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14. ABSTRACT

This paper analyzes the benefits of the U.S. Navy to implement a tactical cloud computing infrastructure aboard naval vessel using current technology found out in the private sector to execute expanding operational objectives. The need for tactical cloud computing specifically targets three technologies for an implementation which cloud computing, artificial intelligence, and application program interface. The paper touches on the effects of the current global environment is affecting the U.S. Navy in maintaining its maritime superiority and pursue the growing threats across the various regions of the world. Technology as a driving factor is creating rising competitors to the U.S. Navy that requires a shift in technology implementation to sustain as a global maritime superpower. The paper identifies, explains, and provides examples of the suggested technologies in private industry. The paper then describes the technologies ability to address U.S. Navy problems through an implementation conveyed in an operational scenario. The paper seeks to develop the argument that with the exponential rate at which technology is advancing a shift is required to implementing technologies quickly that assist in addressing future problems. The technologies listed in the paper are what is needed to posture for future threats and develop from going forth. The hope is to provoke thoughts of the possibilities that a Tactical Cloud computing system presents aboard U.S. Naval vessels exponentially enabling warfighters to achieve objectives.

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NAVAL TACTICAL CLOUD COMPUTING

By Lew E. Challenger

LCDR, USN

A paper submitted to the Faculty of the U.S. Naval War College in partial satisfaction of the requirements of the VADM Samuel L. Gravely, Jr. Naval Warfare Research Group.

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ABSTRACT

This paper analyzes the benefits of the U.S. Navy to implement a tactical cloud computing infrastructure aboard naval vessel using current technology found out in the private sector to execute expanding operational objectives. The need for tactical cloud computing specifically targets three technologies for an implementation which cloud computing, artificial intelligence, and application program interface. The paper touches on the effects of the current global environment is affecting the U.S. Navy in maintaining its maritime superiority and pursue the growing threats across the various regions of the world. Technology as a driving factor is creating rising competitors to the U.S. Navy that requires a shift in technology implementation to sustain as a global maritime superpower. The paper identifies, explains, and provides examples of the suggested technologies in private industry. The paper then describes the technologies ability to address U.S. Navy problems through an implementation conveyed in an operational scenario. The paper seeks to develop the argument that with the exponential rate at which technology is advancing a shift is required to implementing technologies quickly that assist in addressing future problems. The technologies listed in the paper are what is needed to posture for future threats and develop from going forth. The hope is to provoke thoughts of the possibilities that a Tactical Cloud computing system presents aboard U.S. Naval vessels exponentially enabling warfighters to achieve objectives.

NTRODUCTION

The U.S. is among a few nations, known for innovations that have throughout history influenced change on a global scale. The changes created from innovating in the U.S. has always lead to the continuous modernization of the U.S. military forces enabling the nation to retain its reputation as a global superpower. The technological advancement that has occurred over the last decades has empowered other countries to make significant strides in their innovation development that has all but closed the gap in capabilities among many nations. These nations are now transferring their innovations to develop a capable military to promote change. The U.S. military must now devise new methods of employing technology to retain an advantage in an ever-changing global landscape.

Technological advancements have quickly changed the global landscape in the way people live, nations capabilities and how wars conducted. In the past, the U.S. military benefitted from the country's ability to pour money and people into its military force to posture against any threat. The introduction of technology within the military forces has allowed the U.S. military to reduce its force count and still accomplish more with less. The U.S. military has benefited tremendously from the innovations created within the U.S. from government and private organizations. The benefits have led to a military force enabled to attain a reputation globally as both capable and premier.

The U.S. participation in global operations over the last decades has undeniably affected its military forces and nation negatively. The rising U.S. deficit has created a fiscally constrained environment that has significantly affected the nation domestically but, also has drastically affected the militaries ability to sustain its readiness in an uncertain global environment. The negative appeal of entering constant global conflicts and concerns of drastic changes occurring within the military affecting readiness are deteriorating the U.S. military ability to remain

capable. The Department of Defense (DOD) continues to leverage technology more than ever before to meet expanding military missions, and objectives in the current environment.

Currently, the monopolistic hold the U.S. has had in developing disruptive technology is no longer a viable plan for the military to retain a global advantage. There are more epicenters of disruptive technology developing throughout the world in nations such as China, India, and the U.K. A recent global survey that polled for nation's showings most promise for disruptive technology breakthroughs that will have global impacts resulted in the following percentage among the nations[1]:

