax (EBIT) margin; and three had a negative net income margin (net income expressed as a percentage of revenue). Three more companies showed minimal profit/loss (+/- 0.1%). On average in 2012, net margins increased by 2 percent, with only four companies' margins actually decreasing. There was roughly no change in the average return on equity (net income divided by shareholders' equity**)** or assets (net income divided by total assets) for this group from the previous year, with the exception of the larger primes having some large swings in return on equity, which appears to be due to the payment of debt.

The margins and returns for the 30 companies reviewed are also on par with the rest of the Aerospace and Defense industry. In 2012, about half of the firms analyzed showed less liquidity than the Aerospace and Defense industry average, while only about a quarter of them fell under the average in 2013. The 30 companies reviewed typically had a Quick Ratio (current assets minus inventories divided by current liabilities (short-term liquidity)) of less than 1.0, which means that they may not have enough money to pay bills. Of the companies that were of concern financially in the report covering 2012, most have shown improvement, with only one company moving further into the red. Overall, this sample set shows a relatively healthy base of companies that, on average, are financially on par with or better than the Aerospace and Defense industry as a whole. From 2012 through 2013, the industry seems to have rebounded slightly,

with the average revenue and profitability increasing approximately 3 percent in 2012 and another 2 percent in 2013.

4.7.3 Capability Concerns

To reduce the risk of capability loss, MIBP continually assesses the space sector to identify at-risk capabilities. In 2013, MIBP assessed the sector in two ways:

(1) a broad look at the space industrial base with a detailed analysis of company data collected from the 2013 interagency (Air Force, National Reconnaissance Office (NRO), NASA, and DOC) deep-dive survey of the space industrial base (Future Capabilities at Risk), and

(2) a look at the current fragility and criticality of military space capabilities (Current Capabilities at Risk).

Future Capabilities at Risk

The purpose of the first study was to determine if future capabilities are at risk. Specifically, MIBP was concerned about which sectors of the space industry are at increased financial risk and which are reducing spending on R&D. Both of these factors could ultimately put future capabilities at risk. To determine if future capabilities are at risk, MIBP analyzed data from the interagency space deep dive survey completed in 2013. This survey collected a wide variety of data from approximately 3,800 suppliers to the Air Force, Navy, NRO, and NASA over the period 2009-2012. In the survey, suppliers were given 16 different product sectors and were asked to identify which sector(s) they supported. The 16 sectors were:

- Spacecraft and Launch Vehicles
- Non-Earth Based Surface Systems
- Software
- Propulsion Systems and Fuels
- Space Survivability, Environmental Control/Monitoring, and Life Support
- Navigation & Control
- Ground Systems
- Services
- Communications Systems
- Payload Instruments and Measurement Tools
- Computer Hardware and Robotics
- Power Sources and Energy Storage
- Manufacturing Tools and Specialty Equipment
- Materials, Structures, and Mechanical Systems
- Electronic Equipment

- Research and Development[7]

Based on a DOC-developed financial risk metric, it was observed that approximately 40 percent of the 3,800 companies were rated to be at moderate or high financial risk. This was regardless of the size of the company. The factor that appeared to have the largest influence on financial risk was customer diversification. The greater customer diversity a company had, the lower its financial risk. Customer diversity also correlated strongly with support to U.S. Government (USG) contracts. Those with greater than 25 percent in government sales reported to be much less likely to be interested in future government contracts than those that had 1 percent or less of their sales to the government.

Of the 16 sectors, Spacecraft and Launch Vehicles (S&LV), Research and Development (R&D), and Propulsion Systems and Fuels (PS&F) had the highest percentage of companies that were at either moderate or high financial risk. Moreover, companies that supported both the R&D sector as well as the S&LV or PS&F sectors also saw a drop in their R&D employment by 10 percent from 2009 to 2012. They were also identified to be the most vulnerable to USG demand, in terms of loss of personnel with key skills, reduction of production lines, elimination of contract participation, and even business solvency.

When one looks closer at the sales and R&D spending by separating the respondents into those who state that they support the R&D sector and those who state that they do not, the data is alarming. The reported space sales for companies that support the space-related R&D sector are down across all categories, while non-space sales are up across all categories (see Table 4.7.1).

[7] Referring to space related R&D as defined by the Space Deep Dive survey's categories on tab "3.i," section "P: Research & Development." Can be found at: http://www.bis.goc.gov/index.php/space-deep-dive-govt

Table 4.7.1: Percentage Change in Sales Parameters by Sector of Space Deep Dive Respondents from 2009 to 2012

Sector(s) That Respondents Stated they Support	Supports R&D*			Does Not Support R&D*		
	Total Net Sales	Reported Space Sales	Non-Space Sales**	Total Net Sales	Reported Space Sales	Non-Space Sales**
Spacecraft & Launch Vehicles	-10%	-21%	9%	-7%	-10%	-7%
Research & Development*	18%	-12%	25%	N/A	N/A	N/A
Propulsion Systems & Fuels	-6%	-21%	8%	51%	17%	52%
Software	9%	-14%	17%	21%	7%	21%
Computer Hardware & Robotics	10%	-21%	22%	26%	16%	27%
Navigation & Control	0%	-17%	12%	25%	7%	28%
Payload Instruments & Measurement Tools	8%	-1%	12%	25%	5%	26%
Communications Systems	1%	-16%	9%	30%	13%	33%
Services	13%	-15%	24%	9%	2%	9%
Non-Earth Based Surface Systems	-1%	-5%	10%	43%	32%	43%
Electronic Equipment	1%	-21%	16%	46%	17%	47%
Space Survivability, Envir. C&M & Life Spt.	15%	-18%	25%	52%	-8%	52%
Manufacturing Tools & Specialty Equip.	-12%	-22%	4%	36%	13%	36%
Ground Systems	-2%	-27%	6%	49%	6%	55%
Power Sources & Energy Storage	5%	-19%	16%	56%	3%	57%
Materials, Structures & Mechanical Sys.	16%	-20%	26%	49%	12%	49%

* Referring to space related R&D as defined by the Space Deep Dive survey's categories on tab "3.i," section "P: Research & Development." Please go to http://www.bis.goc.gov/index.php/space-deep-dive-govt " and download the survey template for more information.

** Non-Space Sales is assumed to be the remainder of "Total Sales" minus "Reported Space Sales," which does neglect space sales to those companies that are unaware of their participation in the space industry

Based on the data in Table 4.7.2, it is clear that there has been a major reduction in space R&D investment. By comparing total R&D expenditures to space-related R&D expenditures for the respondents that reported space sales, the data shows reductions in space-related R&D expenditures in every sector, even while some sectors have increased their total investment in R&D. This suggests that most sectors in the industry are likely diversifying. It should be noted that most sectors are holding their space R&D investment relative to their space sales constant, even though the absolute investment is dropping. This shows their continued support of space programs, yet reluctance to invest in new at-risk technology. The one exception to this is the Payload Instruments and Measurement Tools sector, which has reduced their space R&D investment percentage, and could potentially be moving away from the space business.

Table 4.7.2: R&D Expenditure Total ($M) and Change by Sector of Space Deep Dive Respondents from 2009 to 2012

Reports Space Sales & -->	Supports R&D*				Does Not Support R&D*			
Sector(s) That Respondents Stated they Support	Total R&D Expenditure		Space Related R&D Expenditure		Total R&D Expenditure		Space Related R&D Expenditure	
	2009 Total ($M)	Change from 2009-2012	2009 Total ($M)	Change from 2009-2012	2009 Total ($M)	Change from 2009-2012	2009 Total ($M)	Change from 2009-2012
Spacecraft & Launch Vehicles	2,046	-6%	812	-7%	921	-42%	67	-11%
Research & Development*	9,944	10%	2,060	-6%	N/A	N/A	N/A	N/A
Propulsion Systems & Fuels	4,071	-1%	1,669	-10%	1,440	5%	20	31%
Software	5,843	3%	1,711	-6%	7,162	29%	168	16%
Computer Hardware & Robotics	4,402	-4%	1,155	-13%	6,035	40%	45	10%
Navigation & Control	5,016	-1%	1,819	-14%	1,814	-17%	109	-15%
Payload Instruments & Measurement Tools	2,491	-3%	710	-19%	4,428	1%	72	-2%
Communications Systems	4,097	11%	1,020	-1%	1,844	12%	113	0%
Services	6,338	4%	1,881	-11%	6,802	18%	179	4%
Non-Earth Based Surface Systems	778	-15%	347	-10%	62	44%	0	19%
Electronic Equipment	3,496	7%	939	2%	7,175	67%	113	10%
Space Survivability, Envir. C&M & Life Spt.	5,480	4%	1,551	-9%	4,132	11%	29	12%
Manufacturing Tools & Specialty Equip.	2,059	-16%	1,207	-16%	838	49%	20	13%
Ground Systems	3,976	6%	1,122	-15%	2,888	25%	241	15%
Power Sources & Energy Storage	3,468	0%	1,283	-9%	2,828	29%	63	4%
Materials, Structures & Mechanical Sys.	5,774	2%	1,745	-11%	3,860	13%	54	93%

* Referring to space related R&D as defined by the Space Deep Dive survey's categories on tab "3.i," section "P: Research & Development." Please go to ' http://www.bis.goc.gov/index.php/space-deep-dive-govt ' and download the survey template for more information.

In conclusion, although the overall space industrial base generally appears to be thriving and profitable, the key builders and designers of government space and propulsion systems are not fairing as well as the overall industry. It is imperative, therefore, that the Department continues to closely monitor the space industrial base to determine which capabilities may be the most vulnerable.

Current Capabilities at Risk

To further identify particular capabilities that may be at risk, the second study first compiled a list of 111 essential military space capabilities. Then, using subject matter experts and a standardized MIBP Fragility and Criticality evaluation methodology, the degree to which each capability was fragile (i.e. supplier viability risk) and critical (important to DoD programs) was rated. After all of the ratings were determined, the team ranked all of the capabilities. From this ranking, the top 15 most-at-risk capabilities were chosen and presented to the Critical Technologies Working Group—an interagency body of subject matter experts under the auspices of the Space Industrial Base Council (SIBC). The SIBC is a collaborative, interagency, whole-of-government forum composed of senior leadership from each of the major space agencies and co-chaired by the USD(AT&L) and the Assistant Director of National Intelligence for Acquisition, Technology and Facilities. The CTWG then conducted more extensive analysis using interagency Technical Teams to determine if a capability was seriously at risk. Of the 15 capabilities studied, seven were identified as requiring near-term mitigation:

- Radiation-hardened electronics
- Radiation test facilities
- Carbon fiber
- Infrared detectors
- Electric propulsion
- Aerospace-grade rayon
- Reaction wheels

This is in addition to other mitigation efforts that are currently ongoing within the CTWG in the following areas:

- Cadmium Zinc Telluride substrates;
- Space-qualified solar cell Germanium supply chain;
- Read Out Integrated Circuit (ROIC) foundry improvement and sustainability ;
- Space-qualified Traveling Wave Tube Amplifiers;
- Focal Plane Arrays (FPA) for Visible Sensors and Star Trackers; and
- Next-Generation Star Tracker System.

The space industrial base was not impacted by program terminations in 2012.

5. Defense Mergers and Acquisitions

Robust, credible competition is vital to providing the Department with high-quality, affordable, and innovative products. It is the Department's policy to oppose business combinations that overly reduce or eliminate competition and are not in DoD's ultimate best interest. The Department is mindful of the past loss of peer-to-peer competition at the prime level resulting from significant industry consolidations over the past twenty plus years. Increasingly, the Department finds itself evaluating proposed mergers, acquisitions, and teaming arrangements that create horizontal capability overlaps and potentially problematic vertical supply arrangements.

The Department examines potential transactions on a case-by-case basis. During the course of a review (other than under the Committee on Foreign Investment in the U.S. (CFIUS)), the Department considers a transaction's potential benefits compared to the potential harm caused by a transaction's reduction of competition, among other factors.

The Department reviews several types of business combinations involving defense suppliers:

- Proposed mergers or acquisitions filed under the Hart-Scott-Rodino Antitrust Improvement Act of 1976 (generally, transactions valued at more than $66 million in 2011);
- Other collaborations among competitors (joint ventures, mergers and acquisitions) of special interest to the Department that do not meet the Hart-Scott-Rodino Act filing threshold; and

- Proposed acquisitions of U.S. defense-related firms by non-U.S. firms for which filings have been made pursuant to the Exon-Florio Amendment to the Omnibus Trade and Competitiveness Act of 1988, as amended by the Foreign Investment and National Security Act of 2007, (P.L. 110-49).

The first two review types described are conducted under Major Defense Supplier merger and acquisition (M&A) reviews pursuant to DoD Directive 5000.62, "Impact of Mergers or Acquisitions of Major DoD Suppliers on DoD Programs."

5.1 Major Defense Supplier Merger and Acquisition Reviews

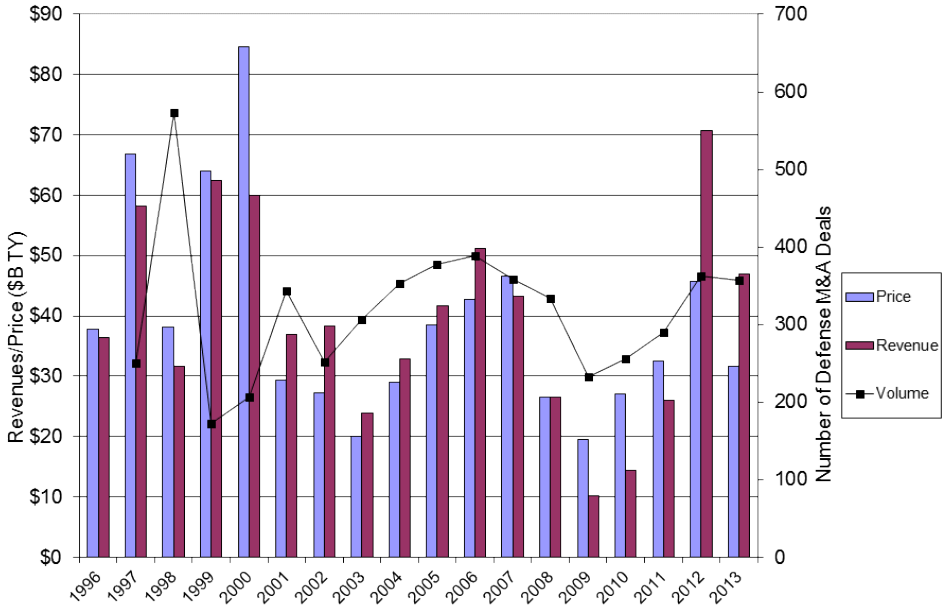
The Federal Trade Commission and the Department of Justice (the "Antitrust Agencies") have the statutory responsibility to determine the likely effects of a defense industry merger on the performance and dynamics of a particular market and whether a proposed merger should be challenged on the grounds that it may violate antitrust laws. As the primary customer affected by defense business combinations, DoD's views are particularly significant because of its special insight into a proposed merger's impact on innovation, competition, national security, and the defense industrial base. Accordingly, the Department actively works with the Antitrust Agencies, but also independently addresses issues where appropriate.

Transaction reviews are structured to identify impacts on national security and defense industrial capabilities. The reviewers evaluate the potential for loss of competition for current and future DoD programs, contracts and subcontracts, and for future technologies of interest to the Department. In addition, the reviews address any other factors resulting from the proposed combination that may adversely affect the satisfactory completion of current or future DoD programs or operations. The policies and responsibilities for assessing major Defense supplier M&A reviews are identified in DoD Directive 5000.62. While these reviews can include transactions that are also evaluated in the CFIUS review process, the issues considered are distinct.

5.1.1 2013 Major Defense Supplier M&A Activity

In 2013, the Department completed 20 significant transaction reviews out of the more than 300 defense-related mergers and acquisitions deemed relevant. Figure 5.1.1 highlights the aggregate number and value of these transactions.

