EMERGING TRENDS AFFECTING FUTURE NAVAL ACQUISITIONS

- Business
- Technology

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TABLE OF CONTENTS

EXECUTVE SUMMARY 3

BACKGROUND 5

DRIVERS IMPACTING DEFENSE 6

Federal Budget 6

Global Trends 6

Emerging Threats 6

BUSINESS TRENDS AND OUTLOOK 8

Private Sector 8

Public Sector 9

TECHNOLOGY TRENDS 12

Global Trends 12

Software and Hardware 13

Emerging Technologies 14

DEFENSE TRENDS AND OUTLOOK 16

Capability Based Planning 16

Sustainment Concepts 16

Logistics Workforce 16

CONCLUSION 18

ENDNOTES 19

EXECUTVE SUMMARY

Advances in technology in the last fifteen years have changed the way the Navy develops, fields, and supports National Security Systems (e.g. combat and weapon systems) to meet warfighter needs. The transition from the traditional MILSPEC business model to an Open Architecture (OA) model is requiring a dramatic cultural shift across the Enterprise. As the Navy adopts the OA open business and system models, leaders must be prepared for the next wave of business and technology trends that will impact the Navy and potentially require a different model in the future. Research indicates the next big IT trend that the Navy should address is Service Oriented Architecture (SOA). According to the Gartner Group, SOA will provide the basis for 80 percent of new IT transformation projects by 2008. SOA takes everyday applications and breaks them down into individual functions and processes. An SOA lets you build, deploy, and integrate these functions and processes independent of the applications and computing platforms on which they run. OA is an enabler of SOA but is not SOA itself.

While SOA is only one trend of significant importance to the Navy, it is essential to look beyond SOA and understand the drivers changing the Defense landscape, as well as other business and technology trends in the Private and Public Sectors. All of these factors could have an impact on the Navy's future operational model to develop, field, and support National Security Systems. Drivers and trends identified in this paper are based on research from a variety of public and private sources.

Drivers Impacting Defense

Changes in the Federal Budget in conjunction with global trends and emerging threats will impact the Department of Defense's funding and priorities for resources. Entitlement payments including Social Security, Medicare, and Medicaid are projected to grow as a share of the Federal Budget and GDP causing a shift in government funding priorities. As energy demand climbs and the demand for oil rises 38% by 2030, governments will need to spend a combined $20 trillion on power, oil, gas production and related facilities. The Congressional Budget Office estimates an $895B decrease in defense spending (DoD baseline) between 2005-2014 (roughly $100B less per year). At the same time, emerging threats are causing a shift in priorities. The Navy will continuously be faced with seeking new operating models and driving efficiencies throughout the enterprise while at the same time meeting shifting priorities to meet the warfighters needs.

Business Trends and Outlook

Private Sector

Current market forces including intensified competition, escalating customer expectations, and unexpected market shifts as well as workforce issues, technological advances, regulatory concerns and globalization are driving companies to change their business models. Companies must continuously innovate to stay ahead of their competition. Traditional Research & Development Departments will not be sufficient to foster and sustain cultures of innovation. Companies will be forced to collaborate with outsiders to generate innovative ideas and therefore must build networks of trust. The Navy can expect to see shifts in the traditional supplier base as new players emerge offering superior products at competitive prices. Traditional Defense companies who do not change their business models will have difficulty competing with these emerging companies that do adapt their business models to stay ahead of the competition.

Public Sector

Public sector organizations are facing pressures from a host of sources, including: an aging workforce replaced by a younger, less experienced cadre, bureaucracies that stifle innovation, an increasingly demanding citizenry, and budgets that are squeezed by a number of internal and external factors. In response, governments will also need to adapt by continuously enhancing business models to innovate and become more efficient at ameliorating existing procedures (through widely-accepted commercial process improvement techniques)—this requires a shift in culture. This will be challenging considering that limited

funding and Government regulations are current factors stifling innovation today in the Public Sector. Increasing accountability and instituting robust governance internally and externally for an expanding contractor support network will be essential. For example, while the DoN Chief Information Officer is already moving forward with adopting SOA principles in business system applications, his governing role over National Security Systems is not yet defined. Organizations will also be required to collaborate more with a host of stakeholders to find new solutions. For the Navy, this equates to seeking new operating models that drive efficiencies throughout the enterprise and leveraging a flexible workforce that quickly adapts to new models.

Technology Trends

Overall global technology trends will reflect an increasing shift to service oriented architectures, open source models, and web services. Modularity, scale-out, and virtualization will require optimization for classes of applications. Multi-core CPUs will deliver commodity real time interactive high definition graphics and enable widespread adoption of immersive applications. The building of situational applications by mixing and re-mixing components will become more and more common. Emerging technologies such as predictive monitoring and nanotechnology as well as dramatic enhancements in human computer interaction will cause shifts in paradigms with greater frequency. While it is difficult to anticipate the effects all of these trends and technologies will have on the development and sustainment of National Security Systems, the Navy must fully adopt a framework that enables agility, scalability, and real time change at all levels. While there are challenges associated with moving toward SOA when applied to National Security Systems and Weapons Systems, the Navy cannot let this stand in the way—Industry, Allies, and Enemies will move forward. These challenges include the requirement to support real-time constraints and special purpose hardware interfaces. For example, in developing the Navy's Integrated Fire Control capability by the middle of next decade, the real-time deterministic nature of that problem dictates certain performance measures that we cannot trade away. The Navy should evaluate the requirements of any system and the capability of the technology at time of implementation to determine whether or not SOA is appropriate.