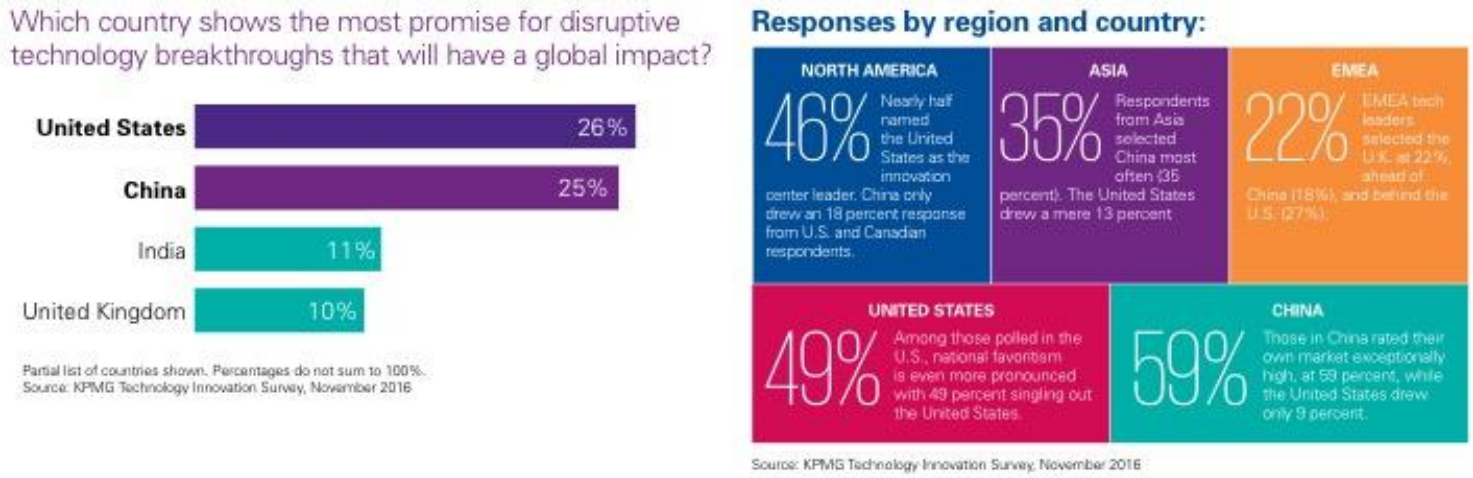

Figure 1:KPMG Innovation Center. 2016. The Changing Landscape of Disruptive Technology: Global Technology Innovation Hubs. Consulting , US: KPMG International

Unfortunately, for the U.S., few near-peer competitors have also invested significantly in their military programs to counter the U.S. military. The technology used by the near-peer competitors are considerably closing the gap in the combat superiority held by the U.S. throughout history as well. DOD has realized that a change of approach is imperative to the U.S future as a superpower. The DOD continues to conduct assessments of possible threats that may hinder combat effectiveness and are working to develop solutions that are necessary force

[1] KPMG Innovation Center. 2016. *The Changing Landscape of Disruptive Technology: Global Technology Innovation Hubs.* Consulting , US: KPMG International, 40

multipliers. The military has focused its efforts in many areas ranging from modernization of its nuclear enterprise, command and control (C2), robotics, artificial intelligence, missile defense, and deep learning.[2]

The U.S. Navy is well-suited as a service to productively capture gains in three of the areas specifically in command and control (C2), artificial intelligence, and deep learning. The expansive global mission set of the U.S. Navy requires versatile and ready units available to conduct a variety of operations anywhere globally to fulfill the objectives of the nation. Naval forces equipped with various sensors, communication equipment, and other competencies allows them to employ those capabilities developed in the assessed areas effectively. In C2, U.S. Naval units equipped with multiple forms of communication suites that cover the spectrum can remain connected to higher echelons while deployed globally. Despite, the options provided by the variety in maintaining C2 through satellite communications, atmosphere radio frequencies, and digital communications through fiber, there are still vulnerabilities to address in the system that requires a shift in accepted reasoning. The other areas of artificial intelligence and deep learning are partially new technologies that have evolved in the most recent decades that present an interesting dynamic for the service. The U.S. Navy's overabundance of shipboard sensors provides a means of discovery to develop the two areas in the missions of the service.

Currently, as there are nations around the world that are exponentially building their naval fleet the U.S. Navy is currently in a stagnation when evaluated on the number of naval vessels slated for development in the future when compared to the other nations of the world. The U.S. Navy does have a slight advantage when comparisons drawn between the capabilities

[2] Orino, B. (2016, January 28). *Six technologies that the U.S. military is betting on*. Retrieved November 2016, from Brookings: https://www.brookings.edu/blog/order-from-chaos/2016/01/28/six-technologies-that-the-u-s-military-is-betting-on

of each country's warships. The various missions conducted globally by the U.S. Navy are many and wide-ranging despite the number of warships in service. Imagine a scenario where a U.S. Navy Surface Action Group (SAG) made up of three destroyers are tasked to execute operations off the coast of a hostile nation. The hostile nation is known for its blatant disregard for all Rules of Law and Conventions of the sea as well as war. A vital shipping lane traverses off the coast of the hostile nation, and intelligence is reporting that the hostile nation has disguised several of its warships as merchant shipping to preemptively attack any foreign warships off the coast of the country. The hostile nation also is in possession of several anti-ship ballistic missiles that it intends to use in any event it deems as a threat to its sovereignty. The nation also has recently obtained the latest jamming technology equipment that can interfere with several communication frequencies.

As the U.S. Navy SAG comes into range off the coast the hostile nation well outside of their land base anti-ship ballistic missile range, they noticed that they are having issue maintain communications. The ships are tactically in a formation where they are slightly out of the line of sight of each other as they approach the nation. One of the destroyers from its position can attain information from its sensors about vessels that are within the shipping lane near the coast. This destroyer is also able to distinguish the hostile nation's warships that are lurking within the shipping lane. Another destroyer from its position can detect the location of various anti-ship ballistic missile batteries that are sitting along the coast of the hostile nation. The last destroyer currently is in lead of the SAG and has various national level assets onboard to use in the executions of missions. Unfortunately, given the situation, the SAG is unable to disseminate their findings succinctly and in a manner that will allow all vessels to have a common operating picture of the environment. The above sequence of events is not as far-fetched as it may seem

despite the capabilities possessed by each warship. Technology has allowed for the ability to collect and analyze data to create information that is used to make decisions to deliver desired outcomes. The incorporation of technology in warfare coupled with the global proliferation of new technology acquired by many actors has presented a problem that may hinder operations in the future for naval warfare. This paper will explain the various benefits and challenges of the technologies necessary for the U.S. Navy to better position itself for the future. It will also explain how the employment of these technologies can benefit the U.S. Navy when used in a few mission areas. Finally, it will offer recommendations for how the U.S. Navy can implement these technologies when given current and future systems slated for development.