Figure 5.1.1: Defense-related M&A Transactions



Source: Infobase Defense Merger & Acquisition data on publicly announced deals. Includes foreign-only deals and failed deals. (Defense Merger and Acquisition Transactions 1996-2013)

Several noteworthy transactions dominated 2013, including GenCorp's acquisition of United Technologies' Rocketdyne, BAE's proposed acquisition of Marine Hydraulics International (MHI), and the DigitalGlobe-GeoEye merger.

With regard to the Rocketdyne transaction, DoD and the Federal Trade Commission (FTC) worked extensively to examine the antitrust aspects of many market elements of the transaction. The FTC concluded that the combination of the only two current domestic providers of Liquid Divert and Attitude Control Systems (LDACS) used for missile defense interceptor control would result in a monopoly for LDACS. Additionally, the Missile Defense Agency (MDA) identified significant national security concerns with any potential disruption in the production lines of either of the LDACS suppliers. The Department concluded that near-term divestiture of either LDACS business unit is not possible as a matter of national security, and the risk to the nation's security is too great to justify a divestiture to preserve competition. The normal course of action would be for the FTC to block the transaction based on an inability to remedy the potential anticompetitive effects. However, the Department identified benefits associated with the combined company – specifically, the ability to sustain the industrial base for liquid rocket engines, a critical capability for U.S. access to space and national security. Based on the Department's position, the Commission concluded that it was not feasible to remedy the loss of competition in the LDACS market. The Commission therefore voted to close the investigation and allow the transaction to proceed unchallenged to preserve the potential benefits cited by the Department.

The Department also worked closely with the Department of Justice (DoJ) in a review of the antitrust implications of the combination of the two leading U.S. commercial satellite imagery providers, DigitalGlobe and GeoEye. Ultimately, DoJ cleared the merger.

While it was never formally filed, DoD and DoJ jointly examined the potential acquisition of Marine Hydraulics International by BAE. The two organizations provide ship repair and maintenance services in the Norfolk, Virginia, area. The two firms decided not to pursue the transaction after DoJ requested additional information.

The year was also marked by the continuation of divestitures to mitigate issues related to organizational conflict of interest regulations and to divest slower growth units.

5.2 Committee on Foreign Investment in the United State

Section 721 of the DPA (50 U.S.C. App. Section 2170 et seq.) authorizes the President to suspend or block foreign acquisitions, mergers, or takeovers of U.S.-located firms if the transactions pose credible threats to national security that cannot be resolved through other provisions of law. Initially enacted as the Exon-Florio Amendment to the Omnibus Trade and Competitiveness Act of 1988, Section 721 was revised by the Foreign Investment and National Security Act of 2007, Public Law 100-49 (FINSA). Under FINSA, national security reviews of foreign acquisitions, mergers, and takeovers of defense-related U.S. firms under Section 721 are the responsibility of the interagency CFIUS, chaired by the Department of the Treasury.

DoD is a member of CFIUS, and MIBP is the DoD lead for the CFIUS program. As a CFIUS member, the Department evaluates the national security aspects of proposed foreign acquisitions of U.S. defense contractors and other U.S. firms indirectly impacting national defense.

Congress provided the Department independent authority in 1992 (under 10 U.S.C. Section 2537(c)) to determine for each CFIUS case whether the firm being acquired possesses critical defense technology under development or is otherwise important to the defense industrial and technology base. The Defense Intelligence Agency, in conjunction with this 1992 statutory mandate, provides the Department with an assessment of the risks of unauthorized technology transfer and diversion. Under FINSA, the Office of the Director of National Intelligence also prepares a national security threat assessment for CFIUS that evaluates potential threats posed by the acquiring firm and country.

When the Department concludes that a merger, acquisition, or takeover under CFIUS review poses credible threats to national security that cannot be addressed through other provisions of law, it proposes mitigation measures under CFIUS (if these are feasible and adequate to eliminate risks posed by the transaction). If this is not the case, the Department then proposes that CFIUS recommend to the President that he block or unwind the transaction. Given the statutory constraints on public disclosure of case-specific CFIUS information and the lead role that the Treasury Department plays as CFIUS Chair in communication with the Congress, both of which were refined by FINSA, the Department cannot publicly discuss specific reviews or present summary case trends. However, under FINSA, summary CFIUS trend data is provided to the Congress in annual reports by the Treasury Department as the Chair of the Committee.

6. Programs and Actions to Sustain Capabilities

6.1 The Defense Production Act

The Defense Production Act of 1950 (DPA), as amended (50 U.S.C. App., §2061 et seq.), is the primary source of Presidential authorities to expedite supply and expand productive capacity of materials and services needed to promote the national defense. For the purposes of the DPA, "national defense" means programs for military and energy production or construction, military or critical infrastructure assistance to any foreign nation, homeland security, stockpiling, space, and any other directly related activity. "National defense" also includes emergency preparedness activities conducted pursuant to Title VI of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) (42 U.S.C. § 5195 et seq.) and critical infrastructure protection and restoration.

Major DPA provisions include:

- The authority to require acceptance and priority performance of contracts and orders to promote the national defense (DPA section 101);
- The authority to allocate materials, services, and facilities in such manner, upon such conditions, and to such extent as deemed necessary or appropriate to promote the national defense (DPA section 101);
- Various forms of financial incentives and assistance for industry to reduce current or projected shortfalls of resources essential for the national defense; or to create, maintain, protect, expand, or restore domestic industrial base capabilities essential for the national defense (DPA Title III);
- Antitrust protection for voluntary agreements and action plans among business competitors to enable cooperation to plan and coordinate measures to increase the supply of materials and services needed for the national defense (DPA section 708);
- The authority to establish a cadre of persons with recognized expertise for employment in executive positions in the Federal Government in the event of an emergency (DPA section 710(e)); and
- The authority to review certain mergers, acquisitions, and takeovers by or with any foreign person that could result in foreign control of any person engaged in interstate commerce in the United States (DPA section 721).

6.1.1 The Defense Production Act Committee

DPAC, was established by Section 722 of the DPA and further defined by Executive Order 13603, is an interagency forum to discuss and share information about the domestic industrial base and DPA authorities and to advise the President on the effective use of these authorities in support of national defense. The DPAC's primary activities include:

- Identifying whole-of-government approaches to strengthen domestic industrial base capabilities to meet national defense supply requirements under normal and emergency conditions, using DPA authorities;

- Developing recommendations for the effective use of DPA authorities;
- Developing recommendations for changes to the DPA and Executive Branch;
- DPA guidance and procedures to support effective use of DPA authorities;
- Developing recommendations to improve information sharing among Federal Agencies on the use of DPA authority, including dissemination of "best practices" and "lessons learned"; and
- Preparing an annual report to Congress, in accordance with section 722 of the DPA.

The position of DPAC Chairperson rotates between the Secretaries of Defense and Homeland Security (DHS) annually on April 1. On April 1, 2013, the Chair rotated from DHS to DoD. The DPAC is comprised of:

- the Secretary of State;
- the Secretary of the Treasury;
- the Secretary of Defense;
- the Attorney General;
- the Secretary of the Interior;
- the Secretary of Agriculture;
- the Secretary of Commerce;
- the Secretary of Labor;
- the Secretary of Health and Human Services;
- the Secretary of Transportation;
- the Secretary of Energy;
- the Secretary of Homeland Security;
- the Director of National Intelligence;
- the Director of the Central Intelligence Agency;
- the Chair of the Council of Economic Advisers;
- the Administrator of the National Aeronautics and Space Administration; and
- the Administrator of General Services.

The Director of the Office of Management and Budget and the Director of the Office of Science and Technology Policy are invited to participate in an advisory role in all Committee meetings and activities. The DPAC Chairperson may also invite the heads of other Departments and Agencies to participate in DPAC meetings as appropriate.

DPAC analysis is conducted through the use of topic-focused interagency study groups. Currently, there are four DPAC Industrial Capability Assessment Study Groups dedicated to examining metal fabrication, telecommunications, power and energy, and lightweight materials. Each of the study groups is tasked with determining common unmet needs and cross-cutting vulnerabilities related to national defense within its respective domestic supply chain.

Metals Fabrication Study Group

The Metal Fabrication Study Group continued its investigation of industrial base shortfalls with respect to the sourcing, fabrication, and finishing of complex metal parts. Analysis conducted in CY 2012 and early CY 2013 revealed that a viable, modern domestic heavy forging industrial base is needed to guarantee the timely availability of quality parts and the ability to scale-up production during times of national emergency. The Study Group also determined that domestic heavy forging capabilities are currently at risk because of market segmentation due to the low-volume, specialty demand of the Department of Defense. To address this issue, the DPA Title III Program made an investment of $17.6 million in FY 2013 to modernize, upgrade, and rebuild the 10,000-ton and 3,000-ton open die presses at Lehigh Heavy Forge Corporation in Bethlehem, Pennsylvania, which is the sole producer of heavy forgings used in propulsion shafts and nuclear reactor containment vessels. This investment will also address manufacturing issues downstream from the forging operations, such as upgrading inspection techniques and other machine tools.

Analysis conducted in CY 2013 revealed that there are challenges upstream from shaping and forming metal parts (such as casting and machining) in processing steps like smelting. Additionally, the study group found that, due to an increase in foreign capabilities, along with institutional, social, and economic barriers, the domestic aluminum smelting industry's ability to remain competitive is significantly strained. The U.S. share of the global aluminum market has declined from 16 percent in 1999 to 4 percent last year; meanwhile, China's share of world production has grown rapidly from 11 to 47 percent over the same time period. The Study Group is evaluating opportunities to partner with domestic producers to advance and scale up sustainable smelting technologies that would reduce environmental impact while promoting domestic firms' global competitiveness.

Telecommunications Study Group

Previous analysis by the Telecommunications Study Group focused on five subsectors: (1) routing and switching equipment; (2) optical transport equipment; (3) sub-components, with a focus on application specific integrated circuits; (4) wireless; and (5) operating system software, with a focus on network management software. This examination established four overarching threats to the American telecom supply chain:

1. The United States is losing its production capabilities in key equipment sectors.
2. Access to competitively priced components produced by trusted and reliable manufacturers is no longer assured in all equipment subsectors and very likely will further diminish unless mitigation strategies are developed and implemented.
3. There are fewer leading U.S. vendors for agencies and universities to partner with on R&D and technology transition.
4. The options and opportunities to successfully translate domestic innovation to U.S. telecom equipment production are increasingly limited.

Over the past year, the study group centered its efforts on long-haul data transmission solutions, which included analysis of responses to a formally issued Request for Information (RFI).

Power and Energy Study Group

For its initial assessment cycle, the Power and Energy Study Group surveyed senior acquisition officials from across the Federal Government, which ultimately led the Group to focus on shortfalls related to: (1) fuel cells, (2) lightweight materials, and (3) GaN substrates. Fuel cells were designated as the top priority.

Fuel cell systems are highly-efficient energy conversion devices that can extend the range of batteries, reduce the number of inefficient combustion generators, and be powered by universally-available logistics fuel (such as propane or methanol) to provide effective support to many of USG's operational energy requirements. Widespread implementation of these devices, however, has been hindered by manufacturing inefficiencies and industrial base shortfalls, such as a lack of manufacturing automation, wasted materials, real-time quality control, and inadequate component compatibility and standardization due to limited production lines.

The Study Group, led primarily by DOE's Energy Efficiency and Renewable Energy/Fuel Cell Technologies Program and DoD's AT&L/MIBP, determined that the private sector is not adequately incentivized to respond to the problems exacerbating fuel cell manufacturing shortages, largely due to uncertain demand. Mitigating the technical and financial risks by addressing manufacturing shortfalls in these areas would likely increase efficiencies, reduce prices, and stabilize demand. The Study Group collaborated with interagency partners to identify specific acquisition requirements for fuel cell power for various USG mission endurance and/or reliability needs. The Study Group continues to characterize fuel cell system requirements and supply chain issues to prioritize potential approaches that will mitigate fuel cell manufacturing shortfalls via a DPA Title III investment for future consideration.

Lightweight Materials Study Group

Advanced lightweight materials (e.g. metals, fibers) availability is a cross-cutting requirement crucial to improved system performance and energy efficiency. Affected critical government systems range from light-weighting for automotive and aircraft to enabling effective alternative energy sources such as wind power. The Lightweight Materials Study Group is comprised of material experts from several government agencies. After extensive deliberations and academic input, the Study Group's analytical team put together a prioritized list of focus areas for industry input. An independent Air Force group validated these findings. An RFI was crafted and released to industry. Analysis of RFI responses reveals that industry has growing interest in polyimide resins for high temperature applications, ceramic matrix composites, and carbon nanotubes for various applications. There appear to be emerging opportunities and government requirements for these and other lightweight materials; however, further investigation is needed to determine the specific insertion points into commercial and defense systems. Also, further study of the technology transition barriers and market demand is needed and will be a focus of the Group going forward.

6.1.2 Defense Production Act Title III Program Execution

During CY 2013, the DPA Title III Program had 34 projects underway, of which four ended in 2013. The Department initiated an additional four projects at the end of the year, expecting contract awards in first half calendar year 2014. At the end of 2013, 40 domestic firms were under agreement/contract under the DPA Title III 34 projects.

Funding for individual Title III initiatives is provided by the Joint or Military Service Program Offices of Record, Defense Agencies, or other Federal Agencies as funding offsets for specific Title III efforts. The Department develops projects in response to specific government requirements and provides funding for these efforts.

6.2 DoD Manufacturing Technology Program

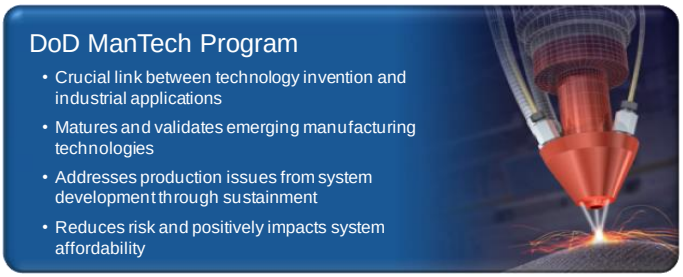
For over 50 years, the DoD Manufacturing Technology (ManTech) Program has demonstrated its value through: (1) process technologies that make new products possible, and (2) manufacturing process improvements that increase defense system affordability. The program provides crucial links from technology invention to production of defense-critical needs in areas beyond normal investment by industry. ManTech ensures technology is affordable and producible, underlying the Department's Better Buying Power initiative and ensuring that U.S. military forces are more agile, deployable, sustainable, lethal, and dominant. While ManTech investments generally translate into initial system affordability improvements or cycle time reduction, ManTech also invests in new capabilities that provide dividends in system performance or life-cycle costs that can far outweigh the initial system delivery costs.

ManTech Program-enabled transition of science and technology (S&T) significantly enhances the industrial base. Specifically, ManTech serves as an important mechanism for technology transition, bringing affordable technologies to acquisition program managers through new manufacturing and production processes and systems, bridging the gap between discovery and implementation of new capabilities for the Warfighter. Further, the DoD ManTech Program can contribute important information to MIBP's ongoing S2T2 analyses through its operational perspectives of the industrial base, as well as its deepening understanding and insights of technology-based supply chain risks. Conversely, ManTech can be used as an appropriate investment lever for targeted industrial base intervention when necessary to help the Department close newly-identified, defense-critical, manufacturing technology-related supply chain gaps.

While ManTech is not statutorily structured to address the entirety of defense industrial base challenges, it is a highly versatile R&D investment program that can serve as a key focal point to bring attention and technological resources to bear on the Department's most pressing requirements for affordable modernization and sustainment. The ManTech Program shares an expansive vision with the broader defense manufacturing enterprise; namely, *a responsive, world-class manufacturing capability to affordably and rapidly meet Warfighter needs throughout the defense system life cycle*. This vision captures the overriding imperative to satisfy Warfighter requirements across the spectrum of manufacturing activities, while doing so *affordably* and *rapidly*. Congress has long recognized this essential enabling role, having established ManTech in Section 2521 of title 10, U.S.C., to:

…further…national security objectives…through the development and application of advanced manufacturing technologies and processes that will reduce the acquisition and supportability costs of defense weapon systems and reduce manufacturing and repair cycle times across the life cycles of such systems.