Defense Trends

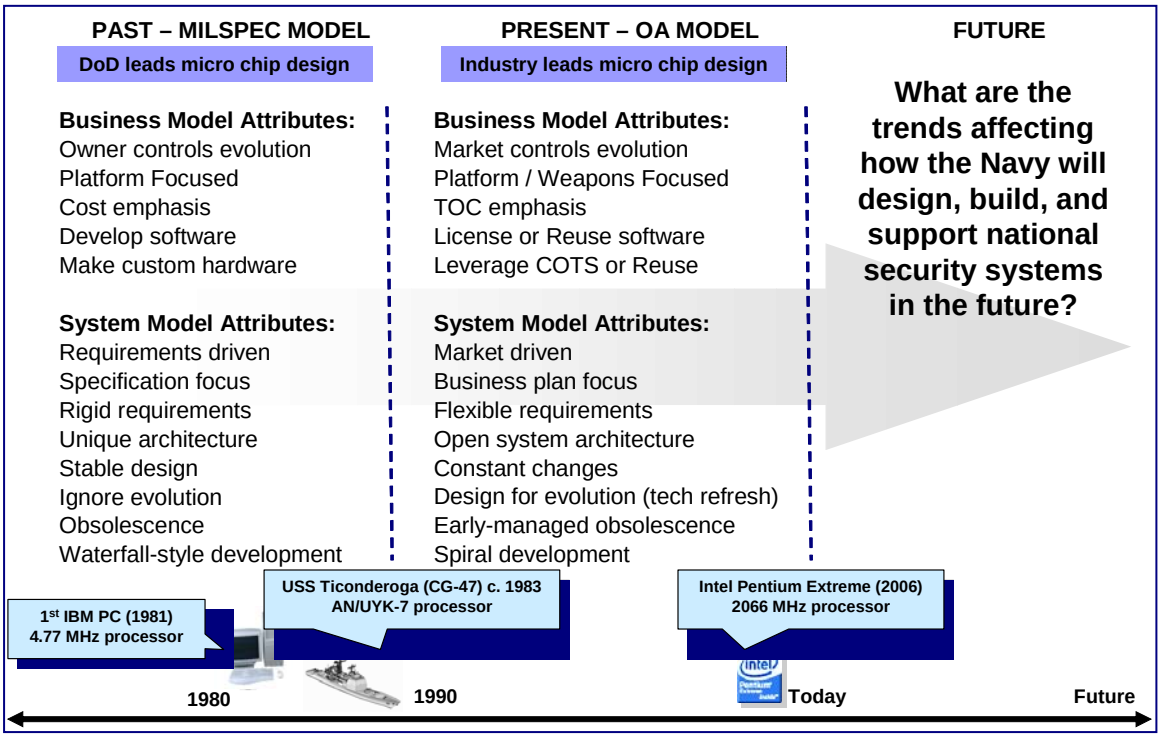
Capability-based planning, dealing not just with single system solutions but with tangible and non-tangible solutions, and family of systems, will render obsolete the way programs are currently structured and budgeted. Supporting systems will demand new approaches to the traditional infrastructure. Support concepts must leverage and build on discrete capabilities fielded in ways tailored to the specific needs of the system. For the Navy to excel in this environment, it will need to cultivate and maintain a logistics workforce with a breadth and depth of engineering skills.

In summary, the next immediate trend beyond OA that will affect how the Navy acquires its systems is SOA. The Navy must prepare now for the coming changes. Beyond SOA, we can anticipate more open source models and other technological innovations including situational applications built with "just enough" functionality, nanotechnology and more energy-efficient power supplies. In addition, the increasing complexity and off-shoring of technology development will require a reassessment of Defense Department acquisition processes and procedures.

On the business front, we can expect to witness more business model and collaborative innovation that affect how products are developed, used, and distributed. With increased competition in our supplier base, we will be able to take advantage of improving capabilities, the rise of small and highly specialized businesses, and collaborative environments that result in technological advances. Embracing these trends—SOA in particular—will help the Navy address drivers impacting our Defense landscape including budget cuts, rising fuel costs, increasing demand for services from the warfighter, and asymmetric threats from emerging competitor nations.

BACKGROUND

Advances in technology in the last fifteen years have changed the way the Navy develops, fields, and supports National Security Systems to meet warfighter needs. The transition from the traditional MILSPEC business model to an Open Architecture (OA) business model has required a dramatic cultural shift across the Enterprise. As the Navy adopts the OA business and system model, leaders must be prepared for the next wave of business and technology trends that will impact the Navy and potentially require a different model in the future. Leadership is already looking ahead to position the Navy for this wave and requested research be conducted on emerging trends of interest during the OA Executive Committee meeting held 24 October 2006.