Applicable Technologies – Cloud Technology, Artificial Intelligence, and Application Program Interface

The following sub-sections will provide descriptions of various technologies, their current use within the private sector, and the benefits of their implementation. The continuous advancement in computing and storage technologies has contributed significantly to a now global data revolution. The data revolution has pioneered ways in which data is used to develop information and perspective better to come to a decision efficiently. The way at which the dissemination of data occurs for analysis and later formed is pivotal to future advancements in technology. This section will begin by describing the implementation and benefits of the spreading of data through cloud technologies.

Cloud Technology

Cloud computing rise to a now ubiquitous technology has resulted in variations of its implementation and misconceptions as to what it is throughout industries. The concept of cloud computing technology which is widely accepted today dates to the 1960's and 1970's with the development of ARPANET, currently known as the Internet.[3] As technology advanced over the years so did the development of computing power and IT infrastructure quickly bringing to fruition the cloud computing capabilities seen today. An understanding of the technology is necessary to realize efficiently applicable capabilities and to differentiate among the various misconceptions in the designation of cloud computing.

The definition of cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal

[3] Pullen, John Patrick. 2015. Where Did Cloud Computing Come From, Anyway? March 19. Accessed January 2, 2017. http://time.com/collection-post/3750915/cloud-computing-origin-story/.

management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models.[4] Cloud computing technology popularity over the last decade has attributed to the use of the word cloud to identify the technology and also adds to the misconceptions in designating what is consider cloud computing.

Essential Characteristics

An understanding of the components of cloud computing is the best way to gain insight of the capabilities it can provide. First, cloud computing has five essential characteristics linked to the model which are on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. The different dimensions provided by each characteristic has significantly contributed to the technology popularity and appeal across industries. The characteristic provided by on-demand self-service is a consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.[5] The practicality of this characteristic is that the control to allocate resources across what would be various areas or departments in a non-cloud environment is done independently by one individual. The characteristic of broad network access allows for the availability of capabilities over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).[6] Broad access allows for accessibility to the cloud through multiple sources. In the past, this ability was costly because of limited access to

[4] Lee Badger, Tim Grance, Robert Patt-Corner, Jeff Voas. 2012. *NIST Special Publication 800-146: Cloud Computing Synopsis and Recommendations.* Special Publication , U.S. Department of Commerce, National Institute of Standards and Technology, Gaithersburg: National Institute of Standards and Technology, 13.

[5] Lee Badger, 2012

[6] Lee Badger, 2012

computing technology as well as prioritization necessary for access. The development of network infrastructure to support high bandwidth transfer has enabled this characteristic resulting in lower cost. Resource pooling as a characteristic is where provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location-independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, and network bandwidth.[7] This characteristic enables the scalability of cloud computing and multi-tenancy. Multi-tenancy defined is the ability where single infrastructure or resources serve multiple instances. An example would be in the past when there were telephone operators that patched many individuals over a single linked phone system. This area of cloud computing presents opportunities currently and in the future as there are advancements in networking, storage capacities, and computing capabilities. Rapid elasticity characteristic is where capabilities can be rapidly and elastically provisioned, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.[8] This characteristic allows for the resilience of the IT infrastructure for industries through the use of cloud computing. This resource is synopsis to the creation of more space or resources at will instantly to meet desired requirements. As the condition is no longer needed the expansion could as quickly return to the previous allocation. The final characteristic in cloud

[7] Lee Badger, 2012

[8] Lee Badger, 2012

computing measured service is that cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.[9] This characteristic is the quantifying and analysis of usage across cloud computing model.

Service Models

Cloud computing delivery to consumers occurs through three service models which are Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), and Cloud Infrastructure as a Service (IaaS). The essence of cloud computing in presenting various capabilities to individuals relates to the division of services. Cloud Software as a Service (SaaS) is a capability provided to the consumer to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a Web browser (e.g., Web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.[10] This SaaS may be the most common service model in cloud computing currently. An example of this type of model would be online email service providers like Gmail and Hotmail.

Cloud Platform as a Service (PaaS) is a capability provided to the consumer deployed onto the cloud infrastructure consumer-created or -acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or

[9] Lee Badger, 2012
[10] Lee Badger, 2012

control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.[11]

Cloud Infrastructure as a Service (IaaS) is a capability provided to the consumer to provision processing, storage, networks, and other fundamental computing resources where the consumer can deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications; and possibly limited control of select networking components (e.g., host firewalls).[12] In this model, the provider may have a robust infrastructure capability that may be co-located with other organizations and provide access allowing others to take advantage of a possible scalable framework.

Cloud Platform as a Service (PaaS) is a capability provided to the consumer deployed onto the cloud infrastructure consumer-created or -acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.[13] This model mostly used in situations where there is a development of new applications to sandboxing for design, testing, and deployment. Sandboxing IT world is the process of isolating untested software for security and other reasoning such as resource use.

[11] Lee Badger, 2012
[12] Lee Badger, 2012
[13] Lee Badger, 2012

Deployment Models

The deployment model of cloud computing is a categorization of the infrastructure by objective or purpose usually under the considerations of cost, capacity, accessibility, and ownership. This type deployment model is the final component or factor for a particular technology to classify as cloud computing. There are four deployment models which are private, community, public, and hybrid cloud. A private cloud deployment model is a cloud infrastructure provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.[14] This deployment model of cloud computing may draw a comparison to the accepted proprietary infrastructure for an organization to conduct operations across its various departments. Unfortunately, this doesn't meet the recognized essential characteristics for classification as a cloud computing technology. Today, the development of networking infrastructure expands the concept to incorporate the management by other parties for an organization to save on cost, maintenance, and management of a cloud infrastructure. A community cloud deployment model is where cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.[15] This cloud infrastructure is a sharing across a particular group such as government entities. Public cloud deployment model is where a cloud infrastructure provisioned for open use by the general public. Business, academic, or government organization or some combination of

[14] Lee Badger, 2012

[15] Lee Badger, 2012

them may own, manage, and operate the cloud. It exists on the premises of the cloud provider.[16] The final deployment model is a hybrid cloud where the cloud infrastructure is composed of two or more distinct cloud infrastructures (private, community, or public). The framework remains unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds)."[17] . The hybrid deployment model is a versatile in that allows for multiple conditions to be met while maintaining a single cloud.