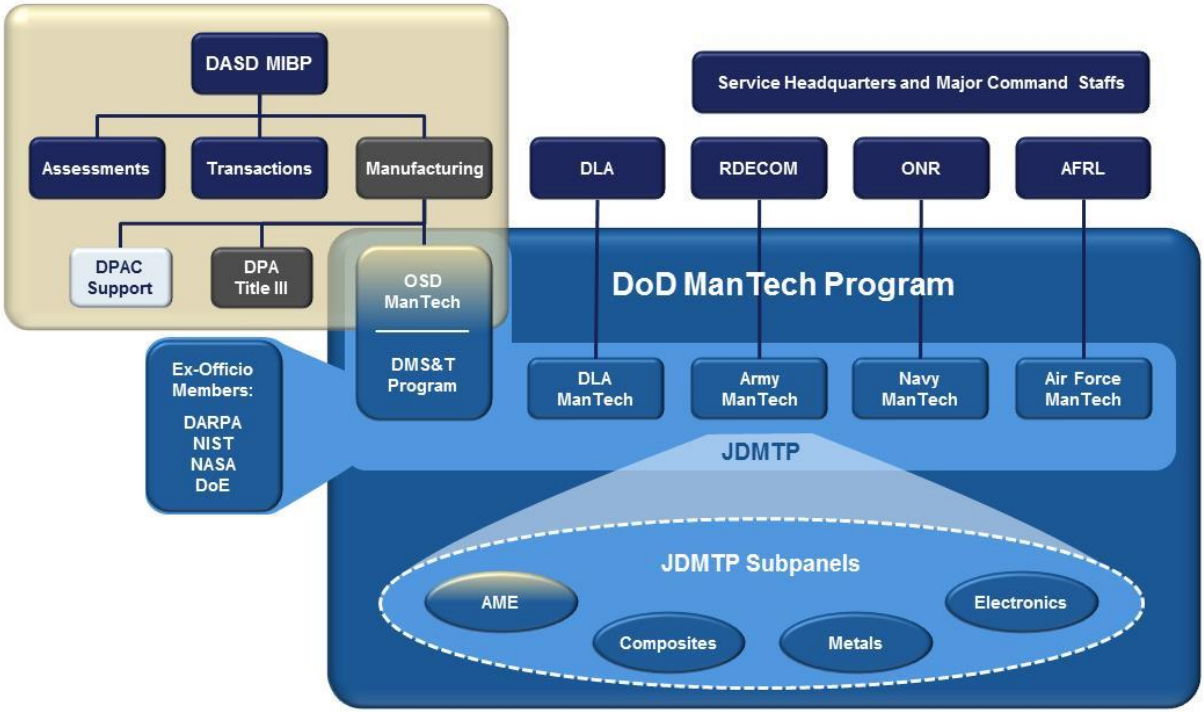
The program's mission is both multi-faceted and vital; namely, *DoD ManTech anticipates and closes gaps in manufacturing capabilities for affordable, timely, and low-risk development, production, and sustainment of defense systems*. The program looks beyond the risk normally addressed by industry and directs investments at improving the quality, productivity, technology, and practices of businesses and workers providing goods and services to the Department. ManTech's role as a crucial link between technology development and industrial application gives the program a unique and vital position within the DIB and the broader strategic security environment.



By its very nature, the introduction of advanced weapon systems entails the use of new product technologies that provide performance enhancements to make the new weapon systems more desirable. The introduction of these performance enhancements is often limited by the ability to manufacture the improved items at an affordable cost and an acceptable production rate with the consistent quality that can be a matter of life and death for the Warfighter. Thus, maturing manufacturing processes and production equipment in parallel with product technology is important if advanced weapon systems are to be fielded on-time, at cost, and with the desired mission performance capability. Advancement of manufacturing technology – the central focus of the ManTech Program – is essential to the introduction of advanced weapon system capabilities. The ManTech Program's activities not only cross multiple organizational boundaries within the Department, but they also span the entire DIB, including prime contractors, subcontractors, suppliers, hardware and software vendors, industry consortia, manufacturing centers of excellence, colleges and universities, and other research institutions. The DoD ManTech community also works closely with other federal agencies, representing defense manufacturing policy and building cross-agency coordination for critical manufacturing R&D needs. The ManTech Program serves the Department as a valuable resource, combining the breadth of programmatic and requirement knowledge with deep technical expertise.

Section 2521 of title 10, U.S.C. requires the USD(AT&L) to administer the DoD ManTech Program on behalf of the Secretary of Defense**,** and this responsibility has been delegated to the DASD(MIBP), who exercises OSD-level oversight of the ManTech Program pursuant to Section 139c of title 10, U.S.C., "Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy." Organizationally, this is accomplished via the MIBP's Manufacturing Directorate and the Manufacturing Technology office. Component ManTech programs are individually executed by the Departments of the Army, Navy, Air Force**;** the DLA; and OSD.

Figure 6.2.1: The DoD ManTech Program



These Component programs collaborate and coordinate their efforts through the Joint Defense Manufacturing Technology Panel (JDMTP). The Component ManTech programs and the JDMTP organizational structures are also depicted above. The Principals of the JDMTP are senior technology managers representing the Departments of the Army, Navy, and Air Force; DLA; and OSD. The OSD Principal possesses the dual role of communication link to OSD as well as the the Defense-Wide Manufacturing Science & Technology (DMS&T) Program manager. Ex-officio members of the JDMTP include the Defense Advanced Research Projects Agency (DARPA), NIST, NASA, and DOE. The JDMTP categorizes ManTech investment areas by the technology portfolios of subpanels—Electronics, Metals, Composites and Advanced Manufacturing Enterprise—enabling Component ManTech programs to maximize opportunities for shared investment in initiatives and strategies with joint application, preventing duplication of effort.

Military Department and DLA ManTech programs comprise the majority of the DoD ManTech investment portfolio and are each overseen and managed from within the S&T organizational structures of their DoD Component. Additionally, the DASD(MIBP), whose ManTech Office administers the DMS&T Program, is a member of the S&T Executive Committee, which is comprised of those key organizations in the Department that oversee and coordinate DoD S&T activities. Although all Component ManTech programs work in concert toward common goals, each has important focus areas to meet individual Component mission needs.

- The Army ManTech Program enables manufacturing improvements of components and subsystems for ground, Soldier/squad, air, lethality, and command, control, communications, and intelligence systems.

- The Navy ManTech Program's critical goal is to reduce the acquisition cost of current and future ships/platforms and the F-35 aircraft, resulting in an affordable investment strategy.

- The Air Force ManTech Program is the DoD lead for manufacturing technology in aerospace propulsion, structures, and Intelligence, Surveillance and Reconnaissance (ISR). It is the only Air Force corporate program working strategic issues and opportunities in manufacturing and industrial readiness. Manufacturing Technology plays a pervasive role in enabling many Air Force S&T Strategy priorities, chiefly through attaining next generation agile manufacturing.

- The DLA ManTech Program focuses on sustainment of the Warfighters and their materiel, as well as ongoing efforts to support improvements in providing a source for non-procurable microcircuits, combat rations, clothing and protective equipment, batteries, forgings, and castings.

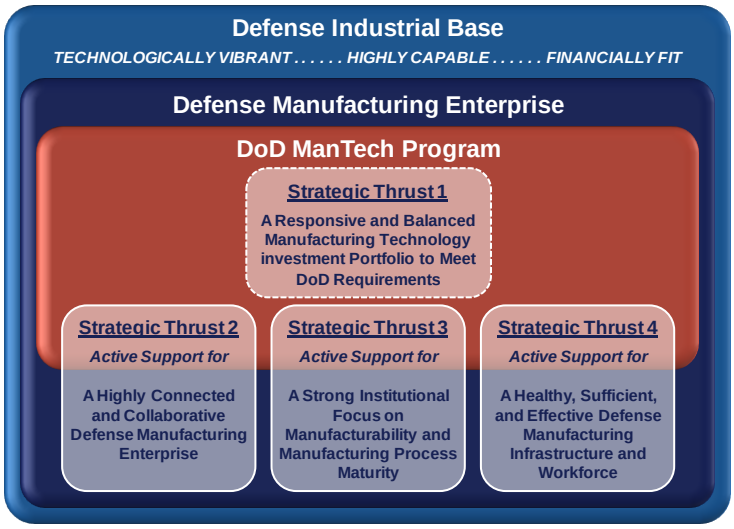
- The OSD-managed DMS&T Program takes a broad, overarching approach towards closing critical gaps in cross-cutting, military manufacturing enabling technologies that will have a significant impact on multiple MILDEPs or platforms.

Please see **Appendix C** for more details on each of these programs.

The JDMTP and MIBP jointly developed a 2012 DoD ManTech Program Strategy that recognizes the ManTech Program's central role within the defense manufacturing enterprise and its extended impacts and leverage across the DIB and broader national security environment. Due to its length, the full DoD ManTech Program Strategic Plan is not included as part of this report, but it can be downloaded at: https://www.dodmantech.com/relatedresources/DoD_ManTech_Pgm_2012_Strat_Plan.pdf. The tenets have been established to unify and guide the joint ManTech enterprise, consistent with the USD(AT&L)'s BBP initiatives and the defense manufacturing vision and ManTech Program mission. The strategy theme is *Delivering Advanced, Affordable Manufacturing for the Warfighter*, with the following four strategic thrusts and supporting enabling goals:

- Thrust 1: *A Responsive and Balanced Manufacturing Technology Investment Portfolio to Meet DoD Requirements*
- Thrust 2: *Active Support for a Highly Connected and Collaborative Defense Manufacturing Enterprise*
- Thrust 3: *Active Support for a Strong Institutional Focus on Manufacturability and Manufacturing Process Maturity*
- Thrust 4: *Active Support for a Healthy, Sufficient, and Effective Defense Manufacturing Infrastructure and Workforce*

This ManTech strategy establishes the program's core focus on ensuring responsiveness and balance across the full portfolio of manufacturing technology investments (Thrust 1). It couples that focus with the objective to actively and collectively support broader defense manufacturing needs (Thrusts 2, 3, and 4). This approach underscores the importance of program support for these broader needs while recognizing it is beyond the program's charter and resources to fully satisfy them. Even so, each of these four thrusts directly supports the Secretary of Defense's current strategic guidance in key ways. In particular, processing and fabrication breakthroughs enable affordable production for effective modernization; material and manufacturing investments made concurrently with S&T R&D projects deliver technological superiority to the Warfighter quickly; and enterprise-level initiatives create more connected and collaborative environments, a stronger focus on manufacturability, and improved manufacturing infrastructure. All of these support the maintenance of a healthier and more resilient industrial base.



The JDMTP is moving forward with joint planning and coordination on major weapon systems. In the case of the F-35 Lightning II, four ManTech projects (two Navy and two Air Force) directly impacted F-35 affordability. With a combined investment of $14.5 million, these initiatives are projected to reduce F-35 program costs by $1.1 billion over 30 years of production. More importantly, these technology advances can be leveraged by current and future defense programs to reduce costs and bolster U.S. manufacturing capabilities.

Other successful projects include:

- The Large Affordable Substrates project provides a domestic source of cadmium zinc telluride wafers for military critical Infrared Focal Plane Arrays.
- The Chip Scale Atomic Clock program enables precise timekeeping within C4ISR systems in GPS-denied environments, reduces unit cost from $8,700 to $400, raises production from 10 per year to 40,000 per year. The potential savings is approximately $291 million.
- The Cold Spray Deposition project creates an automated repair cell, which increases flight readiness rates for Navy and Marine helicopters. Presently, parts are scrapped, increasing sustainment cost and stressing a casting industrial base with long lead times. The savings for the CH-56 Helicopter program alone is projected at $100 million annually.
- VIRGINIA Class Submarine (VCS) initiative: 31 of the Man Tech affordability projects have been implemented or are in process. Realized cost savings per hull of over $27.7 million have been recognized by the VIRGINIA Class Program Office and General

Dynamics Electric Boat, creating an annual ManTech return on investment (ROI) of less than two hulls.

Further joint planning and coordination are exercised by the JDMTP Subpanels. In response to the 2012 ManTech Strategy and particularly in support of Thrust 1, the JDMTP began to develop Joint Technical Pursuit Areas (JTPAs) as part of the annual planning cycle. Thrust 1 focuses on the need to balance mission-specific priorities of Service ManTech Programs with broader Joint-Service priorities that can deliver significant advantages to the DIB. JTPAs represent manufacturing challenges that cross-cut multiple Services and multiple systems; topics that are beyond the risk for a single Service, but that provide dramatic ROI through Joint-Service collaboration. Each of the following four JDMTP Subpanels focus planning on key manufacturing challenges and potential JTPAs to address current and future Joint ManTech investments:

- Electronics:
    - Power and Energy Sources
    - Lead-Free Electronics Risk Mitigation for Aerospace and Defense
    - Printed Electronics
    - Photonics/RF Components for Military Systems
    - Short Wave Infrared ManTech Imagers (JTPA)
    - Transparent Ceramics for Mid-Wave Infrared Windows and Transparent Armor (JTPA)
- Metals:
    - Welding, particularly Gas Metal Arc Welding
    - Automation and robotics
    - Rapid tooling and process control for forgings and castings
    - Additive Manufacturing for DoD Systems (JTPA)
    - Advanced Joining Processes (JTPA)
    - Machining with MTConnect (JTPA)
- Composites:
    - Aerospace Structures
    - High Temperature Composites
    - Naval Composites
    - Specialty Non-Metallic Materials
    - Process Maturation for Advanced Materials (JTPA)
    - High Precision Air Vehicle Manufacturing (JTPA)
    - Enabling Rapid Structures Certification (JTPA)

- Advanced Manufacturing Enterprise:

    - Model-Based Enterprise
    - Network-Centric Manufacturing
    - Intelligent Manufacturing Planning and Execution
    - Industrial Base and Infrastructure Readiness
    - Development of tools to enable better designs
    - Enhancement of interoperability (JTPA)
    - Development and implementation of improved 3D tech data packages (JTPA)
    - Development of tools and methods for intelligent manufacturing (JTPA)
    - Development of tools and methods to improve supply network integration and management (JTPA)
    - Cloud-based capabilities for defense applications (JTPA)

6.3 National Network for Manufacturing Innovation

The Administration has signaled the growing importance of advanced manufacturing to the economic and national security of the United States. Key examples include:

- the President's Council of Advisors on Science and Technology (PCAST) 2011 report, *Ensuring American Leadership in Advanced Manufacturing*;
- the 2011 establishment of the President's Advanced Manufacturing Partnership initiative across government, industry, and academia;
- the 2012 State of the Union Address emphasis on manufacturing's importance to the nation;
- the 2012 release of the National Science and Technology Council's (NSTC) *National Strategic Plan for Advanced Manufacturing;*
- the formation of the DOC-hosted Advanced Manufacturing National Program Office, supported by DoD and other interagency partners;
- the 2012 release of *Capturing Domestic Competitive Advantage in Advanced Manufacturing*, which was the final report from the Advanced Manufacturing Partnership Steering Committee created by the President;
- the 2013 State of the Union Address announcement of the formation of three new Institutes of Manufacturing Innovation, one led by DOE and two led by DoD;
- the 2013 launch of the Advanced Manufacturing Partnership Steering Committee "2.0;" and
- the 2014 State of the Union Address announcement of four additional Institutes for Manufacturing Innovation.

In support of these efforts, and the NNMI in particular, the OSD ManTech office, supported by the Component ManTech programs, provided key funding, technical leadership and program management support to successfully launch the National Additive Manufacturing Innovation Institute (NAMII), the $69 million "pilot" institute. Now called *America Makes*, the Institute officially opened on September 27, 2012, and it serves as a training and collaboration center to bridge the gap between basic research and technology adoption for additive

manufacturing technologies. More commonly known as "3D Printing," additive manufacturing is an enabling manufacturing technology for our military platforms. Participants include DoD, DOE, NASA, NSF, and DOC's NIST. The interagency investment of $30 million has been matched by a $39 million cost share from non-federal sources, and this institute has the goal of becoming self-sufficient in three years.

