Department of Defense

DoD Cloud Strategy

December 2018

FOREWORD

The Department of Defense (DoD) has entered the modern age of warfighting where the battlefield exists as much in the digital world as it does in the physical. Data and our ability to process data at the ready are differentiators to ensure mission success. Cloud is a fundamental component of the global infrastructure that will empower the warfighter with data and is critical to maintaining our military's technological advantage.

The DoD Cloud Strategy reasserts our commitment to cloud and the need to view cloud initiatives from an enterprise perspective for more effective adoption. It recognizes our experience over the past five years and identifies seven strategic objectives along with guiding principles to set a path forward. It emphasizes mission and tactical edge needs along with the requirement to prepare for artificial intelligence while accounting for protection and efficiencies.

The strategy drives implementation toward the enterprise cloud environment, an ecosystem composed of a General Purpose and Fit For Purpose clouds. It focuses implementation activities on two fundamental types of work: first is the stand up of cloud platforms ready to receive data and applications, and second is the ongoing work to migrate existing applications and to develop new applications in the cloud.

This effort is a Department priority. As we execute this strategy, we will continue to seek the active participation and commitment of all DoD Components to realize the benefits of cloud as we operate on the 21st century battlefield.

Patrick M. Shanahan

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1 Strategic Environment

"If we fail to adapt ... at the speed of relevance, then our military forces ... will lose the very technical and tactical advantages we've enjoyed since World War II."
- Secretary of Defense James N. Mattis

Information is vital to United States (U.S.) national security and our ability to understand emerging threats, project power globally, conduct operations, support diplomatic efforts, and enable global economic viability. The Department of Defense (DoD) has multiple disjointed and stove-piped information systems distributed across modern and legacy infrastructure around the globe leading to a litany of problems that impact warfighters', decision makers', and DoD staff's ability to organize, analyze, secure, scale, and ultimately, capitalize on critical information to make timely, data-driven decisions. Today, the Department is largely constrained by physical resources, manpower limitations, organic skillsets and, oftentimes, laborious contracting processes to procure or grow storage and computing capabilities. In addition, the cyberspace domain continues to be an increasingly contested environment. In order for the U.S. to keep its strategic advantage, warfighters and the force that support them need to be provided with the proper capabilities and technologies to succeed.

To this end, commercial industry has made significant strides in addressing these challenges that the Department can leverage. Commercial cloud computing is a subscription-based service that provides network-based storage and compute resources. It allows users to store and access data and programs over the Internet rather than on a local computer hard drive. It also allows users to access information from anywhere at any time, effectively removing the need for the user to be in the same physical location as the hardware that stores the data. The Department must take full advantage of this technology enabler.

1.1 Inadequate Efficiency and Security in Information Technology

The physical information technology (IT) infrastructure deployed across the Department was purchased with a "maximum use" case in mind. In other words, the hardware can support the greatest possible expected demand, regardless of how infrequently that may happen, if at all. This causes much of the physical IT infrastructure purchased to be idle the majority of the time. Commercial cloud infrastructure works differently. It can scale dynamically to support resource demands with the benefit of only paying for the actual use. During most times, systems can be scaled down to support the minimal traffic that is the norm.

By owning and operating the physical hardware associated with on-premises data centers, the Department can incur unnecessary security risks and consume resources that could otherwise be realigned to support warfighters and the workforce in other mission areas. A combination of overly strict policies and procurement procedures make it difficult for DoD to ensure that both hardware and software are updated appropriately. The cost spent on physical hardware has a negative impact on diverting vital resources away from the warfighter and workforce as well as security impacts with a direct burden of responsibility for security updates of both hardware and software on DoD. The Department has historically been challenged to keep up with cyber threats to its IT infrastructure.

1.2 Disparate Cloud Efforts and Disjointed Implementation

DoD has not had clear guidance on cloud computing, adoption, and migration to provide unifying guidance or a coherent plan. This has made it difficult for the Department to embrace modern IT capabilities, to benefit from the efficiency and capacity offered by commercial cloud services, and to continue to evolve with technology at the speed of relevance.