Many organizations continue to become attracted to the implementation of cloud computing for not only what it affords them but also what advancements in various enabling technologies will bring to cloud technology application. Currently, through the five characteristics organizations are capitalizing on the benefits gained through flexibility, cost reduction, agility, increase service quality, and redundancy. The pairing of cloud computing and other technologies is currently a trend that is uncovering new functionalities and expanding perspectives on the future use of the cloud. Technology such as machine learning is an example of technologies currently used with cloud computing.

Artificial Intelligence

The exponential versus linear progression of technology throughout history is giving validity to the law of accelerating return that explicitly states that such advancements will lead to paradigm shifts that drastically change accepted norms.[18] A technological singularity is what is expected to eventually occur which is a point along which artificial intelligence will surpass

[16] Lee Badger, 2012

[17] Lee Badger, 2012

[18] Kurzweil, Ray. 2001. KurzweilAI | Accelerating Intelligence. March 07. Accessed January 4, 2017. http://www.kurzweilai.net/the-law-of-accelerating-returns.

human intelligence.[19] Concepts of artificial intelligence are somewhat new and have led to diverging perspective in the area of study. Currently, there are multiple competing perspectives in defining, implementing and, understanding artificial intelligence. As the AI field develop and research conducted, theories may converge to capture AI better distinctly. One way in understanding AI is to draw a comparison with specific areas of cognitive theories of intelligence. Some ways humans differentiate from other animals are their ability to reason, gain perception, solve problems, learn, and communicate. The way humans can execute these functions is presenting interesting perspective for AI researchers in developing the field.

Scientists have worked for years to unlock the complexity in all aspects of the human brain but, have found much is still to be learned. The studies of the brain have created research on how the brain works and the various processes in the way people learn. AI researchers have now found ways to translate discoveries found in the way the human brain learns to develop AI technologies further. A specific method or technology to improve the way AI learns is machine learning. Each of the methods are distinct subsections of AI technology and have seen great applications in the most recent years.

Machine Learning

Arthur Samuel in 1959 defined machine learning as the "field of study that gives computers the ability to learn without being explicitly programmed."[20] Machine learning like AI is a relatively new field that continues to expand as technology advances. The technology has grown to encompass multiple subcategories and processes that are used to develop the use of

[19] Kurzweil 2001

[20] Munoz, Andres. 2014. "Machine Learning and Optimization." NYU. Accessed 12 15, 2016. https://www. cims. nyu. edu/~ munoz/files/ml_optimization.

machine learning further. Tom Mitchell in 1997, created a more clear-cut definition of machine learning that provides a better understanding of the term. His definition is, "A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E."[21] This categorical definition of machine learning shows that it is not limited to just mathematical problems. Algorithms can be created to solve problems as long available variables are there to gain analysis.

Machine learning current popularity has to do with the growth in computing processing power, affordability of data storage, and the accessibility of the data. Although there are many methods or task in machine learning, there are those used frequently. Supervised and unsupervised learning are the two approaches of machine learning. In a supervised learning output data is trained or in this case analyzed against a developed algorithm where the known outcome is determined. This approach gives the computer a frame of reference in determining what the expectation needed are. After the algorithms had tested to correlate the information, new data is then run against the algorithm without given outcomes to identify its effectiveness. This type of machine learning is similar to teaching rules to an individual initially. After the rules appear to be understood by the person, they are given scenarios to determine their understanding of the rules in the execution of their task. In unsupervised learning approach, the algorithms provided with unaltered data without any foundation or reference. The algorithm has to find structure within the data without any assistance. Deep learning is a segment of machine learning that falls within the unsupervised learning algorithms. The way this method work is that criterions are setup for a computer algorithm. The computer then is tasked with structuring a

[21] Mitchell, Tom. 1997. Machine learning. New York, NY: McGraw Hill.

solution with the data that the algorithms presented. The initial training of an algorithm allows the computer to adjust it within a set criterion eventually shaping problems and developing answers. The expectation for deep learning is that it will allow a computer to conduct a range of human-like functions around analysis and recognition. This method is similar to an individual learning a task on their own without any guidance of any form. The information provided has no particular format until the data is structured. Machine learning although a relatively new technology is a powerful tool that has multiple methods to use to solve an array of problems and its implementation into various systems could enable a myriad of opportunities to capitalize. The ability for an individual to capture value in what technology provides all depends on how they can interact with technology. The piece of technology that allows an individual to communicate through technology and even gain information is through the power of application program interface.

Application Program Interface (API)

The capabilities of the many technologies created over the years have grown tremendously. The intricate inner workings of how these technologies provide the functionality to users have always been something that was overlooked by the majority but, was a very real topic for a few. The disregard for understanding the inner workings of the technology is made possible by the many application program interfaces that run with the software of technologies. Application program interface is a set of routines, protocols, and tools for building software applications. An API specifies how software components should interact.[22] The process to which computers and other technology are created and operate have different distinct methods yet must be able to work with each other to execute tasks given to them. API is at the core of these

[22] Beal, Vangie. 2017. API - application program interface. Accessed 03 14, 2017. http://www.webopedia.com/TERM/A/API.html

multiple technologies working with each other as well as user's ability to perform operations on systems.

As computing power and data storage capabilities increase, there will be an increased need to query the data for information efficiently. The way interface carries out such tasks as querying for data, and the presentation of the data as it is retrieved involves the API of systems. APIs are allowing people to use better the capabilities of developed technologies. The versatility that APIs provide in the use of systems will also allow for better analysis and decision points creations as systems perform the complex tasks such as machine learning. API will also be pivotal in the presentation of data and information to users of systems.