Building upon that success, ManTech leads an interagency effort to launch two new $140 million public-private partnerships for Advanced Manufacturing on behalf of the Department: the DMDI Institute and the LM3I Institute. The DMDI Institute will focus on enterprise-wide utilization of the digital thread, enabling highly integrated manufacturing and design of complex products at reduced cost and schedule. The digital thread captures information generated from concept development and design to analysis, planning, manufacturing, assembly, maintainability, through disposal. By demonstrating the potential for integrating information technology, smart factory processes, intelligent machines, and sophisticated analytics, the DMDI Institute will be a key competitive differentiator for the U.S industrial base. The LM3I Institute technical focus is on the design of lightweight systems, including the design of lightweight materials; the design of manufacturing operations to produce lightweight components; and the integration of these designs into revolutionary new lightweight systems. Significant U.S. investments over the past 15 years in lightweight metals, intended for demanding critical applications, have not transitioned into the marketplace due to cost of necessary scale-up and certification requirements. Defense, transportation, energy, and automotive industrial segments all benefit significantly from lightweight structures and components. By integrating the emerging capabilities in materials design and in process design, with the design of new lightweight components and products, items can enter the marketplace sooner and at competitive price points, driving global competitiveness.

Together, these three institutes (NAMII/America Makes, DMDI, and LM3I), along with the recently established DOE-led institute focused on wide bandgap semiconductor power electronics, will inform the broader NNMI and the Advanced Manufacturing Partnership (AMP) initiatives and directly support the national agenda to aggressively develop or help sustain world-leading advanced manufacturing capabilities, enabling U.S. industry to maintain its edge in a hypercompetitive global environment and to meet vital economic and national security needs.

7. Conclusion

The defense industrial base is a diverse and dynamic set of companies and DoD organic facilities that provide products and services, both directly and indirectly, to the Department of Defense to support national security objectives. A healthy commercial market is vital to the long-term sustainment of the defense industrial base. The Department supports industry developing commercial uses for most military products. However, certain capabilities will remain defense-unique to preserve our technological advantage.

Government and industry stakeholders are keenly aware of the significant pressures on the industrial base. Firms find themselves in a difficult environment to conduct long-term planning as they determine their investment strategies and realign business activities to compete in competitive markets. The continued prospect of more sequestration forces firms to focus on short-term objectives at the cost of developing long-term investment strategies, thus affecting our innovation processes and our future. The firms that will succeed in this environment will need to make strategic investments now.

We are deeply concerned about the loss of technical expertise and design teams that are sustained through new program development. Over the past decade, many industrial sectors have had no or few new-start opportunities in defense-specific areas that are currently undergoing a decline in procurement. The combination of loss of design and production capability could result in costly delays and unanticipated expense, creating a significant impact on the development of next-generation weapon systems to meet tomorrow's Warfighter needs. Investments in research and development drives innovation and modernization. We remain concerned about protecting the adequacy of our R&D investments in capabilities and systems that will allow the Department to dominate on future battlefields and maintain engineering design teams that can develop advanced defense systems.

While our defense industry is currently viable and competitive, we are further concerned about the impact that additional defense budget cuts would have on the ability of industry to provide the broad range of products and services required by the Department and the Nation. In addition, sequestration and prolonged uncertainty could limit capital market confidence in the defense industry, undermining companies' willingness or ability to continue to invest in their defense portfolios. Continued uncertainty will hit smaller, innovative, and niche product companies particularly hard, due to their lack of capital resources to withstand the turmoil and uncertainty. While only a fraction of our industrial base capabilities are truly at risk, the United States is still in danger of losing some key industrial capabilities that are vital for our future national security.

Appendix A - Annual Report Requirements

Section 2504 of title 10, U.S.C., requires that the Secretary of Defense submit an annual report to the Committee on Armed Services of the Senate and to the Committee on Armed Services of the House of Representatives by March 1st of each year. The report is to include:

(1) A description of the Departmental guidance prepared pursuant to section 2506 of this Title.

(2) A description of the methods and analyses being undertaken by the DoD alone or in cooperation with other Federal agencies, to identify and address concerns regarding technological and industrial capabilities of the national technology and industrial base.

(3) A description of the assessments prepared pursuant to section 2505 of this Title and other analyses used in developing the budget submission of the DoD for the next fiscal year.

(4) Identification of each program designed to sustain specific essential technological and industrial capabilities and processes of the national technology and industrial base.

Section 852 of the NDAA for FY 2012 required that the annual report to Congress on the defense industrial base submitted for FY 2012 pursuant to section 2504 of title 10, U.S.C., includes a description of, and a status report on, the sector-by-sector, tier-by-tier assessment of the industrial base undertaken by the DoD. As required, the report included a description of the steps taken and planned to be taken:

(1) To identify current and emerging sectors of the defense industrial base that are critical to the national security of the United States;

(2) In each sector, to identify items that are critical to military readiness, including key components, subcomponents, and materials;

(3) To examine the structure of the industrial base, including the competitive landscape, relationships, risks, and opportunities within that structure;

(4) To map the supply chain for critical items identified under paragraph (2) in a manner that provides the DoD visibility from raw material to final products;

(5) To perform a risk assessment of the supply chain for such critical items and conduct an evaluation of the extent to which:

(a) the supply chain for such items is subject to disruption by factors outside the control of the DoD; and
(b) such disruption would adversely affect the ability of the DoD to fill its national security mission.
(c) Follow-up Review.—The Secretary of Defense shall ensure that the annual report to Congress on the defense industrial base submitted for each of fiscal years 2013, 2014,

and 2015 Includes an update on the steps taken by the DoD to act on the findings of the sector-by-sector, tier-by-tier assessments of the industrial base and implement the strategy required by section 2501 of title 10, U.S.C. Such updates shall, at a minimum—

- Be conducted based on current mapping of the supply chain and industrial base structure, including an analysis of the competitive landscape, relationships, risks and opportunities within that structure; and

- Take into account any changes or updates to the national defense strategy, National Military Strategy, national counterterrorism policy, homeland security policy, and applicable operational or contingency plans.

The Senate Report 112-26 accompanying S. 1253, the NDAA for FY 2012, noted at pages 65-66 that the Senate Armed Services Committee is interested in how the determination of DPA Title III projects will be linked to the outcome of the S2T2 assessments, which would identify sectors of the defense industrial base that may require additional resources. The committee requested the DASD(MIBP) to submit an annual report by April 1, to the congressional defense committees containing a prioritized list of potential investments required to address industrial base shortfalls to be expected to be funded by the Department in future years through the DPA Title III program.

This report contains the required information.

This report simultaneously satisfies the requirements pursuant to Title 10, U.S.C., section 2504, which requires the DoD to submit an annual report summarizing DoD industrial capabilities-related guidance, assessments, and actions and Senate Report 112-26, which accompanied the NDAA for FY 2012, and requires a report containing a prioritized list of investments to be funded in the future under the authorities of Title III of the Defense Production Act.

Appendix B – Summary of Key Industrial Capabilities Assessments Completed During CY 2013

This appendix summarizes assessments conducted by the Military Departments and Defense Agencies during 2015. It is classified For Official Use Only Business Sensitive. For access, contact the Office of Manufacturing and Industrial Base Policy, 703-697-0051.

Appendix C – Related Activities

C.1 Title III – Defense Production Act Summaries

Current DPA Title III Projects

Advanced Carbon Nanotube Volume Production

This Title III project provides infrastructure for the world's first manufacturing production facility of carbon nanotube (CNT) yarn, sheet, tape, and slurry material. The project emphasizes increasing output volume by expanding flexible, scalable, and modular production processes; improving product quality and yield; and reducing manufacturing costs.

Carbon nanotubes exhibit extraordinary strength and unique electrical properties and are highly efficient thermal conductors. They are the strongest and stiffest materials discovered in terms of tensile strength and elastic modulus respectively. CNT materials conduct electricity, shield from electro-magnetic interference and electromagnetic pulses, and enhance ballistics protection while being impervious to corrosion, heat, or sunlight degradation. CNT yarn, sheet, tape and slurry based-products can operate in broader temperature ranges, radiation levels, and corrosive environments than conventional materials.

A pilot facility, made operational through this project, began producing CNT material for test and evaluation purposes, delivering hundreds of feet of sheet material and hundreds of kilometers of yarn made in this facility to customers. From this contractor, CNT Electro-Static Discharge/Electro-magnetic Interference shielding achieved a technology readiness level (TRL) of 8/9 for spacecraft, while CNT heaters, data cables, enhanced soft and hard ceramic armor have all achieved TRL 6.

This project was funded through Congressional increase to the Title III budget. DPA Title III funding is $20.64M, augmented by $8.22M of contractor cost sharing. In addition, the contractor contributed $19.7M through private investment. This was a competitive solicitation.

Advanced Complementary Metal Oxide Semiconductor (CMOS) Focal Plane Arrays (FPA) for Visible Sensors for Star Trackers Project

This project, awarded in May 2012, will expand and enhance the domestic industrial base's ability to produce visible imagers manufactured using Advanced CMOS technology. Advanced CMOS imagers are designed to enable flexible visible imaging systems on-board satellite and other systems for Department of Defense and other U.S. Government needs. Staring Technology for Enhanced Linear Line-of-site Angular Recognition (STELLAR) chip specification and testing framework acceptance have been achieved and industry Pixel Design Arrays (PDAs) are in fabrication with first Cycle of Learning (COL) to be completed by March 2014.

Total government funding for this project is $12.54M, augmented by $4.24M of contractor cost sharing. Government funding is provided by members of the Space Industrial Base Council's

Critical Technologies Working Group under the terms of a MOA with the Title III Office. This effort was sourced through a competitive solicitation.

Advanced Drop-In Biofuel Production Project

The objective of this project is to form one or more Integrated Biofuels Production Enterprises (IBPEs) comprised of partnerships that establish the complete value chain capable of producing drop-in replacement biofuels. The project was initiated in support of the Departments of the Navy, Energy and Agriculture to partner with private industry to accelerate the commercialization of drop-in biofuels for military and commercial use. "Drop-in fuels" can utilize existing infrastructure, are delivered to DoD fully blended with conventional petroleum product counterparts JP-5, JP-8 (aviation fuels) and/or F-76 (naval diesel), and are ready for use with no modification to distribution or aircraft/ship systems.

The three Departments developed a plan to invest over multiple years to spur private industry and financiers to match Title III funds for the construction or retrofit of multiple commercial-scale integrated biorefineries, each capable of producing at least 10 million gallons of neat fuel annually from domestic feedstocks at a competitive price. Proposed integrated biorefineries must be based in the United States or Canada and use renewable biomass from domestic sources.

The project uses a two-phased approach. In Phase 1 of the program, the Department of Defense, acting through the Air Force, DoD's Executive Agent for the DPA Title III Program, awarded four contracts totaling $20.5M for 15-month efforts. Phase 1 involves validation of production technology, verification of technical maturity, site selection, plant design, permitting, and detailed cost estimation. Each Phase 1 contractor is required to match government funding with its own funds on a 1:1 basis.
Phase 2 proposals are due in March and April 2014. Assuming the technical evaluation warrants the decision to proceed to Phase 2, the government anticipates one or more awards, each up to $70M of DPA Title III funding, to cover up to half the cost of building and commissioning the facilities. The remaining cost will be from industry cost-sharing, with any selected contractor required to match Title III funding with its own funds on at least a 1:1 basis.

This project is being funded through increases to the Title III budget made by the Department of Defense and Department of Energy in addition to auxiliary funding to be made available by the Department of Agriculture. Total Title III funding for Phase 1 activities is $20.5M, augmented by $23.5M of contractor cost sharing. Total Phase 2 funding is yet to be determined. This was a competitive solicitation.

ALON® and Spinel Optical Ceramics

ALON® (aluminum oxynitride) and spinel (magnesium aluminate) Optical Ceramics are extremely durable optical ceramics with excellent mechanical and optical characteristics. ALON and spinel components have optical and mechanical properties similar to sapphire; however, they are producible in larger sizes, higher quantities, more complex geometries, and at lower costs.

This is primarily due to the manufacturing processes, which utilize well-understood, conventional ceramic powder processing techniques.

ALON® Transparent Armor represents the state of the art in ballistic windows, providing the highest level of protection at half the weight and thickness of conventional glass laminates. In addition, the transmission of ALON® Transparent Armor offers a 45 percent improvement in situational awareness over low lead glass laminates for Night Vision Goggles. ALON® Transparent Armor was inserted into a commercial airplane requiring the highest level of performance, for which FAA certification was required and obtained. ALON® Transparent Armor is currently being purchased for a number of military helicopters, with production ramping up in 2013. ALON® is also one of the advanced transparent ceramic materials evaluated for future ground vehicle platforms such as the Joint Light Tactical Vehicle (JLTV).

Future systems such as the Joint Air-to-Ground Missile (JAGM) and the Common Infrared Counter Measures (CIRCM) program require ultra-durable and affordable IR transparent dome materials. Both ALON and spinel are candidate materials for these applications. ALON has producibility advantages over spinel, while spinel transmits further into the IR than ALON, making it the material of choice for systems that require extended Mid Wave Infrared (MWIR) transmission. The contractor recently completed a multi-year delivery of ALON® reconnaissance windows to a NATO ally and anticipates a follow on order in 2014. ALON® windows are also used for sensor and laser systems on a number of military/commercial platforms which require ALON's combination of transparency and durability.

Title III is continuing to support an initiative to establish an integrated, flexible manufacturing process capable of producing ALON® and Spinel Optical Ceramic components in the shapes and sizes required for aircraft transparencies, missile domes, reconnaissance windows, and transparent armor applications. Highlights of ALON's impressive accomplishments are:

- 70 percent improvement in powder utilization for small components (~6-in diameter)
- 40-50 percent increase in powder utilization for large plates (~15x27-in)
- 50 percent increase in the maximum size of ALON plates that can be produced in large quantities
- 300 percent increase in throughput for large ALON plates
- Ability to consistently produce large ALON blanks and windows suitable for reconnaissance applications
- 10x improvement in homogeneity
- 6x reduction in stress induced birefringence
- 700 percent increase in throughput for polishing ALON® Transparent Armor.

Going forward, emphasis will be placed on increasing size, quality, yield, and affordability of both ALON and spinel materials, and on facilitating component evaluation, qualification, and insertion.

This project was initially funded through a Congressional increase to the Title III budget. Funding from the Air Force, Army, Navy, and the Industrial Base Innovation Fund (IBIF) added to the effort. Total Government funding is $18M, combined with $3.5M in cost sharing by the

contractor. This was a sole source solicitation as only a single domestic source was identified for the specific technology of interest.

Atomic Layer Deposition Hermetic Coatings Project (Concluded Sep 2013)

In FY2013, the Title III Program completed a six-year partnership with Raytheon RF Components (RRFC) in Andover, MA, a leader in the research, development, and production of compound semiconductor MMICs for the defense industry, aimed at establishing a domestic production capability for ALD coatings used with advanced microelectronics. ALD is a deposition technique that places protective films down one atomic layer after the other directly onto essential circuits; thus, eliminating the need for costly and inefficient protective encapsulates. Compared to traditional metal hermetic enclosures, MMIC protection through ALD coatings will result in reduced cost, size, and weight for microwave active electronically steered arrays (AESA's). Further, current systems that protect the MMICs with a board-level coating will also reduce manufacturing costs by utilizing this new technology.

Metal hermetic enclosures are the traditional solution to protect microwave MMICs against humidity. However, this expensive solution also limits the packaging density of the MMICs. A prior DoD program successfully eliminated traditional hermetic enclosures by using an approach that involved board-level coatings to protect the MMICs from humidity. This resulted in a significant reduction in the cost of a radar system.

The Title III ALD Hermetic Coatings program leveraged this prior DOD program by extending the cost-saving methodology of environmental coatings one step further by building the coatings into the MMICs during the manufacturing process, instead of applying board-level coatings. This approach eliminated the first board-level coating, and it further reduces the cost of the entire radar system due to cost savings at higher levels of assembly.

The production of Gallium Arsenide (GaAs) MMICs with wafer-level environmental protection using ALD coatings was achieved at the conclusion of the program in September 2013. These MMICs will enable a considerable cost savings at the next higher assembly level. In addition, it attained Manufacturing Readiness Level (MRL) of 8, meaning that the process is ready for LRIP in a DoD acquisition program.