The lack of guidance has led to Departmental inefficiencies and has hindered the Department in IT modernization efforts. It has led to disparate efforts with siloed teams, disjointed implementations with limited capability, siloed data, and inefficient acquisitions that cannot take advantage of economies of scale.

1.3 Lack of Cloud Fitness

DoD has stood up a number of clouds that have not been architected or designed for enterprise use. It is imperative that DoD has a cloud strategy to ensure that legacy applications are not moved to cloud without properly rearchitecting them to make use of the data, security, resiliency, and application advantages that cloud provides. Additionally, DoD should independently test and assess cloud network security to verify security compliance and incident response, and review all contractor and third-party testing results to ensure that performance and security monitoring are sufficient. Systems that are not "cloud ready" will most likely use excessive amounts of cloud infrastructure resources, meaning they will not be any more efficient and will almost certainly cost more to operate. This is why system rationalization is critical, but, without proper guidance, many program offices may not do this properly or skip it entirely.

There is currently no enterprise-wide guidance on how to rationalize a system nor for assessing a system's cloud readiness. This gap has further led to the siloed data behavior mentioned earlier and restricted the ability of the Department to share information. This enterprise-wide guidance is imperative to the success of any cloud strategy – enterprise or otherwise.

As DoD has continued to stand up independent clouds, we continue to dilute our already constrained cloud expertise. This enterprise cloud strategy provides the constructs for optimizing our use of cloud talent. To date, the DoD oftentimes relies on outside contracting firms to perform these assessments, never building the organic corporate knowledge to carry us into the future. Decisions are being made at high levels without in-house technical expertise as advisors. The Department must invest in its own future by building technical knowledge within.

1.4 Readiness for Artificial Intelligence (AI)

As DoD embarks to stand up a Joint Artificial Intelligence Center (JAIC), it will require an enterprise cloud infrastructure capability. An enterprise cloud will provide the common data and infrastructure platforms that will enable AI to meet the full promise of warfighter advantage.

DoD has created this DoD Cloud Strategy to align with the larger DoD cyber strategy, strengthening the security and resilience of the networks and systems that contribute to the Department's military advantage.

2 Strategic Objectives

DoD will continue to rely on its ability to process and disseminate information for military operations, intelligence collection, and related activities. To ensure this, the Department must address the unique mission requirements through a multi-cloud, multi-vendor strategy that incorporates a General Purpose cloud and Fit For Purpose clouds (reference Appendix A). To this end, this strategy will design objectives around solving these strategic challenges:

- Enable Exponential Growth
- Scale for the Episodic Nature of the DoD Mission
- Proactively Address Cyber Challenges
- Enable AI and Data Transparency
- Extend Tactical Support for the Warfighter at the Edge
- Take Advantage of Resiliency in the Cloud
- Drive IT Reform at DoD

2.1 Enable Exponential Growth

The pace of data growth is accelerating; in the last two years, the world produced 90% of all existing data. This is a trend that has been going on for a decade, with no end in sight; however, the Department's ability to access all of that data when and where it is needed has not evolved at the same pace. Modern computing capabilities can access, retrieve, manipulate, merge, analyze, and visualize data at machine speeds, providing substantial decision making advantages on the battlefield. To adapt to the continuously growing data environment, DoD requires an extensible and secure cloud environment that spans the homeland to the global tactical edge, as well as the ability to rapidly access computing and storage capacity to address warfighting challenges at the speed of relevance.

DoD relies on critical intelligence to make vital national security decisions. The quantity and quality of intelligence information has been the tipping point in numerous conflicts. As the quantity of raw information production increases, so does the struggle to organize, analyze, and distribute that information to make critical decisions.

DoD must continue to maintain its strategic advantage across the globe. In today's world, this cannot be done without laying the critical foundation needed to harness the power of its own data and information systems. This is the realization of cloud computing: the ability to organize, analyze, secure, scale, and ultimately, capitalize on critical information and fight in the digital age. These capabilities must be ubiquitous and available to all Department decision makers, warfighters, and staff.