Industry Application of Technologies

The implementation of the three technologies of cloud computing, artificial intelligence, and application program interface has had proven success in a few private sector industries. Companies within many industries have been able to modify their operations to incorporate these technologies and have seen tremendous gains from it. Then some businesses have built a model around the concept of the three areas and have created a paradigm shift in the way society operates. The following examples will describe the implementation, benefits, and results produced by the introduction of the technologies in a couple of industries.

Amazon Web Service (AWS)

Amazon provides through its AWS cloud platform a multitude of customized functionality that can easily tailor to a variety of organizations. The services provided by the platform allows capabilities ranging from Analytics to AI. Amazon has developed a framework which functionality can meet the needs of organizations and alleviate functions of antiquated systems. In analytics, Amazon has paired its storage capability with multiple database query systems that can provide structured interactive inquiries to better access stored data and

information as needed. These services are also scalable to the needs of the organization providing agility as necessary as well. The service allows for options to use business intelligence tools to analyze data to produce meaningful information.

Amazon through its AWS service works with many companies and organization across industries throughout the different regions of the world. Amazon work with General Electric (GE) migrating to their AWS platform is a perfect example of the work the benefits provided by this system. GE a multinational company is currently more than 9,000 workloads, including 300 disparate ERP systems, to AWS while reducing its data center footprint from 34 to four over the next three years.[23] They have seen benefits in transitions to a software based system in their renewable energy division. The service allows for software enable wind farms to work with each other to understand the intricacies of the wind turbines in the farm and optimize as necessary to create energy efficiently.

IBM Watson

IBM's is well known for its achievements in the IT industry for some time. They have introduced innovative technologies that have changed the way the world looks at technology. IBM recent innovation Watson is no different from expectations held over the years for the company. IBM claims that Watson learning ability is similar to humans in that it learns from experience and instruction. IBM Watson combines natural language processing, machine learning, and real-time computing power to sift through massive amounts of unstructured data—documents, emails, journals, social posts, and more— to answer questions fast.[24] Watson skills,

[23] Amazon. 2015. AWS Case Study: General Electric's Digital Transformation. Accessed 03 17, 2017. https://aws.amazon.com/solutions/case-studies/general-electric/.

[24] Deloitte & IBM. 2015. "Disruption ahead: Deloitte's point of view on IBM Watson." Deloitte. Deloitte & IBM. Accessed 03 20, 2017. https://www2.deloitte.com/content/dam/Deloitte/us/Documents/about-deloitte/us-ibm-watson-client.pdf.

created from using subsections of AI such as machine learning allows the cognitive system to be versatile in the services that it provides.

In 2011, to display Watson's abilities, IBM entered its cognitive system as a contestant on the game show Jeopardy. Watson performance in winning the game show by a large margin was a defining moment for IBM introducing its technology to the world. Today IBM is advertising Watson as a solution to meet the needs in a growing age of computing for companies. The services and capabilities that Watson provides allows it to be used as a system to augment information for improved decision making within organizations. IBM is continuing to introduce Watson into many organization proposing that adaptability of the service surpasses traditional computer systems because as a cognitive system it learns through various ways. The ability of the system to learn allows it to become astute over a period.

The way in which an individual can interact with Watson through natural language makes the interaction intuitive. Unlike keyword-based search engines, which simply retrieve relevant documents, Watson gleans context from the question to provide the user with precise and relevant answers, along with condensing ratings and supporting evidence.[25] The use of AI technology allows improvement of Watson through training of the system. As technology advances, IBM will be able to grow Watson's capabilities to serve its customers better. IBM recent expansion includes the incorporation of visualization, reasoning, ability to relate to users, and deeper exploration to gain a broader understanding of the information content.[26] IBM is also using APIs to introduce the many services that it expects to deliver through Watson. IBM Watson's capabilities are positioning the cognitive system to have the ability to mine data in a

[25] (Deloitte & IBM 2015)
[26] (Deloitte & IBM 2015)

current and future data rich environment to synthesize information from the data to inform decisions.

An example of Watson's capability in action came in an experiment of the system. During a partnership case with IBM and Twitter, they used Watson Analytics to gain insight on a particular topic. Watson was able to analyze the data targeting periods and the desired topics. The information result is then presented by Watson for the user to alter to gain more from it. Watson interaction functionality is then available for the user to determine a perspective from the results, ask Watson questions about the results, and even have presented recommendations from Watson regarding the results.[27] IBM Watson is a quintessential representation of the possibilities of what a combination of technology could provide. Cognitive systems provide to an organization value with its enabling functionality that was not available before through current traditional forms.

Uber

The complexity and rapid change of technology today affects people's interpretation of the functionality provided with the identity of the technology. An example of this is a famous company started in 2009 called Uber. Uber in every way is a technology company but, to many, it is a transportation service that provides functionality like a taxi service. The distinct Uber application that runs on people's phones connecting drivers and riders is the core business of the company. The underlying technology that permits the Uber application its capability is machine learning. Uber Technology Inc. not only uses machine learning for its software but also throughout the company's operations.

[27] https://www.ibm.com/communities/analytics/watson-analytics-blog/watson-analytics-use-case-3-ways-to-get-insights-from-twitter-data/

Uber uses machine learning and APIs to facilitate meeting their objectives in connecting drivers and riders in a marketplace that analyzes the different variable that could occur. The machine learning examines and learns the different dynamics to provide solutions to problems. The determination of a pricing variable for a ride for example. Machine learning role in creating a model for price considers multiple variables such as drivers supply, demand, and learns from past data collected to provide a price. The capabilities that machine learning provides makes the Uber application versatile and dynamic. [28]

Uber is currently in the process of working to expand its functionality through the use of machine learning. The company is working on creating a variety of APIs and finding ways of improving maps. Uber is also experimenting in the self-driving vehicles which they have an ongoing operation in Pittsburgh, PA currently. As machine learning advances it will allow companies like Uber to develop endless capabilities to grow their business in unimaginable ways. A constant evolution in AI and machine learning could result in the development of full autonomous systems introduced in many industries.