This Title III project significantly reduced technology transition risk to DoD acquisition programs. Not only were production processes developed and refined as part of this project, but significant quantities of ALD MMIC wafers were produced, thus enabling a rigorous assessment of environmental protection, RF performance and reliability, cost, cycle time, and production

capacity. Extensive data validates that the ALD coatings provide excellent environmental protection with virtually no impact to MMIC performance and at no additional cost compared to the existing coating technology utilized.

ALD MMICs are the baseline plan for the environmental protection for several new, pending DOD radar systems. Further, the ALD technology is being extended to GaN MMICs. Since the Title III program was awarded in 2007, GaN MMICs have become the premier technology for high power applications. A GaN transistor has approximately a five times higher output power than a GaAs transistor of similar size; thus, new radar designs use GaN MMICs for the power amplifier and limiter functions while GaAs is used for phase shifters and low noise amplifiers.

Total government funding was $5.4M, augmented by $500K of contractor cost-sharing. Outside of the Title III contract, the contractor invested millions of dollars, demonstrating commitment to developing the ALD coatings technology. This was a sole-source solicitation as only a single domestic source was identified for the specific technology of interest.

Bio-Synthetic Paraffinic Kerosene (BSPK)

The objective of this project is to establish a domestic, large-scale, commercial, feedstock flexible, manufacturing capacity of BSPK. BSPK is a biomass derived fuel product. It is of strategic importance to diversify U.S. energy sources in order to achieve energy security and increase environmental stewardship. Energy security and environmental stewardship for the DoD requires the unrestricted, uninterrupted access to affordable, clean energy sources to sustain mission objectives. Biomass based fuels are an attractive alternative to petroleum-based fuels since they are produced using renewable resources and can be exploited using more environmentally friendly technologies. The U.S. military's lack of diversified fuel options could negatively impact mission capabilities if crude oil supplies were disrupted.

The anticipated output from this project will be 20 to 26M gallons per year of biomass based fuel products such as renewable marine diesel and jet fuel. This output will be achieved by retrofitting portions of an existing oil refinery located in Paramount, CA. The retrofit is a $22.7M cost-share venture between the U.S. Government and industry. The retrofit will consist primarily of revamping/installing hydro-processing units and other supporting equipment. The Technology Investment Agreement (TIA) was executed 21 Sep 2012.

This project was funded through a Congressional increase to the Title III budget. Total Title III funding is $3.61M, augmented by $19.09M of contractor cost sharing. This was a sole source solicitation as only a single domestic source was identified for the specific technology of interest.

CO_2 Absorbent Plastic Project

Calcium hydroxide and lithium hydroxide CO2 absorbent plastics are materials that actively absorb CO2 from the air in environments such as submarines, mines, underwater breathing, and medical anesthesia. If left unchecked, increased CO2 levels lead to impaired thinking, unconsciousness or even death. CO2 absorbent materials traditionally are found in raw granule form, either packed into canisters or sprinkled loosely about on the floor. Reactive plastic CO2 absorbent material encapsulates the absorbent chemistry into a plastic matrix or sheet thereby locking the absorbing material in place, and minimizing dust exposure to the surrounding air. These products improve rate of absorption by as much as 300 percent and also improve absorbent capacity allowing for reduced size and weight absorbers (i.e., 35 percent more absorbent in same storage footprint of lithium hydroxide granules used on submarines).

Micropore's ExtendAir® material is used in controlling the atmospheric CO2 levels in sealed environments such as military submarines, mine safety shelters, military and commercial diving rebreathers, commercial diving habitats, medical anesthesia machines (SpiraLith™), and personal escape devices.

The goal of this Title III effort is to expand the domestic production capability and meet the Department's needs for calcium hydroxide and lithium hydroxide CO2 absorbent plastics. The company has increased their extraction capacity six-fold while improving calcium and lithium hydroxide yields by 39 percent and 23 percent, respectively. Technology insertions include: retrofit of Navy VIRGINIA-class submarines, three combat diver rebreather platforms, certification of absorbent for Mine Safety and Health Administration (MSHA) refuge shelters, and introduction to hospitals for new anesthesia machine absorbents. In June 2013, a new phase of the project was awarded focusing on cost reduction, material recycling, and market penetration into both the military diving and medical anesthesia markets.

Total Title III funding is $16.3M augmented by $2.2M of contractor cost-sharing. This was a sole source solicitation as only a single domestic source was identified for the specific technology of interest.

Coal-Based Carbon Foam

Coal-based carbon foam is an inexpensive, lightweight, fire-resistant, impact-absorbing material that can be fabricated in a variety of shapes, sizes, and densities. It replaces conventional materials that are higher cost, of lower structural capability, are hazardous for fire, and are heavier. Its electrical conductivity can be varied over nine orders of magnitude and it has a low coefficient of thermal expansion.

Carbon foam's applications include lightweight tooling, blast mitigation panels, and hot structure applications. It exhibits similar properties as alternative materials, but at a lower cost, and it outperforms other products in noise reduction, fire resistance, impact resistance, energy absorption, and thermal properties. The goal of this Title III effort is to expand the domestic production capability for coal-based carbon foam to meet the Department's needs for blast mitigation, hot structure applications, and low-cost tooling.

During the program, TRL increased CFOAM production capacity by 30 percent by re-designing a large kiln furnace. Production efficiency improvements yielded an overall material cost reduction of 35 percent. The company developed a rapid prototype composite tooling surface, reducing fabrication time by 75 percent and overall prototype tooling costs by half. Lastly, in 2013, an 8 ft x 25 ft high-temperature/high-pressure horizontal autoclave was installed, increasing CFOAM capacity three-fold, from 8,500 cu ft to more than 36,000 cu ft annually.

This project was funded through Congressional increase to the Title III budget. Total Title III funding is $10.5M, augmented by $900K contractor cost-sharing. This was a sole source solicitation as only a single domestic source was identified for the specific technology of interest.

Conductive Composites Nano-Materials Scale-Up Initiative

This Title III project will establish a domestic source for high performance chemical vapor deposition (CVD) coated materials to solve current and future warfighter materials problems. The project is scaling up coatings capabilities utilizing commercially-available materials (nickel, carbon substrates) to construct nickel-coated nano-materials that can be subsequently blended into a normally non-conductive substrate (i.e., polymers, paints) to make them conductive. Tasks include a comprehensive production expansion plan, evaluation (and implementation) of critical processes for optimization, and improvement of product quality, yields, and production cost reduction. Title III also focuses on business and marketing planning to monitor long-term growth of project vendor(s), emphasizing business planning and activities that will support sustainable economic viability.

To date, the project installed a second nickel-CVD (NiCVD) fiber coating machine, increasing capacity fourfold. Additionally, a modified and upgraded NiCVD nonwoven coating machine increased capacity fivefold. A new organo-metallic gas synthesis unit was installed, doubling capacity. The industry partner is in the process of moving their manufacturing facility to a new location, anticipating a February 2014 completion, with production running by March 2014.

This project was funded through Congressional increase to the Title III budget. Title III government funding is $5.16M across Phases I and II. This was a sole source solicitation because it was identified as the only domestic source for the specific technology of interest.

Extremely Large Domestic Expendable & Reusable Structures

The objective of this project is to ensure a dedicated source for the manufacture of larger-scale diameter composite structures to satisfy defense and non-defense U.S. space industry requirements. The project includes evaluating and modifying current production facilities; and procuring, installing, startup, qualifying, and operating an advanced machining center; an automated ultrasonic inspection system; and a combined Automated Tape Laying & Fiber Placement Machine [known as a Dockable Gantry System (DGS)], as well as other support equipment.

Driven by the need for improved fuel efficiency and operability, composite materials are commanding an important role in airframe, engine structures, and space launch vehicles. Automated composite technologies and improved non-destructive inspection techniques are all being implemented to deliver affordable, high performance parts and assemblies for the DoD and the U.S. aerospace industry. Several DoD and NASA programs will benefit through the efficient and expanded production of larger scale components. Such programs include those applications requiring crew and heavy-lift cargo transport capabilities. These systems will provide mission support for continued crew transfer and logistics supporting the International Space Station, current and future space crew exploration vehicles, and payload/satellite deliveries.

Recent accomplishments include: finalizing the design of the DGS, initializing site preparation and initiating machine fabrication; installing an improved camera system, and releasing a machining center to production.

This project was funded through Congressional increase to the Title III budget. Total Title III funding is $14.3M, augmented by $9.1M of contractor cost sharing.

Gallium Nitride Advanced Electronic Warfare Monolithic Microwave Integrated Circuit Producibility

The objective of this Title III project is to establish a domestic, economically viable, open-foundry merchant supplier production capability for Ka-band GaN MMICs. The overarching goal is to achieve MRL 8, which means that the process is ready for LRIP in a DoD acquisition program. This will be achieved through the application of process improvement techniques such as Six Sigma and LEAN manufacturing to reduce process variation and enable repeatable MMIC performance and reliability. This project leverages prior Government sponsored work by DARPA, Air Force Research Laboratory (AFRL), and Office of Naval Research Naval Research Laboratory (ONR/NRL).

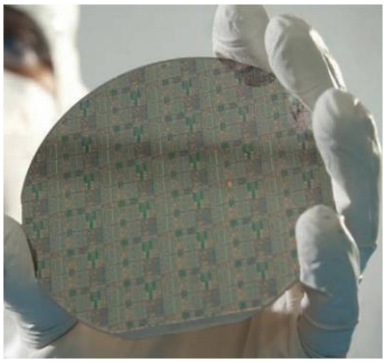
The transition to a 100mm GaN MMIC production line is complete, reducing manufacturing costs by 41 percent. Also, various MMIC manufacturing improvements have been initiated to further reduce costs. Fabrication of the four baseline Manufacturing Readiness Assessment (MRA) lots is complete, and testing and evaluation is underway to determine GaN MMIC yield, cost, capacity, cycle time and reliability in Year 1. The preliminary results look encouraging.

This project is funded in part with offsets transferred to the Title III budget from the Navy. Total government funding is $8.6M augmented by $8.6M of contractor cost-sharing. A single contract was awarded in January 2013 in response to a competitive 2012 BAA solicitation.

Gallium Nitride Radar and Electronic Warfare Monolithic Microwave Integrated Circuit Producibility

The objective of this Title III project is to assess, improve, and validate production-ready processes for S-Band and Wideband GaN MMICs, and ensure multiple domestic sources of supply for GaN MMICs.

In addition to GaN's high power density, another important benefit is the high input and output impedance that translates to wider bandwidth power amplifier designs that maintain higher power and efficiencies than existing semiconductor technologies. The overarching goal is to achieve a MRL of 8 (ready for LRIP) through the application of Six Sigma techniques to reduce process variation and demonstrate repeatable MMIC performance, life, and reliability.



Both industry partners working this project have completed their respective baseline MRAs, improvement phases, and final MRAs for the project. Both contractors are performing an extensive suite of reliability and operational tests.
This project was funded in part with offsets transferred to the Title III budget from the Navy. To date, total government funding is $35.4M, combined with $3.6M in cost sharing/contribution by the contractor. This project was awarded to two contractors through a competitive solicitation.

Gallium Nitride X-Band Monolithic Microwave Integrated Circuits (Concluded 2013)

Title III partnered with Raytheon RF Components in Andover, MA, to assess, improve or refine, and validate a domestic source of supply for X-Band (8 GHz to 12 GHz) GaN MMICs. The project improved and matured the production of GaN MMICs evidenced by achieving a MRL of 8: process ready for Low-Rate Initial Production. When comparing the final results to the baseline MRA, it exceeded all threshold yield performance requirements, resulting in a 3-fold improvement in product yield and a 76 percent cost reduction of its GaN MMICs. In addition to the yield improvements, the team logged more than 1M hours of reliability testing over the course of the project. The comprehensive reliability testing helped eliminate early MMIC failures and exceed the Median Time to Failure performance requirement by 1000 times.

This project was funded in part with offsets and other funds transferred to the Title III budget from the MDA. Total government funding was $9M augmented by $2.3M in contractor cost-sharing. This was a sole-source award to expedite the technology insertion by capitalizing on prior government investments in a production process that was already demonstrated and capitalized, thus enabling the Title III project to efficiently utilize its limited resources to focus primarily on manufacturing improvements.

Heavy Forgings Capacity Improvement Project

The purpose of this Title III project is to upgrade and refurbish equipment at the single domestic source for heavy forgings. DoD applications include propulsion shafts for surface and sub-surface naval vessels, periscope tubes, ring forgings for bull gears, and reactor vessels.

Heavy forgings are unique and require a 10,000-ton open die forging press (the largest and only one of its kind in North America) in order to produce parts that begin with ingots that are up to 11 feet in diameter and weigh up to 600,000 lbs. In addition to the press, other special

requirements include ingot manipulators, forging ovens, building foundation and structural capacity to support the processing of such heavy ingots. The focus of this Title III project is to address production constraints and single points of failure that are critical to maintain the supply of heavy forgings to the DoD. This project is critical to shore up the single domestic source for heavy forgings.

Major accomplishments in Phase I include upgrading a vertical boring mill to eliminate a single point of failure and rebuilding the contractor's 10,000 ton open die forging press

In September 2013, a Phase II effort was awarded and included activities to increase capacity, provide new capabilities, and address potential high consequence events. Some of the projects being addressed include rebuilding a second large open die forging press, the procurement and installation of a new multi-axis vertical boring mill, and the procurement of new state of the art ultrasonic inspection equipment.

The total project funding level is $23.9M, which includes Government funding of $20.5M and contractor cost-share of $380K. Outside of this project, the contractor has invested in excess of $10M, demonstrating commitment to the heavy forging business in support of the DoD. This was a sole source solicitation as only a single domestic source was identified for the specific technology of interest.

High Homogeneity Optical Glass

This Title III project is structured to increase the manufacturing capacity, optimize production yields, and ensure greater availability of affordable High Homogeneity Optical Glass (HHOG) products. HHOG blanks are the basic building blocks in the fabrication of high precision optical lens systems, which are key technology drivers for several commercial, defense, and national security related applications. The blanks produced are of the H4 grade, which have a very tight tolerance for refractive index variation. If the refractive index is non-uniform, or non-homogeneous, then light rays passing through the material at different locations will be bent in random directions and in an amount approximately proportional to the non-homogeneity. This can have several effects depending on the application.

The primary goals of this project include increasing manufacturing capacity, optimizing production yields to greater than 70 percent, and ensuring greater availability of non-active and active HHOG products. Project goals will be achieved via improvements to raw materials and enhancements to production processes and associated control systems. Of particular concern to the DoD are lens products required in optical designs for aerial, satellite and other space surveillance equipment.

To date, the industry partner built customized power control cabinets, enhanced the forming system, retrofitted annealing ovens, acquired optical lens manufacturing equipment, and improved raw material blends.

This project was funded through Congressional increase to the Title III budget. Total Title III funding is $5.8M augmented by $5.3M of contractor cost-sharing. This was a competitive solicitation.

Integrated Advanced Composite Fiber Placement Program

This project will expand the U.S. domestic industrial base capability for the production of large aerospace composite products employing advanced fiber placement technologies.

Fabricating and installing state-of-the-art production equipment will provide manufacturing efficiency improvements of 30 percent or better. Automated Fiber Placement technology enables efficient placement of composite fibers directly onto complex geometry tooling that is required for a wing contour. The automated fiber placement process includes the ability to mechanically place composite material in a convex contour at higher degree angles. Unlike other manufacturing processes, it applies a band of material in individual tows or tape directly perpendicular to the surface of the part while applying pressure and heat to enhance the laminate properties. These features are suitable for fabricating composite structures where complex contours are required, performance and weight are critical parameters, and precision application of material in specific orientations is desired.

Several complex aerospace parts such as wing skins, ducts, nacelles, and fuselage skins are fabricated using advanced fiber placement processes. Other DoD systems anticipate using these advanced materials and design concepts for munitions, armaments, and hull structures for manned and unmanned robotic vehicles.