In order to position the Navy for the future, it is important to understand the drivers changing the Defense landscape, as well as the business and technology trends in the Private and Public Sectors. This paper identifies these factors that could have an impact on the Navy's future operational model to develop, field, and support National Security Systems. Drivers and trends identified are based on research from a variety of sources, including:

- Defense organizations—The Defense Science Board, Office of the Secretary of Defense, Office of Force Transformation
- News publications – Economist, Business Week, Wall Street Journal, Harvard Business Review
- Consulting firms – McKinsey Consulting, IBM, Accenture, Infinia Foresight
- Studies – 2006 CEO Study, Global Innovation Outlook, Global Technology Outlook

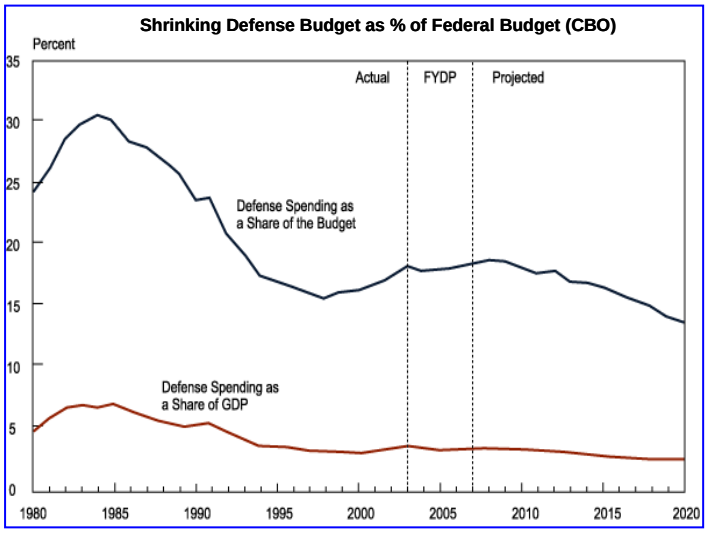
DRIVERS IMPACTING DEFENSE

Federal Budget

- The Global War on Terror will strain the U.S. Defense budget, creating **increased pressure and calls for cuts** to large weapons programs such as the Future Combat System and new aircraft development.[1]

- The current Department of Defense (DoD) budget will be unsustainable with slow growth and the shift in the Federal budget towards entitlements. The Congressional Budget Office estimates an $895B decrease in defense spending (DoD baseline) between 2005-2014 (roughly $100B less per year). [2]

- Financing of public debt will continue to grow as a share of the Federal budget, thus, eroding Defense spending as a share of the budget. The debt burden could quickly become unsustainable if foreign governments lose confidence in the US economy and halt purchase of US government bonds, resulting in a Federal budget crisis. [3]



Global Trends

- Global energy utilization will increase by over 50% in the next 25 years largely due to the growing demands of developing nations. It will take upwards of 116 million barrels of oil per day, twice the global daily expenditure of 2005, to sate this need while dumping twice as much carbon dioxide into Earth's atmosphere exacerbating already alarming global climate changes. The combined impact of a severely diminishing oil supply and human caused climate change will force significant investment in both energy efficiency and alternative, clean fuel sources over the next decade. Governments will need to spend a combined $20 trillion on power, oil, gas production and related facilities as global energy needs are forecast to increase 53% by 2030.[4]

- Globalization and unexpected market shifts are having an impact on organizations today and forcing significant change. In 2005, the combined GDP of emerging economies increased by US $1.6 trillion – which represents US $200 billion more growth than the developed world combined.[5] Emerging economies now control two-thirds of the world's foreign exchange reserves and consume 47% of the world's oil.[6] According to a recent CEO study, these trends in addition to increased competition, escalating customer expectations and technological advances are impacting how companies operate.

Emerging Threats

- Threats will continue to cause shifts in priorities for Defense Resources. For example:
  - Some 32 nations are developing or manufacturing more than 250 models of drones, according to the Defense Department's UAV Roadmap. Defense Advanced Research

Projects Agency (DARPA) is looking to spend about $11 million over three years for their drone-killer, dubbed the Peregrine.

- High-precision, low cost manufacturing machines, that can make sophisticated parts for ships, planes and weapons, can now be located nearly anywhere and owned by anyone. Computer Numeric Controlled (CNC) machines take a design (in digital format) and are able to accurately produce parts for a custom motor cycle, jet engine or missile. Such CNC machines can be purchased for as little as $2500. This gives rise to the possibility of portable factories that could be located anywhere, used by anyone for nearly any purpose. This also raises the specter in which rogue nations could sell weapons of mass destruction or missiles as digital files to anyone with a portable CNC factory to build their own weapons. [7]

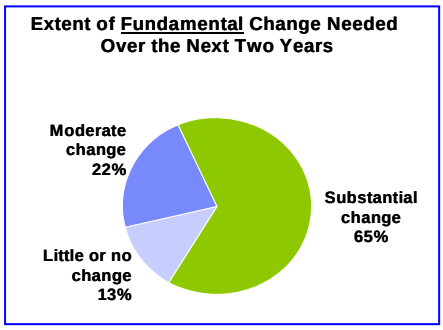
- Terrorist groups are acquiring sophisticated anti-ship missiles in their arsenals. During the Israeli / Hezbollah War, the Israeli corvette Hanit was hit by a C-802, an Iranian-made variant of a stealthy, turbojet-powered, Chinese anti-ship missile. The missile was fired from a truck-mounted launcher and cued by a coastal radar installation, which provided data for the initial launch. Long range, anti-ship weapons, which were long believed to be only the capability of potential enemy governments, are now making their way to terrorist groups.[8]

Key Takeaways: Changes in the Federal budget in conjunction with global trends and new emerging threats will impact the Department of Defense's funding and priorities for resources. As a result, the Navy will continuously be faced with seeking new operating models and driving efficiencies throughout the enterprise while at the same time meeting shifting priorities to meet the warfighters needs.