[28] http://www.techrepublic.com/article/how-data-and-machine-learning-are-part-of-ubers-dna/

US NAVY: A Global Naval Force

The US Navy reputation as a premier naval force has sustained over the years because of its ability to incorporate the latest innovation onboard its naval vessels. U.S. naval ships undergo regular upgrades as a means to extend not only the life but, also to maintain the vessels capabilities in a dynamic warfare environment. There have been increasing threats to the U.S. Navy maintenance of its global superiority that requires an aggressive implementation of technology to remain relevant and meet evolving military objectives.

The way in which the U.S. Navy operate throughout the globe to execute aims set forth by the National policy makers is unparalleled. U.S. naval vessels weapons and sensors capabilities allow units to perform a variety of operations within as well as outside the realm of warfare. Each U.S. naval unit depending on the class of ship can provide an assortment of functionality that may support and facilitate the completion of the missions assigned.

Inevitable Concerns

The United States has maintained its standing as a global superpower for good. The entire U.S. Armed Forces have played a role in the achievements and maintenance of that reputation throughout the globe. Currently, there are rising hegemonic superpowers that are posturing themselves to challenge what is considered the status quo with the U.S. position. These nations are amassing their militaries to unprecedented numbers in the history of the nations. The U.S. military engagements of operations in the recent years have affected their readiness in some way and created a state of fatigue not just on the forces but, also the equipment.

The operations, on the other hand, has allowed the U.S. military to understand and shape its capabilities to be ready for future threats that may be on the horizon. During, the World Wars the U.S. was a relatively young nation that possessed an advantage over other national competitors in that it had a very robust industrial base. The industrial base that the U.S. had at its

disposal allowed the nation to build its military fairly quickly to counter any threat that may arise. As the world changed and strategic policy put in place to deter from another World War occurring the need for a robust industrial base dwindled as well as the necessity of a large military.

In the years that followed the U.S. military didn't have many threats from a variety of hegemonic powers. The U.S. military eventually gained its title as a global force focusing on the quality of its military instead of quantity. A technology focused military seek capabilities that provided an edge in conducting operations. The result of a technology driven strategy provided smart munitions, multiple technology-driven aviation platforms, and naval vessels. These technologies enable the U.S. military to continue to be versatile in its many objectives. As the technology and globalization began to increase throughout the world, global powers focus on their national interest increased. Nations began considerable investment in their militaries expansion in many cases mimicking that of the U.S. military. Many countries began their focus on their navies to not only protect their coastline but, also to conduct and project power. Technology has allowed for these nations ability to focus on quantity and still maintain some form of capability to remain competitive in the technology employed on their naval vessels. They also have focused on ways of countering techniques and equipment used by the U.S. to establish an advantage over what they see as a definite threat to their rise.

The U.S. is currently entering into a difficult period for the nation and its military especially the Navy to address the many perspective threats currently and in the future. The lack of an industrial base to quickly produce naval vessels to counter threats is no longer available. Rising Nations Navy size is projected to surpass that of the U.S. Navy shortly. The U.S. Navy should focus more on reinforcing the technology employed on its naval vessels to sustain its

position in the world. If U.S. Navy implements specific technologies, it will significantly improve the way it operates and fights allowing its naval forces to do more with less.

Cloud Computing, AI, and API within the U.S. Navy

The following section will consider specific application and possible implementation of the cloud computing, AI, and API technologies onboard U.S. naval ships. This section will apply the benefits the listed technologies has created within the private sector and analyze the possibilities that could occur within the U.S. Navy specifically onboard naval ships by providing an analysis of the SAG scenario given earlier in the report with the given technologies available for use onboard each ship in the SAG.

A U.S. Navy Surface Action Group (SAG) made up of three destroyers are tasked to execute operations off the coast of a hostile nation. The hostile nation is known for its blatant disregard for all Rules of Law and Conventions of the sea as well as war. A vital shipping lane traverses off the coast of the hostile nation, and intelligence is reporting that the hostile nation has disguised several of its warships as merchant shipping to preemptively attack any foreign warships off the coast of the country. The hostile nation also is in possession of several anti-ship ballistic missiles that it intends to use in any event it deems as a threat to its sovereignty. The nation also has recently obtained the latest jamming technology equipment that can interfere with several communication frequencies.

The U.S. Navy SAG prior to departing on their task towards the hostile nation receive viable intelligence packages downloaded onto each ship onboard database. As the ships transits to theater towards the hostile nation the onboard AI technology on each ship processes the newly downloaded information to develop viable scenarios for the SAG. The AI understanding the capabilities possessed by its ship and that of other ships in the SAG made up of three destroyers

begins to structure problem sets and actions from the information downloaded in addition to real-time available updates received from satellite. The AI has over time learned through machine learning doctrine, naval tactics, strategy and multiple available military sources of data collection. The AI also has a firm understanding of the ship crew and capabilities from the workups exercises conducted before executing assigned mission.

As the ships are approaching within the range of the hostile nations anti-ship ballistic missile capabilities, the AIs technology onboard the ships of the SAG begins to coordinate information gathered from their individual sensors to inform their structured analysis for the commanders. The commanders are then offered recommendations on their commander API console where they can review among themselves and develop more on what the AI has formulated. The Commodore of the SAG picks an action to execute. The AI quickly develops and runs a scenario from synchronized information. The result of the analysis displays with recommendations for the Commodore to select with a dissemination request to send to other commanders in the SAG. The Commodore decides to attach a proposal posed by the AI to his selection regarding employing deception tactics due to continual merchant traffic off the coast of the nation.