The project is creating commercially-viable production capabilities, and will share manufacturing enhancements with the commercial composite production community as appropriate. Recent accomplishments include: installing a large format autoclave and releasing it for production; designing, fabricating and installing three state-of-the-art fiber placement machines.

This project was funded through Congressional increase to the Title III budget. Total Title III funding is $27.1M augmented by $15.3M of contractor cost-sharing. This was a sole source solicitation as only a single domestic source was identified for the specific technology of interest.

Light-Weight Ammunition

This effort will establish and qualify a domestic production capability for the manufacture of lightweight ammunition based on polymeric material. The initial focus is the development, production, and qualification of lightweight .50 caliber machine gun rounds that that can be deployed in conventionally fielded weapon systems at a comparable cost to standard brass ammunition. The lightweight .50 caliber ammunition weighs approximately 25 percent less than standard brass ammunition.

Polymer-cased .50 caliber ammunition DoD qualification testing is underway at Naval Surface Warfare Center (NSWC) Crane for two weapon systems, M2 and GAU-21. Over 20,000 rounds have

been tested, and the preliminary results are encouraging. The lightweight .50 caliber ammunition was also successfully demonstrated in the XM806 weapon, a lightweight, developmental version of the M2 gun; and in the GAU-19, a three-barreled, aircraft specific weapon system.

Due to Army/SOCOM interest and support, the contractor recently began developing a prototype .300 Winchester Magnum precision round based on its polymer cartridge case design. The goal is to meet or exceed the ballistic performances and reliabilities set by the current (all brass) specification.

This project was funded through Congressional increase to the Title III budget. Funding of $3M was added from the U.S. Marine Corps. Total government funding is $15M, augmented by $10,000 of contractor cost sharing. This was a sole source solicitation as only a single domestic source was identified for the specific technology of interest.

Lithium-Ion Battery Production for Military Applications Project

This project will establish a long-term, viable, world-class domestic manufacturer of high-energy density lithium-ion (Li-Ion) batteries that is responsive to customer requirements with respect to performance, reliability, quality, delivery, and price. High energy density Li-Ion batteries are suitable for a number of military systems to include enhancing UAVs endurance, providing portable power to support the mission for the dismounted solder, long endurance autonomous systems, tactical vehicles, unattended sensors, and reconnaissance and surveillance systems.

The Li-Ion cells of interest will have an energy density greater than 250 Watt-hours per kilogram (Wh/kg) at 250 Watts per kilogram (W/kg) continuous (i.e. 1C rate) for military applications. The intent is to create a flexible manufacturing line capable of producing multiple battery form factors for both military and commercial applications. The project will effectively reduce the cost of high energy density Li-Ion batteries by leveraging increased combined assembly line volumes, even at low production run volumes of individual battery form factors. There will be commensurate improvements in power density, discharge rate, temperature range and safety and delivery of sample cells/batteries to the Government for independent testing. A key overall objective will be to achieve a MRL 8 capable of supporting LRIP.

This project is being executed as a multi-phase effort. Phase I (1 year) is a twelve-month effort, while Phase II will be a 36 month effort. Total funding for both phases is $24.4M. Two Phase I Contracts were awarded in January and March 2013. Phase I will deliver sample cells for independent government testing along with the delivery of key deliverables to include the strategic business and marketing plans and the final scientific and technical report.

The Phase II option will be a competitive down-select to one contractor with the basis for selection comprised of Phase I business plan deliverables, as well as technical and manufacturing accomplishments. Phase II will focus on refining Li-Ion ion cell chemistries for military applications, production capacity expansion, process improvements and advancing to MRL 8.

Lithium Ion Battery Production for Space

This Title III program will support the development of a domestic source for prismatic Li-Ion cells and their constituent active materials for spacecraft use. Li-Ion rechargeable battery technology provides higher power for longer durations with lower weight and favorable space constraints when compared to Nickel Cadmium (NiCd) or Nickel Hydrogen (NiH) rechargeable batteries. The Li-Ion battery offers the highest energy and power package of developed batteries today. Additional advantages include better recharging capability with no memory effect and increased temperature operating ranges. This technology offers designers a weight savings option compared to other battery types for overall weapon systems performance.

In 2013, the initial technical effort to create production capability for prismatic low earth orbit (LEO) cells and constituent materials was completed. Tasks completed this year included qualifying the meso-carbon micro-bead (MCMB) anode production line, installing and qualifying the cathode precursors production line (cobalt oxide and nickel cobalt aluminum hydroxide), and qualifying the lithium cobalt oxide (LCO) and lithium nickel cobalt aluminum oxide (LNCAO) cathode production line.

Also in 2013, a follow-on effort to qualify production of 18650-size wound cells for space launch vehicles and micro-satellites was initiated. The follow-on effort leverages the long life material production capacity established in the earlier phase of this project and a California Energy Commission grant to install production capacity for 18650 cells as well as other industry proprietary technologies.

This project was funded initially by funding provided from the DoD Title III budget plus other funding that was transferred from the Air Force and another government agency. A Congressional increase for Title III provided $1M during project execution. Total government funding is $55.2M augmented by $15M of contractor cost-sharing. This was a competitive solicitation.

Low Cost Military GPS Receivers

Military GPS receivers are a vital piece of equipment for soldiers on the battlefield. GPS receivers allow the warfighter to perform both strategic and tactical maneuvers with a high degree of confidence of success. Without secure, reliable GPS receivers, soldiers lack both their specific positioning on the battlefield and that of their fellow soldiers.

The primary objectives of this Title III project are to create domestic production capabilities for essential subcomponents for the Defense Advanced GPS Receiver (DAGR) and to pursue methods for reducing their weight, size, power consumption and cost while improving performance capabilities.

A new phase was awarded in August 2013 to improve on size, weight, power consumption, cost, and capability to ever improve the capabilities of the dismounted soldiers.

This project was funded through Congressional increase to the Title III budget. Total government funding is $11.1M augmented by $16M of contractor cost-sharing. This was a sole-source solicitation as only a single domestic source was identified for the specific technology of interest.

Military Lens System Fabrication and Assembly

This Title III program will establish a domestic resource for mono-spectral and advanced multi-spectral optical systems and lens components. This effort will develop a manufacturing capability for design, fabrication, finishing, coating, assembly, and testing of mono- and multi-spectral night vision optical systems that can be integrated into military and commercial surveillance systems.

Multi-spectral systems are shared aperture systems that allow widely separated wavelength bands to be transmitted through a common aperture and share common elements in the optical train. They offer considerable advantages for the warfighter, including weight and volume reduction, by allowing the warfighter to carry fewer pieces of equipment; improving performance, by allowing both bands to utilize the full aperture of the systems; and optimized system design for a larger set of operating conditions/environments.

The industry partner transferred Title III advanced optical lens equipment to a new dedicated 30,000 square foot facility and reinitiated production. Lens production capacity increased from less than 500 lenses to over 80,000 lenses per year though equipment purchases and manufacturing improvements.

This project was funded through Congressional increase to the Title III budget. Industrial Base Innovation Fund (IBIF) also added funding of $0.9M. Total government funding is $8.8M and is augmented by $2.5M of contractor cost-sharing. This was a competitive solicitation.

Mini-Refrigerant Compressors for Man-Portable Cooling

Title III collaborated with industry to establish a domestic low-volume production facility for mini-refrigerant vapor compressors. The program's industry partner purchased a production facility, and Title III assisted with plant facilitation and purchasing manufacturing, assembly, and test equipment.

The mini-compressor weighs 1.3 pounds, has a diameter of 2.2", and a height of 2.7". It is contained within a hermetically sealed case; has a sensor-less, brushless motor; operates on 12, 24, or 48 volt DC power; and interfaces with an external motor drive board. Industry is currently developing a capability for mini-compressors to operate on alternative input power options including solar power, and a universal power supply. Two models of the mini-compressor are available with slightly different displacement cooling capacities: a 360 W (1.4cc) and 455 W (1.9cc) product to meet different user requirements. In 2014, industry will begin producing quieter versions of these compressors to cater to commercial market requirements.

Although personnel cooling is a viable application (i.e. aircrew cooling and dismounted soldier cooling), this technology's primary DoD and commercial application is with electronics cooling. The compactness of these mini-compressors enables them to be installed within electronics cabinets to provide active cooling of components. This increases the performance, reliability, and life of mission-critical electronics systems in high temperature environments.

Today, miniature refrigeration compressors provide cooling to critical electronic components installed within Electronics Transit Cases. More than 1,500 MIL-hardened Electronics Transit Cases have been fielded to date in Mine Resistant Ambush Protected (MRAP) armored fighting vehicles operating in support of Oversees Contingency Operations. Mini-Compressors provide electronics cooling for Persistent Threat Detection Systems, which are fielded by the U.S. Navy. Mini-compressors may also be selected to provide electronics cooling for the Joint Light Tactical Vehicle (JLTV), which is currently in a competitive acquisition.

This project was funded through Congressional increase to the Title III budget. Total Title III funding is $11.8M, augmented by $0.6M of contractor cost sharing. This was a competitive solicitation.

Non-Aerospace Titanium for Armor and Structures Transformation Project

The excellent strength-to-weight and corrosion-resistance properties of titanium make it useful for many structural applications. It also has excellent ballistics properties that, along with the low weight, make it ideal for armor. Due to large increases in commercial aerospace demand for titanium, lead times for titanium have grown to over one year, while costs have more than tripled.

By working outside the aerospace titanium supply chain, this Title III program will help reduce cost and shorten delivery lead-times for structural titanium and titanium armor. The initial effort will focus on implementing the capability to direct-roll titanium in widths and thicknesses that can be used for armor tiles on military ground vehicles. Military applications include reactive armor tiles, armor, and structural material for military vehicles and tanks, and naval ship piping, which is subject to corrosion.

Finishing equipment, installed in the first phase of the project, processed armor brackets, Joint Light Tactical Vehicle (JLTV) prototype parts, and components for retrofitted racking systems on DoD vehicles. A plate mill was procured for enhanced in-house production capability.

This project was funded through Congressional increase to the Title III budget. Total Title III funding is $12.8M, augmented by $2.1M of contractor cost sharing. This was a competitive solicitation.

Polyhedral Oligomeric Silsesquioxanes (POSS™) Nanotechnology

This Title III project is scaling up production of Polyhedral Oligomeric Silsesquioxanes (POSS®), a nano-sized material that, when used as a chemical additive, can greatly enhance the performance of polymers for a variety of DoD and commercial applications. POSS® has been

demonstrated as useful in applications such as radiation shielding for space-based microelectronics, coatings that prevent growth of tin whiskers on lead-free solder, photoresist material for semiconductor manufacturing, automotive fuel filters, food packaging, optical lenses, and aircraft tires. POSS® was the enabling catalyst for the world's first synthetic organ transplant in 2011.

This project has taken POSS® from the laboratory to full-scale commercialization and developed and qualified POSS® products for numerous customers. Title III resources are being utilized to increase production capacity through equipment purchases and upgrades to meet current and future demand. Title III efforts are also expanding sales and marketing activities to broaden market penetration.

This project was funded through Congressional increase to the Title III budget. Total Title III funding was $21.29M, augmented by $2.22M of contractor cost sharing. This was a competitive solicitation.

Radiation-Hardened Cryogenic Readout Integrated Circuits

Title III resources will be utilized to establish a viable, domestic foundry for commercial production of less than or equal to 0.18 micron deep sub-micron CMOS)Radiation-Hardened Cryogenic ROICs. These microelectronics are a critical technology employed in the manufacture of FPAs that are utilized in high altitude and space-based imaging and missile systems. The next generation imaging requirements are dependent on the availability of advanced ROICs that provide high density with analog components, smaller pixels (increased resolution), and increased functionality through on-chip processing. Additionally, ROICs need to be physically larger (enabled through stitching technology) to meet increasing focal plane array size requirements, reducing particle counts that improve production yields, and improving fabrication cycle times. These improvements will collectively increase the mission capability of the systems.

Title III funding is providing industry the capability to produce a 0.18um Large Format (LF) ROIC device per vendor design. Funding is also being used to determine radiation immunity standards via vendor surveys to better understand industry needs. Yields have more than doubled and continue to gain efficiency. Better failure analysis resulted in reduced defect densities and yield improvement. In addition, as part of the Title III effort, the contractor has attained Trusted Foundry certification.

This project was funded through a Congressional increase to the Title III budget and Air Force funding. Total government funding is $13M augmented by $19.7M of contractor cost-sharing. This was a competitive solicitation.

Radiation-Hardened Microprocessors (Concluded in Jun 2013)

The United States' security is provided by an intertwined collaboration of efforts by numerous government agencies that rely on instantaneous and reliable communications and data transfer provided by the nation's satellite network.

This Title III project with BAE Systems in Manassas, VA successfully scaled up production capacities for high-performance radiation-hardened microprocessors for critical space systems. The effort migrated the BAE Systems RAD750™ processor from a radiation tolerant 132 MHz device to a radiation hardened 250 MHz device giving the DoD and commercial customers access to the latest technology in radiation-hardened microprocessors for space. The effort has yielded several benefits for microprocessor for space, including: improved size, weight, and power (SWAP), improved radiation total dose performance compared to commercial version, and improved computational performance at the same price. These microprocessors will enable spacecraft to operate in the challenging radiation environments of nuclear threats as well as long-term natural radiation, with greater on-orbit processing capabilities and reduced ground support required. A projected ten-year supply of microprocessors is currently in inventory.

This project was a collaboration of efforts involving the DPA Title III Program Office, the Defense Threat Reduction Agency, U.S. Air Force Space and Missile Systems Center, and other government agencies. This project was funded through Congressional increase to the Title III budget and other government agencies. Total government funding was $15.4M augmented by $4.2M of contractor cost-sharing. This was a sole-source solicitation as only a single domestic source was identified for the specific technology of interest.

ROIC Foundry Improvement and Sustainability

There are a number of challenges related to the design and fabrication of Large Format (LF) ROICs. As detector arrays grow in size and number of pixels per array (> 1M), the complexity of the ROIC increases and adds to the challenges of the foundry that must now utilize advanced CMOS processing techniques at 0.18 micron and below, with competitive wafer sizes (8 inches).

Other factors affect the design, processing, and performance of the ROICs for government space programs. The ROIC must exhibit very low noise to avoid contributing substantially to the noise of the sensor. Defect density in the ROIC reduces yield during manufacturing and may affect the operability of the sensor once it is hybridized. In addition to the low yields due to defect density, wafer size, and design complexity, there can also be long periods of time between orders due to the relatively small market for LF ROICs, resulting in production gaps.

As a result, it is difficult in this environment to keep equipment and staff running at peak performance. The scope of the Title III ROIC Foundry Improvement and Sustainability Program is to maintain minimal but adequate production capabilities at domestic foundries to assure the necessary supply of strategic ROICs deemed useful for government space programs. The primary goal is a sustainment initiative where, in addition to running continuous production, there is the added objective of making continual design and process improvements so that more aggressive yields can be realized in a timely manner.

The first of two vendors for this project was placed on contract in April 2010 and has more than doubled their yield in small wafer lots, demonstrating continued process improvement. Failure analysis has been improved with the capital purchase of an upgraded KLA Inspection

Tool. This tool allows for closer inspection of 0.18 micron ROICs to detect smaller (and potentially damaging) defects that were undetectable with older inspection tools. The vendor continues to work closely with a design house to improve testing programs resulting in improved defect densities.

A second contractor was placed on contract in June 2012 with initial wafer runs utilizing 0.25 micron ROIC chips that were completed in mid-2013. Early yield results significantly beat expectations and are anticipated to exceed project goals. The contractor has moved to a 0.18 micron ROIC chip with yield results beginning early 2014. This vendor is also working closely with a design house to assist with required testing programs. This cooperation has led to faster yield reporting and identification of potential wafer defects.

This project was enabled with funding transferred to the Title III budget from the Air Force, Missile Defense Agency, and another government agency. Total government funding for the project is $10.5M. Cost sharing/contributions by the contractors are $5.58M and $5.47M respectively. Competitive solicitations were the basis for execution of this project.