2.2 Scale for the Episodic Nature of the DoD Mission (Elasticity)

By implementing a scalable solution, mission owners will gain significant efficiencies in the execution of mission capabilities and cyber operations by fully embracing the dynamic elasticity of commercial cloud architecture. The Department's cloud infrastructure will allow for provisioning and deprovisioning of resources automatically. This provides optimum asset utilization when compared to traditional IT infrastructure that is constantly in use, even when demand is minimal. This efficiency will also eventually improve the government's budgeting, billing, and payment practices by providing detailed resource usage reports for all mission owners. This transparency will further drive more efficiencies in the future on how applications are built.

Additionally, the cloud pay-for-use model will provide the flexibility to optimize costs across the IT portfolio and allow DoD to adapt to changing priorities, budgetary conditions, and industry developments. To achieve this cost transparency, strong governance will need to be put in place for how applications are built and data is transmitted and stored. As we develop these standards, implement them, and subsequently learn and better align our services and data to an enterprise solution, we can look to automated tools and techniques to better inform accurate tracking of financial execution of cloud resources.

2.3 Proactively Address Cyber Challenges

DoD must create a standard cloud-based cyber architecture that addresses the needs of commercial and internal-based clouds and encompasses infrastructure, applications, and data. This must include the ability to keep the environment "evergreen" in terms of security and technology.

DoD will produce a unified cybersecurity architecture that addresses cloud and the needs of classified and unclassified missions and data. The capabilities will be tested and assessed independently and frequently to ensure that cybersecurity attributes remain effective against developing threats.

DoD must embrace modern security mechanisms built into modern commercial cloud providers' platforms to ensure the security of these large amounts of data and to safeguard the information. This requires shifting the focus of security from the perimeter edge of the network to actively controlling use of the data itself. In addition to modern encryption algorithms and key management built into commercial cloud services, proper tagging of data will allow for it to be tracked and protected at the necessary levels. DoD will develop a Data Management Strategy that provides the focused discussion with respect to data.

In addition to DoD data security, each Cloud Service Provider will be integral to combating cyber challenges and securing the cloud. The Cloud Service Providers will automatically scan infrastructure resources and generated logs, which will be used to identify vulnerabilities early and to make intrusion detection and mitigation in near-real time a reality across much of the enterprise. With the rise of hardware vulnerabilities, such as Spectre, and increased insider threat, a focus must be applied to both software and hardware—which change at an incredible pace. Keeping up with those changes is difficult, but failure to keep pace has created significant security risks and will only increase in the years to come. Here, again, modern commercial providers have addressed this problem. Moving infrastructure from DoD-managed, on-premises facilities to the cloud will take advantage of the rapid roll out of software and hardware updates. Cloud Service Providers are able to shift workloads within their data centers such that updates are seamless to customers. Hardware with defects or vulnerabilities is constantly swapped out and software patches are applied with vigor in a secure and fault tolerant manner.

Although commercial cloud has many security advantages and opportunities for the Department, the transition to the commercial cloud environment also presents new security challenges. The transition from traditional IT management to the managed cloud service model alters the balance of visibility and control with ease of use, automation, leading edge technology adoption, and optimization of its information domain. The DoD CIO is responsible for defining the security guidelines in the cloud environment. The risk and the responsibility for executing the security in the cloud environment is shared between the Cloud Service Provider(s) and the system owners. DoD CIO will identify the command and control (C2) requirements of the shared cybersecurity responsibility model between DoD and commercial vendors to ensure standard execution of C2 responsibilities for DoD information in commercial cloud. The specific requirements of securing a cloud environment will strain the traditional technical workforce and requires specialized skills where the Department currently has limited expertise.