BUSINESS TRENDS AND OUTLOOK

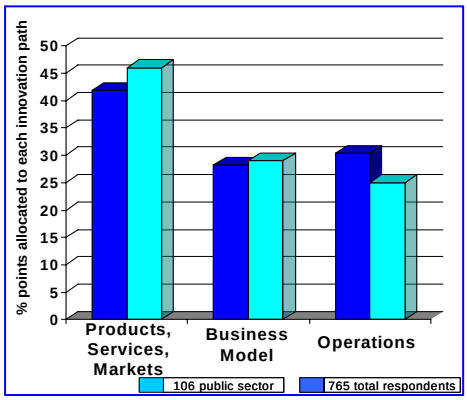
Private Sector

- **Market forces** such as intensified competition, escalating customer expectations, and unexpected market shifts as well as workforce issues, technological advances, regulatory concerns and globalization **are forcing significant change**. Chief Executive Officers (CEOs) anticipate their organizations to be inundated with change over the next two years.[9]



- **Improved capabilities of competitors** (e.g., better knowledge or better talent) is cited as the largest single factor contributing to increasing competitive intensity.[10]

> *"The world is changing very fast. Big will not beat small anymore. It will be fast beating the slow." - Rupert Murdoch, Chairman and CEO, News Corporation*



- CEOs are using **business model innovation** to pre-empt threats and create them. Global connectivity (created through telecommunications, IT infrastructure, and open standards) makes new skills and partners accessible and practical to employ and enables new forms of collaboration, and thus new business models. The same connectivity exposes firms to new competitors with different business models and cost bases which can force companies to change their models.[11]

- **Innovation and the free flow of information** are the primary drivers of an accelerating pace of change in the global business environment. These factors contribute most to the accelerating pace of change.[12]

- Significant opportunities for innovation and entirely new business models exist at the back end of the product lifecycle—in how products and their component parts are reused, redistributed and disposed of.[13]

- Companies can create **competitive advantage** through voluntary eco-friendly initiatives that get ahead of government regulations and restrictions.[14]

- A new breed of **small and highly specialized businesses** is capable of operating globally and even disrupting existing business models. [15]

- Traditional approaches to **Research & Development**—and even the creation of "innovation" departments and job titles—won't be sufficient when it comes to fostering and sustaining cultures of innovation.[16]

- **Collaborative innovation** involves groups of people who normally do not work together sharing their collective insights that lead to new inventions beyond those possible through traditional methods.[17]

- **Internet-based "virtual worlds**" are emerging as collaborative tools and new markets.[18] A new market exists in providing the software, computers, and chips that power 3-D worlds and it is also a new venue for marketing your wares.[19] Companies are using "Second Life", a popular three-dimensional online computer world, to hold virtual meetings.[20]

- Real value will come less from managing **knowledge** and more—a lot more—from creating and exchanging it. Exchanging knowledge on a company-wide basis in an effective way is much less a technological problem than an organizational one.[21]

- In the 21st Century, companies will seek to identify, quantify, and mitigate uncertainty and doubt in business decisions vice only focusing on risk management as a technique for managing outcomes.[22]

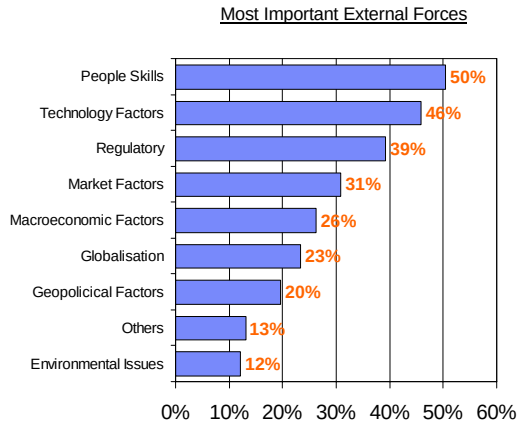
- 19% of the entire U.S. workforce holding executive, administrative, and managerial positions will retire in the next 5 years. There will be a shortfall of 3 million workers between the projected workforce and the number of jobs required in the U.S. by 2016. According to the Future of Work Thinksite, work cultures and organizations will evolve to meet this shift in demographic conditions including:
    - Professional Nomads: "free agents" that are not aligned to a specific company or organization will move from firm to firm, taking on short-term assignments
    - Ethical Culture and Vision: companies must develop, communicate, and adhere to a well-defined set of ethical guidelines
    - A Network of Trust: whether or not collaboration is successful will be determined by the level of trust between employees in an organization[23]

Key Takeaways: Market forces including intensified competition, escalating customer expectations, and unexpected market shifts as well as workforce issues, technological advances, regulatory concerns and globalization are driving companies to change business models. Companies must continuously innovate to stay ahead of their competition. Traditional R&D Departments will not be sufficient to foster and sustain cultures of innovation. Companies will be forced to collaborate with outsiders to generate innovative ideas but must build networks of trust. The Navy can expect to see shifts in the Defense market as new players emerge offering products at competitive prices. Traditional Defense companies who do not change their business models will have difficulty competing with companies that do adapt their business models.