Silicon Carbide Powder Production and Ceramic Armor Manufacturing

High-purity silicon carbide (SiC) powder, specifically submicron alpha SiC powder, is a critical material for national defense. This refined form of SiC powder is the key ingredient required to produce high-quality, light-weight, and cost-effective SiC ceramic armor for the Warfighter. Primary applications include armor for land, air, and naval platforms and lightweight body armor. This Title III project is increasing the domestic production capacity for both submicron alpha SiC powder and SiC ceramic armor.

Powder capacity expanded from 588,000 kg/yr. to >800,000 kg/yr., including a cost reduction from $5/kg to $3.28/kg. New capacity for flat ceramic tiles increased from 17,000 sq. ft/yr. to over 42,000 sq. ft/yr., including a cost reduction per tile from $30 to $12.

This project was funded through Congressional increase to the Title III budget. Total Title III funding is $4.9M augmented by $6.2M of contractor cost-sharing. This was a competitive solicitation.

Small Secure Satellite Communication (SATCOM) Transceiver

This Title III project will establish a domestic capability for the manufacture of Small Secure Satellite Communication (SATCOM) Transceivers. A SATCOM Transceiver is a critical technology item that will be used to locate and recover U.S. Department of Defense and Allied/Coalition Isolated Personnel in harm's way.

The project will introduce manufacturing technology, production processes and procedures, and automated production systems to expand the U.S. industrial base production capacity for this critical technology item. The project is also striving to achieve quality and affordability objectives and it will ultimately provide greatly improved and more secure personnel recovery capabilities for the warfighter.

Two critical internal components were assessed at Manufacturing Readiness Level 8 in 2012, indicating Low-Rate Initial Production readiness capability. In 2013, Pilot Build 1 completed the UHF RF card and its performance exceeded threshold and objective requirements for final yield and first time test yield. Also in 2013, the Single Card System (SCS) Embedment Guide was completed, enabling authorized organizations to incorporate SCS modules into other enclosures and platforms, thus extending the applications for this hardware. The Joint Personnel Recovery Agency conducted a successful test of the prototype SCS-based handheld radio in July 2013.

Space Qualified Solar Cell Germanium Substrate Supply Chain Improvement Project

The purpose of this project is to enhance and expand the ability of the domestic industrial base to produce space-qualified germanium substrates for use on Government satellite systems. Commercial-grade germanium (Ge) substrates do not possess the quality necessary to produce high-reliability space solar cells.

Ge substrates are the basis for the solar cells used on all National Security Space (NSS) satellites and are forecast to continue as such for at least 10-15 years. Current state-of-practice solar cells built on Ge substrates operate at 28-30 percent efficiency. State-of-the-art Ge solar cells operating at 33 percent efficiency will transition to production in the near term, while 35-37 percent Ge solar cells are currently in development.

Major accomplishments in 2013 include expanding Ge crystal boule growth up to 2400mm (from 600mm), demonstration of a novel high-efficiency method of germanium oxide reduction, purchase and overhaul of Ge ingot zone refining equipment, and acquisition and installation of a large capacity Ge wafer saw.

Total government funding for this project is $8.55M, augmented by $8.8M of contractor cost sharing. Government funding is provided by members of the Space Industrial Base Council's Critical Technologies Working Group, under the terms of a MOA with the Title III office. This was a sole source solicitation, as a determination was made that only a single space-qualified domestic source existed.

Terahertz Spectrometer

This Title III project will establish a domestic capability for the manufacture of Terahertz (THz) Spectrometers. These devices will provide the DoD and Department of Homeland Security (DHS) communities with an advanced solution for the detection of hazardous chemicals. Emphasis is being placed on developing required modifications to improve system performance and producibility for the next generation Terahertz Spectrometer. The goal is to achieve a lighter, smaller, more affordable spectrometer with automated detection software, a web interface for remote operation/monitoring, and an alarm capability. The project leverages prior work performed by the U.S. Army Research Laboratory (ARL).

The design decisions made to date for the three major components, the gas sample cell, THz transceiver and custom electronics, are on track to support the achievement of the size, weight and cost reduction goals of the program. Also, the baseline MRA is complete. The overall process is currently at MRL 5: Components in Production Relevant Environment. The project's goal is to achieve MRL 8: LRIP readiness.

This project was funded through Congressional increase to the Title III budget. Total Title III funding is $3.6M augmented by $690K of contractor cost-sharing. This was a sole-source solicitation as only a single domestic source was identified for the specific technology of interest.

Thermal Battery Production

This Title III initiative will strengthen and expand the only domestic source for Cobalt Disulfide thermal batteries. Military unique, high performance batteries are the only viable power source for many strategic and tactical missile systems. The Missile Defense Agency and multiple DoD acquisition program offices identified high performance Cobalt Disulfide battery technologies as having insufficient domestic capacity and capability to meet program requirements. The focus of this Title III program is to scale up production capacity and expand capabilities required by military customers. The applicability of these batteries to a wide variety of DoD missile systems offers Army, Navy, and Air Force Program Offices the ability to greatly enhance system performance.

Major accomplishments in 2013 include the continued upgrading and improving manufacturing processes, including the upgrade of a large pellet hydraulic press to increase throughput significantly, installing a new vision system to inspect battery pellet stacks, and the delta qualification of in-house produced cobalt disulfide with greatly improved quality control.

This project was funded through Congressional increase to the Title III budget. Total Title III funding is $16.9M. This was a competitive solicitation.

Titanium Matrix Composites (Concluded in Oct 2013)

Titanium Matrix Composites (TMCs) and Enhanced Titanium (ETi) offer material properties that enable aircraft designers to engineer components that are stronger, lighter, and more durable than existing steel and pure titanium components. These improvements can expand U.S. air superiority margins over opposition forces by increasing lethality for U.S. munitions, increasing survivability for the warfighter, and ultimately increasing mission success rates. Title III funding enabled expansion of the domestic production capacity of TMCs and ETi to support the warfighter and assist in developing a database of TMC and ETi material characteristics and the processes required to produce TMCs and ETi.

Title III partnered with FMW Composites Systems, located in Bruceton Mills, WV, to enhance the market success for TMC, Ti powder and ETi materials. The focus of the program has

been manufacturing affordability, feedstock quality improvement and capacity expansion for the SiC fiber, Ti/ETi powder and ETi and TMC components. With the support of the Title III program, FMW established a 50,000 square foot facility in Bruceton Mills, with the capability and capacity for on-site manufacture of SiC fiber, Ti/ETi powder and TMC components.

In past years a significant amount of resources established affordable, high-quality SiC fiber production capabilities at the facility located in Bruceton Mills, WV. In March of 2012, six reactors (one "six-pack") were operational, enabling engineering to focus energies on refining the process to meet fiber specifications from both diameter and strength parameters. These efforts have enabled FMW to qualify its own higher quality, lower cost, SiC monofilament fiber. The current capacity of one six pack is 600 lb./year, which serves as the modular prototype for eventual expansion potential to 6000 lbs/yr.

FMW also established a titanium powder production capability at the Bruceton Mills facility. The new Ti/ETi powder production facility enables FMW to produce an initial capacity of 65,000 lbs/yr. of the Ti/ETi powder with one shift operation, and a capacity of 350,000 lb./year with three shift operation. The core production capability is in place and producing high quality Ti/ETi powder at affordable prices. The capability includes: primary melt (from Ti sponge plus master alloy or from scrap), casting capability of bar stock, clean non-contacting gas atomization, and basic sieving operations.

FMW co-located powder metal billet fabrication capability and TMC component production capability in the Bruceton Mills facility. In prior years of the Title III program, component processing and fabrication capability was enhanced in the FMW Bridgeport location prior to the establishment of the Bruceton Mills site. All titanium related processing and fabrication capability is now co-located in Bruceton Mills. The Bruceton Mills location is vertically integrated from raw materials (powder and fiber) to finished product with ISO 9001/AS9100 quality registration.

This project was funded through Congressional increase to the Title III budget. Total Title III funding is $28.9M augmented by $1.3M of contractor cost-sharing. This was a sole-source solicitation as only a single domestic source was identified for the specific technology of interest.

Traveling Wave Tube Amplifiers (TWTA) for Space

This project builds on the previous accomplishments by developing the infrastructure required to domestically produce advanced space-qualified K-band Traveling Wave Tube Amplifiers (TWTAs) designed for next generation commercial and government applications. A TWTA is a vacuum electronic device whose function is to amplify a radio-frequency signal. K-band TWTAs provide superior signal strength and larger bandwidth compared to today's satellite communications.

Establishing a globally competitive domestic source for next-gen high power, space qualified, K-band TWTAs is necessary for the DoD to obtain high quality components, on time, and at a fair market price. This project will greatly reduce the schedule, performance, and cost risks to government satellite programs that are inherent with having only one supplier. Recent

accomplishments include completing designs, automating test systems, procuring parts, and building subassemblies.

Total government funding for this project phase is $7.6M, augmented by $7.6M of contractor cost sharing. Government funding is provided by members of the Space Industrial Base Council's Critical Technologies Working Group, under the terms of a MOA with the Title III office. This is a follow-on effort to the Phase I sole source solicitation. This was a sole source solicitation as only a single domestic source was identified for the specific technology of interest.

Vacuum Induction Melting, Vacuum Arc Remelting Furnace Capacity

Low alloy Vacuum Induction Melting, Vacuum Arc Remelting (VIM VAR) steel is high-purity corrosion resistant steel that is processed through multiple melts under vacuum to reduce excess gases and other impurities. VIM VAR steel is essential for many military applications including engine bearings, helicopter rotor shafts, transmission gears and engine mounts. This Title III initiative will address production constraints and single points of failure in order to reduce lead times and ensure the domestic supply of low alloy VIM VAR steels for critical military components.

Major accomplishments in 2013 include adhering to the military requirement of maintaining lead times below 20 weeks by improving the throughput of the ultrasonic testing area and upgrading and expanding the inspection lab in order to support new customer requirements.

This project was funded through Congressional increase to the Title III budget. Total Title III funding is $25.6M augmented by $33.5M of contractor cost-sharing. This was a competitive solicitation.

DPA Title III Projects in Active Acquisition in 2013

Additive Manufacturing for Liquid Rocket Engines Project (2013 New Acquisition)

The purpose of this project is to advance the domestic capability for precision manufacturing of components utilized by NSS agencies to launch critical assets into Earth orbit.

The industrial base for liquid rocket engine (LRE) cryogenic upper stage precision manufactured components is high cost and facing component obsolescence challenges. Direct Metal Laser Sintering (DMLS), an additive manufacturing technique, is estimated to provide a 30 percent to 80 percent reduction in critical component cost and schedule for upper stage precision manufactured components. Advanced additive manufacturing equipment has been developed -- and is becoming available -- that provides the necessary build envelope and capabilities to produce larger critical components for LREs. A build envelope of greater than 23" x 15" x 19" provides a 600% volumetric increase in the powder bed over existing additive manufacturing equipment and enables most of the high value components to be produced.

Total government funding for this project is $6.35M and is expected to be augmented by contractor cost-sharing. Government funding is provided by members of the Space Industrial

Base Council's Critical Technologies Working Group, under the terms of a MOA with the Title III office. Acquisition for this effort is currently underway via a full and open competitive solicitation. Contract award is anticipated in early calendar year 2014.

Solid Rocket Motors Production Project (2013 New Acquisition)

The Solid Rocket Motor Project will upgrade the domestic solid rocket motor industry in order to support defense and other Government programs.

Emphasis will be placed on cost reduction and quality improvement efforts for the Divert and Attitude Control System (DACS) for the Standard Missile. However, results of the effort will also support production of Solid Rocket Motors for other programs requiring the use of solid rocket motors. The resulting improvements will support the production of missile programs critical to national defense, including small (tactical), medium (missile defense), and large (strategic) solid rocket motors. The primary objective will be to upgrade production equipment, the supporting infrastructure, and the automated control systems, where needed. The SRM project is anticipated to work in conjunction with efforts from the MDA and the Air Force DMS&T Program. Avenues to reduce risk will be investigated by dividing the project into more than one distinct deliverable, thus reducing technical, schedule, and cost risk. The Title III project will primarily benefit military needs as there is limited commercial business in the SRM market sector. This effort will ensure that a critical domestic source remains economically viable and competitive after the conclusion of the Title III project.

Total Title III government funding for this project is $10.0M and is expected to be augmented by contractor cost-sharing. This is a competitive solicitation. Contract award is anticipated in the first half of calendar year 2014.

Submarine Valve Regulated Lead Acid (VRLA) Batteries (2013 New Acquisition)

This Title III project will advance the domestic production of valve-regulated lead acid batteries used in submarines. The effort will focus on utilizing and improving industrial manufacturing capabilities and quality management systems for affordable production to meet DoD submarine VRLA battery performance requirements. This includes an increased battery life expectancy with minimal submarine VRLA battery intervention (cell replacements, isolations, and/or charge-profile adjustments), a significant improvement, given the varied operational scenarios encountered in U.S. Navy submarine operating environments.

This project was funded through Congressional increase to the Title III budget. DPA Title III funding is $19.36M and contractor cost-sharing is anticipated. This is a competitive solicitation. Contract award is anticipated in early calendar year 2014.

Tungsten Rhenium Wire Production Sustainment Project (2013 New Acquisition)

The objective of this effort is to create a viable domestic source capable of efficiently and cost effectively manufacturing a high yielding, reliable and reproducible tungsten-3 percent

rhenium (W-3%Re) wire. The quality of the material will be required to meet DoD and commercial Microwave Tube (MWT) Industry standards for use in vacuum tube electronics.

Rhenium powder is mixed with tungsten powder to increase the re-crystallization temperature of the material, which makes the material more ductile, or able to be drawn into wire. Rhenium significantly reduces the brittle characteristics of tungsten at room temperature, and W-3%Re wire has much better ductility, stability, and tensile strength than pure tungsten in high temperature applications.

This project was funded through Congressional increase to the Title III budget. DPA Title III funding is $5.5M. Contractor cost sharing is anticipated. This is a competitive solicitation, and contract award is anticipated in the first half of calendar year 2014.

C.2 DoD ManTech Component Program Summaries

Defense-wide Manufacturing Science and Technology Program

The DMS&T Program responds to a recommendation from the 2006 Defense Science Board ManTech study. The DMS&T Program concurrently develops manufacturing processes with emerging technologies and transitions advanced manufacturing processes and technologies for achieving significant productivity and efficiency gains in the defense manufacturing base. The program addresses cross-cutting, game-changing initiatives that are beyond the scope of any one Military Department or Agency. It complements the component ManTech programs by focusing on early, emerging technologies, crosscutting DoD priorities, and enterprise-wide, above-the-factory-floor manufacturing issues. These DMS&T initiatives are identified and ranked through road mapping and data call activities conducted in collaboration with DoD and industry manufacturing representatives and are intended to benefit multiple defense systems and platforms. The primary transition target may be a single Military Department or Defense Agency application, but there will be secondary transition targets in alternate components or applications, which may require additional assistance from those component ManTech or acquisition programs.

Investment Strategy

DMS&T has four areas of investment: Advanced Electronics Manufacturing, Advanced Materials Manufacturing, Enterprise and Emerging Manufacturing, and Institutes for Manufacturing Innovation. Advanced Electronics Manufacturing addresses efforts in a wide range of advanced manufacturing technologies including but not limited to sensors, radars, power generation, switches, and optics. Advanced Materials Manufacturing addresses efforts in a wide range of advanced manufacturing technologies including but not limited to composites, metals, ceramics, nanomaterials, metamaterials, and low observables. Enterprise and Emerging Manufacturing addresses efforts in a wide range of advanced manufacturing technologies including, but not limited to: direct digital (or additive) manufacturing, machining, robotics, assembly, joining, and advanced manufacturing enterprise.

Institutes for Manufacturing Innovation (IMI) will serve as regional hubs to accelerate technological innovation into commercial application and concurrently develop educational competencies and production processes via shared public-private sectors. Collaborative execution and funding by DoD, DOE, DOC, NASA, and NSF to support the establishment of the IMIs will spur industry cost-share for manufacturing innovation and quickly develop a pathway for technology-focused regional hubs for collaboration among government, industry, and academia that will meet critical government and Warfighter needs. The concept of these institutes is highlighted in the PCAST report titled "Capturing Domestic Competitive Advantage in Advanced Manufacturing," published in July 2012.