Historically, information security has been heavily focused on perimeter defense: limiting network access at the boundary. Unfortunately, this model is challenging for a commercial cloud environment where data is being accessed remotely and shared within and between deployments, regions, and from each Cloud Service Provider to other data locations, such as on-premises data centers at military installations. Therefore, the Department will shift its security focus from perimeter defense to securing data and services. This shift will be accomplished first through strong authentication for both people and machines and secure encryption mechanisms both at rest and in transit. In order to facilitate remote access, the DoD cloud environments will supply built-in cryptographic technology that enables organizations to encrypt communications by default. Since the information security responsibility is shared between the Department and its Cloud Service Providers, the Department will include language in all cloud computing contracts directing Cloud Service Providers to monitor their cloud infrastructure and maintain authenticated, encrypted logging of security-relevant events that generate an audit trail and are engineered to be resistant to tampering. To address the workforce strain in adopting these new security postures, the Department will include cloud adoption assistance and specialized training for its workforce as a part of DoD Cloud Service Provider contracts.

2.4 Enable AI and Data Transparency

DoD must enable decision makers to use modern data analytics, such as AI and machine learning (ML), at the speed of relevance to make time-critical decisions rapidly in the field to support lethality and enhanced operational efficiency. The algorithms used to inform decisions are dependent on the Department's data and information being organized, secure, and visible in a common environment. An environment where data is stored in a multitude of disparate and disjointed stove pipes reduces the efficiency and tempo of the Department. To maximize the utility of cloud computing technologies, data must be managed properly and follow modern technologies like data lakes and data hubs, which are accelerated and amplified by cloud technology.

Data stored in an enterprise DoD cloud will be highly available, well-governed, and secure. Data will be the fuel that powers those advanced technologies, such as ML and AI. This critical decision making data will be made available through modern cloud networking, access control, and cross domain solutions to those who require access. Common data standards will be a key part of the Department's methodology for tagging, storing, accessing, and processing information. Ensuring an enterprise cloud environment will increase the transparency of this data, and drive the velocity of data analysis, processing, and decision making. Leveraging advances in commercial cloud security technologies will ensure the Department's information is protected at the appropriate level.

Commercial cloud provides the ability to scale and secure both the collection and the analysis of data stored in an enterprise DoD cloud. This gives mission owners the capability to make decisions with the most relevant information. The distributed nature of cloud computing allows for a more flexible execution environment while simultaneously providing increased information security. This allows for scaling and distributing data repository stores while maintaining security posture and providing new opportunities to obtain mission insights through data collaboration. Similarly, the computing power required for analysis of massive amounts of data can be scaled seamlessly in seconds. This ability to scale will ensure that mission execution is not hindered by insufficient computing and storage capacity and enable the creation of new information models that were previously unachievable.

2.5 Extend Tactical Support for the Warfighter at the Edge

The DoD cloud environment will serve mission owners in every environment, across the range of military operations, from the tactical edge to the home front, both CONUS and OCONUS, and at all classification levels and disseminations (e.g., NOFORN and REL). We must embrace computing solutions that enable warfighters in their environment versus forcing them to conform to the current environment of siloed data and legacy applications. The integration and operation of computing solutions will be straightforward and repeatable, regardless of the required classification level of the system. This will allow warfighters to make data driven decisions and enhance DoD ability to share data with allies and operate as a coalition force. The security of the classified environments will support the level demanded by mission requirements.

Industry has made huge strides in disconnected operations. The Department's General Purpose and Fit For Purpose clouds will capitalize on these efforts to provide the warfighter with the latest technology where they need it and when they need it regardless of the environment. Cloud devices employed by warfighters at the tactical edge will be ruggedized and adaptable, providing for automatic synchronization to the greater cloud once communication is sufficient or reestablished. While certain DoD programs are not immediately amenable to migration to the cloud, some of these sytems may ultimately be bridged to the cloud, while others may be addressed through separate non-cloud solutions. But overall, this auto synchronization of information will ensure warfighters are retaining data, feeding it back into models, and fighting with the most recent algorithms. Doing this in a secure environment will be a force multiplier and directly support the primary goal of the cloud environment: information superiority.