Public Sector

- The evolving **global economy, threats of international terrorism** and **rising social services costs** are among the challenges that are forcing govern-ments to redefine their strategies.[24]

- Over the next two years fundamental changes precipitated by **increased**



- *"Growing pressure on public finances and penetration of technology are both key."*
- *"Need to reduce competition between Government agencies and introduce culture of sharing to give better overall service to citizens"*
- *"Resource constraints limit the amount of time people can spend on innovation"*
- *"We are too busy getting the day to day operation done to look to the future."*

Public sector respondents

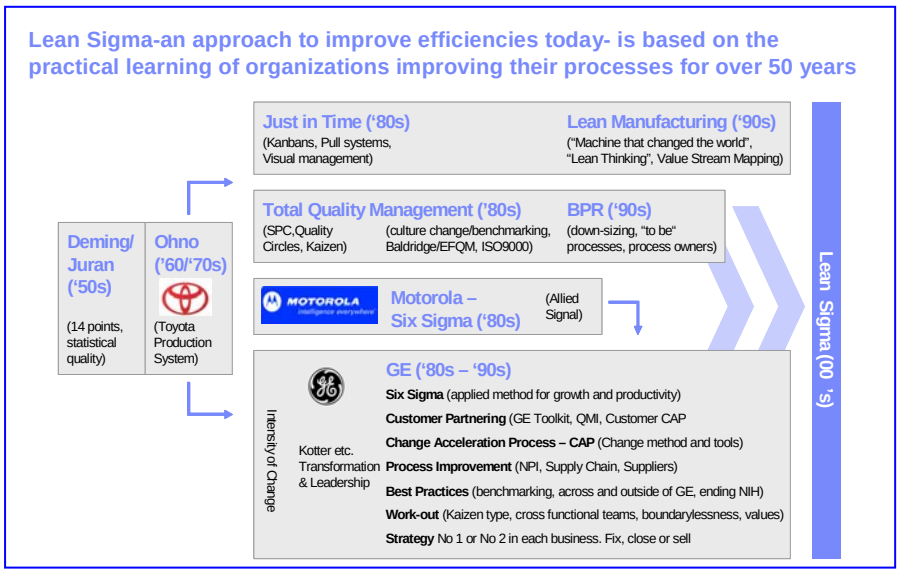
pressure from an aging workforce, technology innovation, regulations, and budget constraints will require new innovative approaches.[25]

- In the next decade, 43% of the civilian workforce will be eligible for retirement.[26] The younger civilian workforce will be much smaller and will include a new cadre of Senior Executive Service (SES) leaders. There will be a probable rise in the average age of uniformed workforce due to the desire to retain experience.[27]

- Governments have to react to **increased demand for services from constituents** and are responding in doing so in three ways:
  - Instituting top-down performance improvement initiatives
  - Pushing responsibility to the lowest levels to enhance accountability and offering more choices to empower constituents
  - Creating transparent processes to contract with service providers and hold them accountable[28]

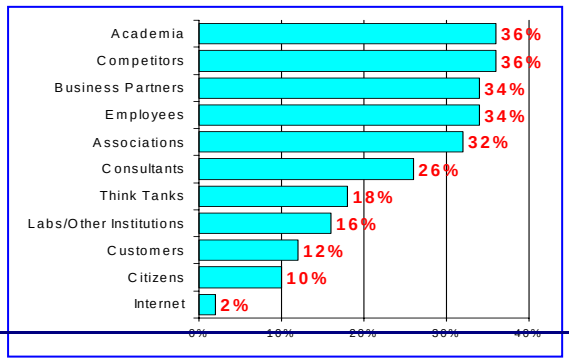
- Public Sector leaders will need to **shift focus to** enhancing existing **organizational capabilities, developing new business models, improving services, outcomes & performance** in light of budget pressures. However, in a recent study, limited funding and Government restrictions were cited as are primary reasons stifling innovation in the Public Sector. [29]

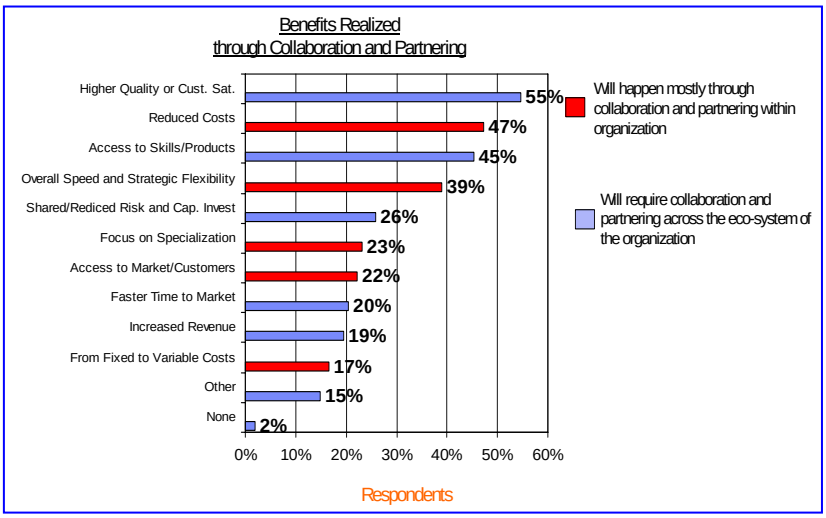
- Public Sector leaders are increasingly looking at "lean" techniques, which aim to optimize costs, quality, and customer service constantly. This applies to a range of activities from repair of military vehicles to processing of income tax returns. In a UK military armored vehicle repair shop, a lean transformation generated a 44 percent increase in the availability of equipment.[30]