The task is then disseminated internally on the lead ship and encrypted to send to other ships in the SAG. The AI from a sensor onboard realizes that there is an anomaly occurring and narrows it to jamming of radio frequencies by the hostile nation. The AI determines an alternate path to send information through a very high-frequency acoustic signal. The other destroyers within the group with acoustic receivers onboard analyze the high-frequency acoustic data transfer received and populate to their designated commander API console. The commanding

officers (CO) then verify the tasking to disseminate to their crew and reply a confirmation receipt of actions to Commodore.

The COs of the destroyers then begin their ships preparation before entering further within targeting range of hostile nation. The watch station onboard the ships are given their specific tasking from the disseminated orders. The watch standers then work with the AI to execute assigned tasks which include implementation of such procedures as EMCON, weapons pairing, deception tactics to employ and other pertinent orders. The crew performs and confirms completion through their watch standing API consoles. The COs are provided real-time updates as tasks completed. A watch stander identifies an issue with one of the tasks provided by the AI that may not be able to be conducted due to missing supply onboard. The AI informs the COs and mirrors the acceptable solutions that it provides to the sailor on his API console for the CO per his requested settings. The sailor confirms the task completion with the given solution given by the AI and the commander receives notification of all tasks complete.

The destroyers begin to execute their formation staggering in their designated steam areas. The first ship lingers south of the hostile nation near merchant traffic out of visual range to identify and tag vessels in the area within minutes. As the destroyer detects merchant ships, it senses signature emissions of hostile nations warships. The ship tags these ships hostile and disseminates the information to other ships in the SAG. The destroyer in identifying merchant's vessels receives a notification for a vessel of interest (VOI) within the merchant shipping suspected of heading to a known ally of the hostile nation from intelligence reports. The VOI is then analyzed using the sensors onboard the destroyer with the AI and information is gathered to amplify what is already known.

The second destroyer is tasked to position itself to identify mobile coastal anti-ship ballistic missile batteries along the coast and surveillance from passive sensors. The AI begins conducting search and identifies all known batteries. The targeting data disseminated across the SAG. The ship in tandem conducts surveillance along the coast and receives information that the hostile nation has identified one of the other destroyers. The identified destroyer by the hostile country has the Commodore aboard, and they are preparing to take action on the ship. The information passed throughout SAG and commander sends orders to conduct strikes on battery sights immediately. AI quickly determines the missile coordination and watch standers begin conducting attacks from two of the three ships. The missiles fired from the destroyers hit all coastal battery rendering them neutralized but, one anti-ship ballistic missile is successfully launched from the hostile nation. The AI aboard the Commodore ship identifies the inbound missile and develops a solution. The two of the three destroyers are unable to target the incoming missile because of their recent strike on the coastal battery. The third ship CO in the south receives an alert to target the incoming missile, and a missile is immediately fired to intercept the inbound anti-ship ballistic missile fired from the hostile nation. The AI determines the trajectory from assessed information and the hostile nation missile is destroyed just before getting in engagement range of the Commodore ships close in weapons system (CIWS) guns. Follow on orders populates to the COs from the theater commander to execute and they regroup to depart from off the hostile nation coast.

The scenario described above may appear to be fiction in nature given the current state of the U.S. Navy but it's is a foreseeable future for U.S. Naval forces. The U.S. Navy has already created the foundation for this system to be developed from already in placed programs. The robust sensors and technology are already aboard naval ships today. The requirement would be

the implementation of the mentioned technology in this paper to in effect link the systems and develop the necessary interfaces for the coordination to occur.

The following are challenges and recommendations o employ cloud computing, AI, and API onboard US Naval vessels. These challenges and recommendations should not be limited to suggested employment. As these technologies evolve in the private sector, their capabilities could spread to other areas of the naval forces and other services to dramatically enhance the warfighters ability to attain mission objectives. These technologies would provide a game-changing effect in how not only the U.S. Navy fights but is essential in facing a threat that overpowers forces in quantity.

Challenges and Recommendations for Adopting Cloud Computing, AI, and API Technologies

There are a few challenges of adopting cloud computing, AI, and API systems as a tool aboard U.S. naval vessels. The U.S. Navy is a service that is rooted in its traditions of the sea and way of operations. The dangers of the environment and restrictions create difficulties, unlike any other warfare environment. The challenges in the implementation of these technologies range from differences due to cultural resistance to additional research necessary in each technology application to make it suitable for warfare related tasks. There are only slight variations in the way the Navy operated in the past to how it does in present day. The variable that has created the small difference is the implementation of technology aboard ships. Technology has assisted the Navy to execute operations safely better and increased the lethality as well as the effectiveness of Naval warfare overtime. Although technology has presented multiple benefits to the U.S Navy, there is an apprehension that its implementation has had on the service that continues to create diverging views. The challenges that are most compelling to the adopting of the technologies mentioned in this report are change resistance, DOD acquisition process, and technology evolution.

Change Resistance

The military just like any other organization that stands the test of time has developed a culture that defines it yet changes creating a multiplicity of perspectives within the organization. The U.S. Navy is not an anomaly and has traditions that are staples but, changes in some way to advance the organization. The principles that service members attain during their indoctrination years into military service that they have accepted as their foundation and that are regularly referred to as they progress through their career in the service are pivotal in shaping their perspectives. These principles will vary as military services implements changes throughout the

years creating divergence in views. The difference in views is what creates a resistance to change that hinders advancements from occurring to better an organization.