Highlighted Projects

ManTech completed a Chip Scale Atomic Clock (CSAC) program to enable precise timekeeping within C4ISR systems in GPS-denied environments that reduced its size, weight, power and cost and improved manufacturing processes and yields to reduce unit prices from $8,700 (in 2009) to $1,425 (in 2013) for a single order. The Army's Research, Development, and Engineering Command believes the final unit price could be $500 with a potential price of $300 (with competition). Factoring in the improved production capability from 100 (in 2009) to 40,000 units/year (in 2013), the resulting potential savings is approximately $291M. CSAC integration into a Rockwell Collins GPS receiver successfully demonstrated the atomic clock was able to provide high quality, long holdover time for several hours when GPS was unavailable, which would be beneficial to warfighter when operating in caves and in and around buildings in urban battlefields. The GPS receiver can immediately re-acquire satellites when moving into open environments, while miniaturized packaging allows the soldier to carry equipment more easily.

The Advanced Body Armor Project received the 2013 Defense Manufacturing Technology Achievement Award. This program has aggressively identified and exploited new materials in concert with processing and manufacturing technologies and enabled their practical application to the manufacture of lighter body armor materials and components. In certain instances processing techniques enhanced the mass efficiency of the "as received" constituent materials – expanding the range of enabling body armor weight reduction strategies beyond materials alone. Results from this project show they not only meet the 10% weight reduction goal, but address the need for a cost effective, repeatable, and reasonably implementable set of material and process technologies that will benefit the Army, Marines, Navy, Air Force, and Special Operations Forces body armor systems.

The Silicon Carbide High Efficiency Power Switches project looks to enable a new class of power electronics that allows flexible new architectures at higher voltages, higher frequencies, lower volume/weight, higher temperatures, higher efficiency (reduced fuel consumption), and better power quality. Benefits include:

- Power: 70 percent more efficient than Si circuits, causing a 2-8 percent fuel savings for mechanical-drive platforms (operated at $\leq$ 3 MPH). For 2 percent efficiency increase in combat vehicles alone, savings could be $648M/year during wartime operations tempo.

- Cooling: Greater operating temperature (>100°C coolant) and high efficiency; cooling system size, weight, and power is significantly reduced.
- Reliability: Si power electronics (80°C coolant) have no thermal margin. SiC power electronics have >60°C margin and can provide ’Limp Home” functionality.
- Endurance: Ability to sustain operations for an extended time without support or replenishment.

America Makes (formerly the NAMII) is a public-private partnership led by DoD with significant funding from the Departments of Energy, Commerce, NASA, NSF, and over 80 members of private industry (large and small businesses, universities, community colleges, and other organizations). The focus of America Makes is to accelerate the adoption of additive manufacturing and 3D printing technologies in the U.S. manufacturing sector and to increase domestic manufacturing competitiveness. America Makes fosters a highly collaborative infrastructure for the open exchange of additive manufacturing information and research; facilitates the development, evaluation, and deployment of additive manufacturing technologies; engages with educational institutions and companies to supply education and training to create an adaptive, leading workforce; serves as a national institute with national and regional impact on additive manufacturing capabilities; and links and integrating industry with existing public, private, or non-profit economic development resources with an emphasis on assisting small and medium-sized enterprises. U.S.-based OEMs and their supply chain partners will benefit from the research and development projects conducted through America Makes, as well as from the tools and environments that America Makes creates for collaboration and innovation.

Army

The Army Manufacturing Technology (ManTech) Program’s mission is to provide affordable and timely manufacturing solutions that address the Army’s highest priority. ManTech exists to improve end-item affordability by addressing manufacturing and producibility risks, thereby enabling the transition of critical technologies to weapon system platforms. The program accomplishes this by linking Army program offices, the Army S&T community and the defense industrial base to demonstrate effective, efficient, affordable and adaptable manufacturing processes that are typically beyond the risk of these groups to address on their own.

The Deputy Assistant Secretary of the Army for Research and Technology (DASA(R&T)) is responsible for the Army ManTech Program. The DASA(R&T) provides strategic guidance and is the final approval authority for Army ManTech Projects. The U.S. Army Research, Development and Engineering Command, a subordinate command of the Army Materiel Command, has been designated as the Army’s ManTech Program Manager. Projects within the ManTech portfolio are executed by the Army S&T community in close coordination with relevant Program Executive Office and Program Manager (PEO and PM) transition partners. These project offices within the community are responsible for coordinating capability goals, deliverables, and projected cost/benefit data; and conducting transition and implementation planning for the execution of individual ManTech projects. This allows the Army to maximize technology transition by leveraging both technical and acquisition subject matter expertise for specific weapon systems. This also results in a balanced portfolio aligned with S&T, PEO and PM Offices and Department of the Army priorities.

Investment Strategy

The investment strategy for the Army ManTech Program is to address requirements relevant to the Program stakeholders: Army PEOs, PMs, Army S&T community, and industry. The ManTech office engages these groups to identify priority efforts to be addressed.

Current Investments are aligned to the following Army S&T portfolios:

Air Portfolio - improves manufacturing processes to include improved power-to-weight ratio, specific fuel consumption, and affordable manufacturing of lighter-weight, multi-functional coatings for wear resistance

Ground Maneuver Portfolio - automates armor manufacturing, affordable vehicle protection and transparent armor

Lethality Portfolio - addresses manufacturing cost and risks associated with energetic materials and component subsystems of missiles and munitions, cannon barrels and offensive weapon delivery systems

Innovative Enablers Portfolio - utilization of digital product data, reverse engineering and robust supply chain tools to reduce acquisition lead times and system life cycle costs

Soldier/Squad Portfolio - affordable manufacturing of lighter-weight, multi-functional materials, and power systems that directly benefit the Soldier

Command, Control, Communications and Intelligence Portfolio - addresses the manufacturing improvements for positional, navigational and timing devices (e.g. Global Positioning Systems), situational awareness displays, and electro-optics systems

ManTech proposals are vetted and prioritized through a series of stakeholder reviews and criteria-based evaluations. Evaluation criteria are centered on alignment with the stakeholder-identified investment areas, the strength of the projected transition, the projected impact on end-item or system affordability and the overall benefit to the Army. Upon funding a project, the ManTech office tracks cost, schedule, performance, and transition and implementation planning activities through semi-annual Internal Program Reviews (IPR). These IPRs and other supporting program documentation inform future strategic planning and feed directly into the Army ManTech budget item justifications and success stories.

Highlighted Projects

One of the highest priorities for the Army is lightening the Soldier's load. An example of Army ManTech's strategy in support of this priority is enabling hybrid manufacturing processes for lightweight body armor. This project was recognized with the 2013 DoD ManTech Achievement Award.

Insensitive Munitions Explosives formulation number 104 (IMX-104) is a newly-developed IM explosive formulation used in munitions such as the 81mm High Explosive Mortar. This explosive formulation provides a more compliant product to better safeguard Warfighters from unplanned stimuli.

Army ManTech investments in transparent spinel armor increased production capacity for large transparent ceramic-based armor plates by addressing base material processing, scaled up tooling sizes for larger batch processing, improved secondary processes such as grinding and polishing, and developed new non-destructive evaluation processes for inspection.

Navy

The Navy ManTech Program develops enabling manufacturing technology and transitions this technology for the production and sustainment of Navy weapon systems. Customers range from the acquisition PMs and industry responsible for transitioning major Navy weapon systems from development into production to the logistics managers at the naval depots and shipyards responsible for repair, overhaul, and remanufacture of major weapon systems.

The Office of Transition within the ONR manages the Navy ManTech Program with oversight from the Chief of Naval Research. ONR's Office of Transition includes transition-centric programs including ManTech, Future Naval Capabilities (FNCs), the Small Business Innovation Research (SBIR) *I* Small Business Technology Transfer (STTR), and other transition initiatives.

The Navy ManTech Program executes its projects through its Centers of Excellence (COEs) that have expertise in specific technology areas. ManTech's seven COEs are: Center for Naval Shipbuilding Technology (CNST) (Charleston, SC); Composites Manufacturing Technology Center (CMTC) (Anderson, SC); Electro-Optics Center (EOC) (Freeport, PA); Electronics Manufacturing Productivity Facility (EMPF) (Philadelphia, PA); Energetics Manufacturing Technology Center (EMTC) (Indian Head, MD); Institute for Manufacturing and Sustainment Technologies (iMAST) (State College, PA); and Navy Metalworking Center (NMC) (Johnstown, PA).

Investment Strategy

Reducing the acquisition cost of current and future platforms is a critical goal of the Navy. As a result, in 2006, ManTech adopted an affordability investment strategy to help key naval programs achieve their respective affordability goals by transitioning needed manufacturing technology which, when implemented, results in a cost reduction or cost avoidance for these programs. Current investments are focused on both acquisition and life-cycle affordability for the following key Navy platforms: VIRGINIA Class submarine (VCS), DDG 51 Class destroyer, Littoral Combat Ship (LCS), nuclear aircraft carriers (CVN 78 Class carrier), and JSF. A recent change to the investment strategy is the addition of the OHIO Replacement Program (ORP) to the existing VIRGINIA Class submarine initiative for a coordinated program executive officer (Subs) affordability initiative, starting in FY2014.

Strategic planning is an ongoing effort. Navy ManTech annually analyzes acquisition plans to determine major ship and aircraft acquisition programs that might benefit from a close partnership with Navy ManTech. Platforms for investment are determined by total acquisition funding, stage in acquisition cycle, platform cost reduction goals, and cost reduction potential for manufacturing, all of which determine platforms for investment. As the platforms currently supported mature through their respective acquisition cycles, ManTech's investment targets will change.

Although different in focus, scope, and size, the five affordability initiatives (guided missile destroyers, CVN 78 Class Carrier, LCS, VCS / ORP, and JSF) function similarly. For each, ManTech has established an IPT with representatives from Navy ManTech, the platform Program Office, and representative industry. The IPT meets regularly to coordinate and review the portfolio and ensure that projects are completed in time to meet the platform's window of opportunity for implementation.

The Navy ManTech Program schedules periodic program reviews for each of the affordability portfolios. In these reviews, the platform's IPT assesses the overall portfolio as well as individual projects with respect to technical progress, cost and schedule progress, and probability of implementation to meet the platform's window of opportunity.

Affordability Assessments. To review progress towards meeting both platform and ManTech affordability goals, the Navy conducts affordability assessments semiannually. In these assessments, cost avoidance/savings per project as well as estimated total savings per platform are identified and have the concurrence of both the Program Office and the industry implementing the technology.

Technology Transition Plans. For each project, ManTech develops a Technology Transition Plan (TTP) highlighting the path from the technology development that ManTech performs to implementation on the factory floor, identifying implementation actions, roles and responsibilities, and required resources. TTPs are signed by Navy ManTech, the relevant COE Director, a management representative of the industrial facility where implementation will occur, the Program Office, and, if appropriate, the Technical Warrant Holder.

Highlighted Projects

Since switching to its affordability focus in 2006, Navy ManTech continues to impact both ship and submarine affordability and, more recently, began impacting aircraft affordability as well. ManTech established good working relationships with relevant Program Offices and industry and a detailed internal planning effort. Affordability assessments on a per-platform basis, agreed upon by both the relevant Program Offices and industry, demonstrate good cost-reduction potential and ManTech's transition rate for projects is increasing. Affordability projects transitioned and have been implemented on factory floors, and cost reduction values are being 'booked' by industry for these programs.

For the VIRGINIA Class submarine (VCS) initiative, extensive interaction and cooperation between Navy ManTech, Navy ManTech COEs, General Dynamics Electric Boat, Northrop

Grumman Shipbuilding-Newport News, Program Executive Officer (Subs), and the Program Manager (Ship) 450 Program Office resulted in a focused ManTech initiative

A major success in the VCS Affordability Initiative this past year was the implementation of the shipyard material flow processes and technologies project. In this effort, Navy ManTech helped improve material handling processes at construction facilities at both General Dynamics Electric Boat (GDEB) Groton and Quonset Point shipyards.

In addition, ManTech's Joint Strike Fighter (JSF) Affordability Initiative is ramping up very successfully. Due to these successes, Navy ManTech received letters from both VADM David Venlet (PEO JSF) and Mr. Doug Ebersole, Director of JSF Engineering, in recognition of ManTech's role in helping JSF in its cost reduction goal.

Focusing on affordability, Navy ManTech is committed to working with acquisition programs and industry to provide the technology needed to reduce production costs. The continued collaboration of ManTech, Program Offices, and industry on cost-reduction opportunities can and will help platforms achieve their affordability goals.

Air Force

The Air Force Manufacturing Technology program has led the way in developing methods and tools for MRAs and continues to lead assessments on new technology, components, processes, and subsystems to identify manufacturing maturity and associated risk. Increasing numbers of weapon system primes and suppliers have integrated manufacturing readiness into their culture to aid product and process transition/implementation, reducing cost, schedule and performance risk.

Investment Strategy

Manufacturing Technology plays a pervasive role in supporting many Air Force S&T Strategy priorities, including the development and demonstration of technology solutions that decrease manufacturing risk and increase weapon system affordability. A more capable and leaner warfighting force requires an efficient and responsible manufacturing and industrial base. The Manufacturing Technologies program addresses this need by strategically aligning objectives to enable next generation agile manufacturing. These objectives include moving manufacturing considerations to bear earlier in the design cycle to reduce acquisition cost and risk; enabling seamless lifecycle management through an integrated digital thread to improve process control, optimization, and agility; integrating the industrial base enterprise to predict, identify, and react to supply chain issues; and creating the factory of the future with flexible, smart machine cells and assembly processes that are efficient even at low volume production. Several strategic planning initiatives are underway that will be used to guide future investment decisions. They are: 1) the novel integration of digital data, tools, and analysis, the so-called "digital thread," across the "as-designed," "as-built," and "as-maintained" weapon system lifecycle for increased situation awareness and efficiencies; and 2) development of an Open System Architecture (OSA) for pod systems as a part of the overall intelligence, surveillance, and reconnaissance (ISR) systems' trade space:

1. **Digital Thread for Production.** The Digital Thread is the creation and use of a digital surrogate of the system development process, enabling dynamic, real-time assessment to inform decisions in acquisition. This surrogate is an interrogable technical description of the weapon system resulting from the generation, management, and application of data, models, and information from authoritative sources across the system's life cycle. The Digital Thread initiative will define methods to more closely link and integrate detailed design, production, and sustainment activities to reduce program risk and development cycle time, improve affordability and reliability, and tailor maintenance to the "as-built"/"as-maintained" configuration to ensure operational capability.

2. **Agile Manufacturing for ISR.** The objective of this initiative is to provide the ability to reconfigure multiple airborne assets with different sensors, data links, and enhanced processing capabilities while minimizing aircraft integration and recertification. These open architecture systems could be platform independent and integrated onto multiple manned and unmanned aircraft. These open architecture pod systems are both a capability and life-cycle efficiency enabler, allowing mission re-configurability, upgrade efficiencies, and reduced parts obsolescence issues for ISR Systems.

Highlighted Projects

Helicopter Brownout Producibility*:*

Air Force ManTech contributed to the 3-Dimensional Landing Zone (3D- LZ) Joint Concept Technology Demonstration (JCTD) program (shared among the Air Force, Army and Naval Air Systems Command) by leading the Helicopter Brownout Producibility program, coupling small business innovation w/JCTD requirements to address brownout, a major cause of helicopter mishaps.

The following 3D-LZ program benefits were achieved:

Enabled the manufacturing maturity and design of the key sensor technology for the JCTD, advancing the Manufacturing Readiness Level from 3 to 6

Enabled combined flash LAser Detection And Ranging (LADAR), Forward Looking Infrared (FLIR), obstacle warning, and terrain awareness

Successfully mitigated low speed brownout landing risk

Enabled the distributed laser system to meet JCTD's challenging size/power requirements, repackaged from a 15-inch turret to the upper half of a 12-inch Q29 production turret

Defense Logistics Agency (DLA):

Please refer to Section B.6 Technology Capability Concerns (Pg B-47 to B-65) for DLA's ManTech programs.