- In the future, the Public Sector will greatly **benefit from increasing the depth and scope of collaboration** with others, especially citizens and constituents. However, Public Sector Leaders rarely rely on citizens or customers for new idea generation.[31]

Internal and External sources for New Idea Generation



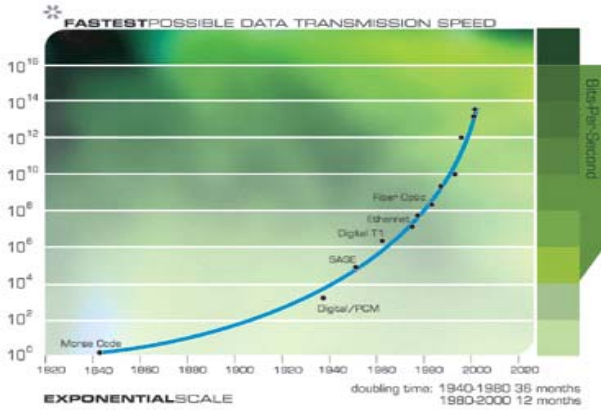


Key Takeaways: Public sector organizations are facing pressures from a host of sources, including: an aging workforce replaced by a younger, less experienced cadre, bureaucracies that stifle innovation, an increasingly demanding citizenry, and budgets that are squeezed by a number of internal and external factors. In response, governments will need to adapt by becoming more efficient at ameliorating existing procedures (through widely-accepted commercial process improvement techniques), instituting robust governance internally and externally for an expanding contractor support network, collaborating with stakeholders to find new solutions, and continuously enhancing business models. For the Navy, this means applying methods to improve existing processes, enhancing contractor governance structures, and optimizing the return on a decreasing budget.

TECHNOLOGY TRENDS

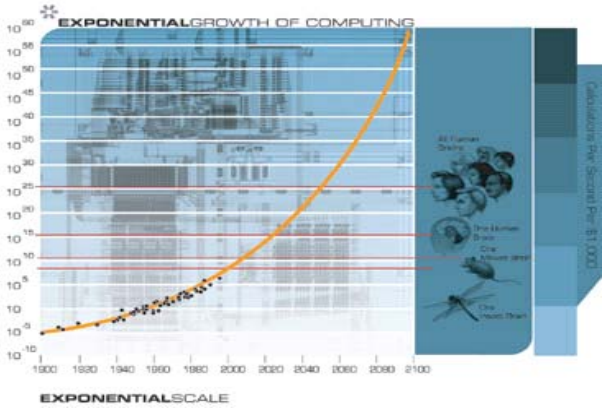
Global Trends

- The world will encounter continued quantum leaps in Information Technology (IT) and in other areas of science and technology. There will be an exponential rate of advancement in digital technologies. Digitalization[1] will facilitate "faster, better, cheaper" production.[32]



- The movement of the Technology Industry offshore will jeopardize the US lead. There is a risk of losing or exposing risk of the defense-critical integrated circuit market as the Super Computer Industry shifts predominantly offshore and DoD commands only 1-2% of world market.[33]

- The value of IT is increasingly compromised by complexity. **Radical simplification** will seek to develop new approaches, including focused solution and component packaging, to reduce or encapsulate the full complexity of the underlying hardware, software, and services.[34]



- **Service Oriented Architectures** are creating new business models that increase competitive pressures on companies. Put in the framework of Porter's Five Forces Model, a commercial widely accepted methodology for examining market factors, these companies will need to adapt because:
    - Standards-based services are just as available to (major) players in related industries—**threat of new entrants**
    - Customers want streamlined integration or they shop elsewhere—**bargaining power of buyers**
    - Suppliers demand improved, cost-effective collaboration—**bargaining power of suppliers**
    - Product, process, and business model replication is easier with standards-based services—**threat of substitutes**
    - SOA adopters set higher bar for performance—**rivalry among existing competitors**[35]

- Firms will need to reexamine traditional return on investment (ROI) methods in order to understand the value provided by new technologies and approaches such as SOA and Web Services.[36]

- More companies will move towards **open source models** to take advantage of external support and the inherent ability of open source communities to promulgate new technology.[37]

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[1] Digitalization, expansion of mobile and ubiquitous computing, expansion of broadband infrastructure, convergence of digital media, personalization of information-technology services and development of intelligent-agent technologies, are a few of the trends that garner attention

Software and Hardware

- Open source software is "important to the National Security and National Interest of the U.S."[38] and "plays a more critical role in the DoD than has generally been recognized."[39] Various government agencies will further explore and promote the use of open source software.

- Modularity, scale-out, and virtualization along with the slowing of device performance gains are necessitating that significant systems performance gains be made through **optimization for classes of applications**.[40]

- **Multi-core CPUs** will deliver commodity High Performance Computing (Supercomputer) capabilities to consumers and businesses alike. New chip designs are packing multiple CPU cores into a single module and tightly coupling it with high speed cache memory to keep more data closer to the CPU. Within the next decade Intel and others are forecasting chips that will contain 40 to 80 cores some of which will probably be dedicated to special purposes such as graphics. These new multi-core CPUs will deliver commodity real time interactive high definition graphics and enable widespread adoption of immersive applications such as three dimensional modeling and simulation as well as virtual reality and metaverses that now require very expensive built-for-purpose hardware. Commodization of high end computing resources will drive future user interfaces and interactions from a two dimensional to a three dimensional paradigm.[41]