The opposition to the implementation of technology is no different when first introduced. The U.S. Navy has however achieved overcoming the friction through the creation of a path to change that garners the acceptance of change by its service members over a period. The change presented by cloud computing, AI, and API are no different from that which is happening within society. The issue is the application within the area of war and the validity it provides. The only answer to the claim of is these technologies beneficial to the U.S. Navy is to test to see what the results of the application. The world is changing because of technology and the law of accelerating return states that it may occur in exponential rate which resistance to an ever-changing current may result in the drowning of the service on the world stage.

Acquisition Progression

The Byzantine process that is the acquisition process in the U.S. Department of Defense is resulting in the missed opportunity to capitalize on game-changing technologies in warfare. The current system of acquisition may have had a valid reason for why the DOD developed it the way it is. The problem is that although the process has evolved from sound understanding gathered over time, it is becoming antiquated because that way technology is driving the speed of adoption in the world. A common misconception between the civilian and military world is that the DOD has the latest and greatest technology. In some respect, there is truth in some areas of the misconception but, technology isn't one of those areas. The unfortunate reality is that change at which technology evolves makes it hard to quickly implement the latest innovation if it's associated with going a rigorous procurement process which can take a longer period. The result is that while technology evolves in months the gaining of it through the process can takes years.

The result is that just like the old process the technology is old when given final approval for installation.

Technology Evolution

As stated in the law of accelerating returns technology when developed will progress at an exponential rate that creates issues in guaranteeing the latest product. The field of AI is currently in an influx of discoveries that's presenting a fundamental understanding of possibilities it can provide to the world. Although, in a relative beginning stage of application machine learning and deep learning continues to evolve presenting difficulties in gauging the extent of its processes. Private industries implementation of AI has considerably improved business operations and product development resulting in learning that has advanced AI development. The complexity in the way AI areas of study are structuring solutions are also seeing the formation of human-like assumptions that is leading to hesitation because of the possible implication of achieving full AI capabilities. Currently, there have been an acceptance of AI functionality as long as there is a human in place executing tough measures that are felt to be beyond an AI comprehension.

Discussion and Recommendations

The challenges that the implementation of cloud computing, AI, and API can easily overcome if the U.S. Navy goes into the process with an understanding of the possibilities the technology can provide to operations. The current use of these technologies within private industry and the civilian world are reaping tremendous benefits that result in a change in the approach to addressing problems. These technologies are quickly seeing acceptance, and it's only a matter of time before they are being leveraged by other nations to increase the capabilities of their systems. An early positioning in researching what benefits are available from these technologies will allow the U.S. Navy to shape future operations against adversaries through systems based on the areas in the paper. The following are recommendations that are offered to develop ways of starting an implementation of the technologies within the U.S. Navy.

Recommendation 1 – Install localize datacenter computing aboard ships

The U.S. Navy has a variety of technology installed aboard U.S. Navy ships used throughout daily operations. The installation of data center like computing aboard the ship will allow for the synthesizing of the data collected from the sensors. A U.S. Navy shipping with added computing power will also allow for the units to have pre-stored databases of information loaded before deployments to develop products. The new computing power and storage will also free up the dependency on high bandwidth satellite communication and only require latest updates downloaded for operations. Ships will also be able to upgrade centers to accommodate future technology through a plug and play installation process.

Recommendation 2 –Modify future Consolidated Afloat Network and Enterprise Services (CANES) to create storage and computing segment

Currently, the Navy is expected to install the Consolidated Afloat Network and Enterprise Services (CANES) system aboard all its units (ships and submarines) and land sites. The CANES

system is an open architecture that allows for future interoperability with systems installation. The expected goal is to use the system as the backbone of a future Tactical Cloud. My recommendation is to begin the process by implementing the technologies discussed in this paper specifically AI and API. If AI and API were researched and applied quickly to the future evolution of the program, it would position the Navy to experiment to develop a reliable autonomous system eventually as future AI technology improves.

Recommendation 3 – Install the technology on smaller units to test and then scale

The U.S. Navy could first install the technology aboard smaller units such as Joint High-Speed Vessel and Littoral Combat Ships to test the concept. These ships are as smaller platforms have a smaller scope of systems that could easily be leveraged and assess what these technologies can provide to the units in operations. As the concept matures and the benefits quickly realized in how the ships execute its operations it can then scale to the larger class of ships. The result is that the proven concept tested on other units will create buy-in on the technologies implementation and leveraged aboard all ships.

Recommendation 4 – Create R&D project with private industries leaders in technologies

The creation of a private sector and U.S. Navy R&D group specifically targeting AI will allow for lessons learned from the current development of systems in many industries to translate to military application. The pairing of the military with successful companies who are shaping current technology could easily streamline the rigorous military testing process due to these enterprises work many issues out of systems. The military can also leverage the partnership with companies to eventually lead technology again for the future.

Conclusion

The U.S. Navy is currently feeling the effects of years of operational high operational tempo across U.S. DOD services. The current and future evolving threats are continuing to grow despite efforts put towards them. The situation has created readiness gaps and cost that are hindering the sustainment of units to continue to meet the threats. The use of various technologies to assist in alleviating the effects are emerging as a possible solution. The implementation of specific technologies will allow the military to quickly address mounting threats promptly with the current level of support allocated. Technology will allow the capable U.S. Navy to become even more operationally aware and technologically current to face added requirements placed on the service.

The versatility, agility, and additional combat capability that a tactical cloud environment will provide to units is immeasurable given what it offers. The installation of an aboard AI system within a tactical cloud infrastructure provide Naval units better awareness and use of sensors. Ships will also have the ability to instantly develop, decide, and achieve military objectives like never before. The continued and evolving use of the technologies within the private sector is setting a precedence of the inevitable that the future is here and not embracing it could further translate to a disadvantage. The choice to not explore the implementation of a tactical cloud as described in this report within the U.S. Navy may be to the detriment of the U.S. naval force in maintaining maritime superiority.

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