- **By standardizing and leveraging pre-existing assets,** organizations—together with their business partners -- can create a powerful portfolio of **solution building blocks** that reduce risk, improve returns, and better focus their investments.[42]

- The building of **situational applications** – applications built with just enough function to satisfy a business need, usually by business users – by mixing and re-mixing existing components are becoming more and more common.[43]

- **Self Configuration Managing Software and Hardware** solutions could emerge to address the challenges associated with an increase in modular system designs. A foreseeable solution may require all architectural elements to keep track of their own configuration and be able to report their configuration through the open architecture interface. This configuration data would be available to shore-based planning and maintenance activities. The configuration data would also drive displays for shipboard maintenance, monitoring, damage control, and operations. Cost savings would be realized by only replicating the shipboard configuration files ashore, not managing them ashore. If the configuration data includes physical location on the ship, could also significantly reduce need to do ship checks prior to upgrades.

- This concept could be extended to require ILS products such as technical manuals, repair part data, PMS cards, embedded training, condition based maintenance monitoring, operational manuals, etc. to be embedded within the architectural elements and accessible through the Open Architecture interface. In this manner, installing a new component would automatically carry the ILS tail with it. Without this feature or a similar feature, keeping the ILS up-to-date on ships employing Mission Modules will be extremely difficult. Once the above system is in place, it becomes practical to consider upgrading components instead of replacing / repairing them if economical (Alteration equivalent to Repair (AER)).[44]

- **Self Integrating Systems** to automatically configure into a useful system from the collection of architectural elements that can communicate with each other may also be on the horizon. Each architectural element would have capabilities and needed resources. The human operator would

indicate the priority of different capabilities and the system would dynamically respond by assigning resources and tasks to different available architectural elements to fulfill the human operator's priorities. The system could reconfigure itself both to changes in priorities or to changes in available resources. Self Integrating Systems can be very robust – system capability can be maximized with arbitrary additions or deletions of architectural elements. This is particularly important for ships that are required to continue mission capabilities following weapons induced damage.

- Currently, casualty modes of operation are often accommodated with specialized software code that is seldom exercised. Because this code is seldom used, the probability that bugs will be identified and eliminated is much lower than the "normal" mode software. A Self-Integrating System does not differentiate between normal and casualty modes of operation – A casualty mode is the same as a normal mode, except that fewer resources are available. Another benefit is the reduced cost of integrating new capability into a system.[45]

- **Extending Self-Integrating Systems** to the entire ship. A mission system requires resources (such as electrical power and cooling water) from external distributed systems. In addition to the previously discussed benefits of Self-Integrated Systems, implementing the distributed systems as self-integrating systems that derive their priorities from the mission systems can synergistically increase the robustness of the entire ship. Hard-wired load shedding will disappear. Instead available power will be apportioned to the highest priority loads based on the ship operator's priorities and the configuration of ship components that are currently meeting those priorities.

- The value of this increased level of robustness will increase in the future for two reasons: Reduced Manning and the use of Electromagnetic and Directed Energy weapons. A highly robust ship design can tolerate equipment outages while still being capable of fulfilling missions. This enables deferring maintenance until external resources are made available – thus reducing maintenance workload for the small crew. Eliminating chemical munitions and propellants through the use of electromagnetic and directed energy weapons will enable the ship to withstand increasing amounts of weapons induced damaged before sinking. A self-integrating ship will maximize the capability of the ship with whatever components survive multiple weapons hits. The ability of a ship to fight "Hurt" is an important force multiplier with the small size of our fleet as compared to historic norms.[46]

Emerging Technologies

- **Predictive Monitoring** enables equipment manufacturers and operators to predict maintenance problems before they occur. Manufacturers can save 51% in maintenance labor costs by using predictive monitoring techniques. In the utilities and rail industries, predictive monitoring has reduced the need for preventive maintenance and inspection by 60%.[47]

- Detecting and responding to events on a just-in-time basis is critical whether the events are business needs or public emergencies. The **Event-Driven World** addresses the increasingly sensor-driven world we live in and how events, rather than data, are beginning to be recognized as a unit of information.[48]

- **Human-computer interaction** draws on rapid developments in the way people interface with technology and can create real business value. The Internet and technologies that interact with it are better enabling distance work, collaboration, and training.[49]

- The field of **Augmented Cognition** is using sensors to infer the mental state of someone using a device. Augmented cognition focuses on deducing a cognitive state with the aim of somehow enhancing it when someone is overwhelmed with information. An augmented cognition system would try to help him cope by diverting some of it. "Augmented cognition should be able to help

soldiers and fighter pilots make sense of high volumes of data and exploit them, rather than being swamped by them."[50]

- **Hybrid planes** will follow the success of hybrid cars. The current designs for hybrid aircraft involve replacing the auxiliary power unite (APU) with a far more efficient system based on a fuel cell—a device that combines a fuel with oxygen to produce electricity. This approach has strong advantages over combustion: fuel cells are quiet, efficient, and produce far fewer emissions. Boeing estimates that the efficiency of the APU in converting energy from fuel into electricity could go from 15% today to as much as 70% with fuel cells. [51]

- The set of technologies and approaches known as **Web 2.0** (including Wikis, Blogs, Mash-Ups, user presentation standards, syndication, non-IE browsers, etc.) are introducing new models for highly connected and adaptive capabilities, particularly in the area of **social computing**.[52]

- Nanotechnology sets out deliberately to exploit the properties found in objects measuring from 1 to 100 nanometers, one-billionth of a meter. Most usefully, the ability to make stuff with atomic precision will allow scientists to produce materials with improved, or new, optical, magnetic, thermal or electrical properties. For example, General Electric's research centre in Schenectady in New York State is trying to make flexible ceramics. If it succeeds, the material could be used for jet-engine parts, allowing them to run at higher, more efficient temperatures. In 2004, the American government spent $1.6 billion on nanotechnology, well over twice as much as it did on the Human Genome Project at its peak. In the longer term nanotechnology may produce much bigger innovations, such as new kinds of computer memory, improved medical technology and better energy-production methods such as solar cells.[53]

Key Takeaways: Overall global technology trends will reflect an increasing shift to service oriented architectures, open source models, and web services. Modularity, scale-out, and virtualization will require optimization for classes of applications. Multi-core CPUs will deliver commodity real time interactive high definition graphics and enable widespread adoption of immersive applications. The building of situational applications by mixing and re-mixing components will become more and more common. Emerging technologies such as predictive monitoring, human computer interaction and nanotechnology will cause shifts in paradigms with greater frequency. While it is difficult to anticipate the effects these trends and technologies will have on the development and sustainment of National Security Systems, the Navy must fully adopt a framework that enables agility, scalability, and real-time change at all levels.

DEFENSE TRENDS AND OUTLOOK

- Supporting the warfighter is requiring seamless integration between Services and Agencies – major cultural transformation is necessitated. **Increased standardization and a combined workforce** will be required due to continued budget constraints. [54]

Capability Based Planning

- Acquisition under Capability Based Planning will widen its perspective to:
  - Infuse technology and programmatic reality into planning and decisions
  - Shape, engineer, and validate solutions to capability needs
  - Make decisions on systems within a capabilities context (systems perspective)
  - Engineer the relationships across the set of systems that together satisfy the need (systems of systems)
  - Synchronize the interaction among programs to satisfy multiple capabilities (roadmaps)
  - Provide a coherent logistics transformation strategy supporting distributed, adaptive operations

- Requirements will transition from a focus on material solutions to include greater emphasis on non-material solutions such as new doctrine and tactics, or on leveraging capabilities of several systems/programs to meet the need

- Capabilities will be addressed in different ways:
  - Provided by families of systems or portfolios of programs
  - Included across families of systems to foster interoperability and consistency of data
  - Combinations of material and non-material solutions that are phased across multiple spirals of development[55]

Sustainment Concepts

- Future distance support initiatives will:
  - Focus on providing a portfolio of distance support capabilities/services, not necessarily a distance support system
  - Seek to proactively provide the right support in the right place and at the right time based on the needs of the system and user using prognostics and predictive methods.[56]
  - Allow distance support concepts to be tailored to system support methods particular to the product or capability supported
  - Leverage new support concepts such as PBL, autonomic logistics, sense and respond operations to target delivery and timeliness of support products[57]
  - Employ automatic monitoring and management of systems and system support operations[58]
  - See logistics bandwidth integrated in overall structure[59]

Logistics Workforce

- The future **Logistics workforce** will:

  - Be dominated by Engineering Competencies- the increased number of lines of code in new weapon systems requires the same software engineering skill sets as the software engineer developing the code

- Necessitate the need for Business Management Competencies – there is a shift from "doers" to "managers of doers" due to the growing contracted workforce
- Place importance on Continuous Process Improvement (CPI) in the areas of financial management, analytics knowledge, project management, contracting, human capital management, etc. for all workforce categories
- Redefine Logisticians – categories of the Logistics workforce will merge together, blurring boundaries. Non-merged, distinct Logistics workforce categories will be a less efficient and effective model. The predictions that future workers will change jobs up to eight times in their careers will impact the career Civil Service.
- Shift to a Services-Driven World Vice Task-Driven Mechanical World—the shift to services will lead to measuring outcomes vice activities[60]

Key Takeaways: Capability-based planning, dealing not just with single system solutions but with a variety of material, non material, and family of systems solutions, will render obsolete the way programs are structured and budgeted. The Department of the Navy should consider working towards a capability-based program structure and implement virtual organizations to create mission solutions that cross platform and domain boundaries. Also, supporting systems will demand new approaches to the traditional infrastructure, and support concepts must leverage and build on discrete capabilities fielded in ways tailored to the specific needs of the system. Finally, a logistics workforce of technically competent individuals must be developed to function effectively in this environment.

CONCLUSION

The next wave of business and technology changes beyond OA that will affect how the Navy acquires its systems include business model and collaborative innovation that affects how products are developed, used, and distributed, as well as the increasing complexity and offshoring of technology development that will require a reassessment of Defense Department acquisition processes and procedures. Service Oriented Architectures, open source models, situational applications built with “just enough” functionality, more energy-efficient power supplies, and the potential benefits of nanotechnology are just a few of the technological innovations that will affect how the Navy acquires its systems and the increasing capability of those systems.

As a direct result of increasing competition within the contractor community, the Navy will be able to take advantage of improving capabilities, business model innovation, the rise of small and highly specialized businesses, and collaborative environments that result in technological advances. These business trends should help the Navy address the emerging issues that impact its business—budget cuts, rising fuel costs, increasing demand for services from the warfighter, and asymmetric threats from emerging competitor nations.

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