2.6 Take Advantage of Resiliency in the Cloud

Enterprise cloud allows for continuity of operations and efficient failover in times of crisis and operational disruption. Cloud computing is a key component in overcoming these challenges and ensuring comprehensive mission execution, due to its distributed, scalable, and redundant nature. Executing this cloud strategy will incorporate standard approaches to leveraging cloud for this mission resiliency. The enterprise cloud will offer support for failover in times of infrastructure degradation as well as recovery from operational outages and significant cyber incidents.

The distributed, redundant nature of cloud computing overcomes another cyber challenge with its ability to failover in times of crisis. Our commercial cloud solutions will use advances in technology to automate failover, solving a major deficiency throughout the Department. DoD will only be able to ensure continuity of operations for digital services. We will accomplish this by taking advantage of multi-region and multi-availability zone (AZ) architecture, which exists natively within major cloud providers, and pairing this with the effective deployment of secure

Cloud Access Points (CAPs) to cloud-based cybersecurity solutions for increased resilience. DoD cloud architectures will allow for workloads to shift from one AZ or region to another, within a single cloud provider, nearly instantaneously upon detection of the failure of a primary data center. This will be vital in the case of human-made or natural destruction of a large geographic area. The configuration of automated failover is not itself automatic. To fully achieve this capability, applications will need to be re-architected for the cloud. This will allow the Department to bypass the cost and manual effort currently required for the Department to maintain multiple instances of the same data across cloud providers or on-premises data centers, which does not provide the same level of failover as that provided by commercial cloud.

2.7 Drive IT Reform at DoD

The cloud will allow DoD to further consolidate its sprawling data center assets. The Department still has an opportunity to further rationalize and has done significant work to rationalize and reduce data centers. The cloud will provide an opportunity to accelerate and extend those consolidation opportunities, as well as the opportunity to deliver integrated Defensive Cyber Operations (DCO) and achieve efficiencies through rapid deployment of common services. An enterprise cloud perspective will enable more centralized cloud management and a broader availability of security service options for wider cloud adoption by DoD to include those DoD Components with smaller implementation staff.

3 Strategic Approaches and Guiding Principles

DoD requires an extensible and secure cloud environment that spans the homeland to the global tactical edge, as well as the ability to rapidly access computing and storage capacity to address warfighting challenges at the speed of relevance. Technologies such as AI and ML have the potential to fundamentally change the character of war. DoD will embrace an approach that leverages multiple cloud providers who can provide General Purpose and Fit For Purpose clouds. The interoperability of the multi-vendor and multi-cloud environment will be governed by one overarching enterprise cloud strategy. To achieve the objectives outlined above, the Department will pursue a set of guiding principles that will inform future decisions about enterprise clouds: Warfighter First, Cloud Smart-Data Smart, Leveraging Commercial Industry Best Practices, and Creating a Culture Better Suited for Modern Technology Evolution.

3.1 Warfighter First

Throughout the Department's transition to commercial cloud services, it needs to continuously test that cloud solutions are built in a manner that never puts the warfighter and his/her mission at risk. This will require the Department to rigorously red team and challenge itself with independent assessments of the cloud environment and to utilize tactical distributed computing. At all times, DoD needs to ensure that cloud is addressing the needs of improving military lethality. By constantly challenging itself around lethality with red teams, DoD can ensure that the cloud will be positioned to support the challenges of the global environment.

3.2 Cloud Smart-Data Smart

To achieve the objectives outlined above, the Department must pursue a Cloud Smart-Data Smart approach. This approach includes:

- Cloud Smart: One cloud strategy to adopt cloud solutions that streamline transformation and embrace modern capabilities for multiple clouds and missions
- Data Smart: Data transparency and visibility enabled by enterprise infrastructure, application standards, and data tagging.

The Department seeks to leverage the decision making advantages on the battlefield enabled by AI and ML. The Department will best take advantage of these capabilities by executing this succinct, integrated, and adaptive cloud strategy that encompasses multiple clouds and missions across the entire DoD. Systems/applications can be designed with the cloud in mind to simplify adoption and to allow for integration across the Department. Common data and application standards associated with conducting operations in the cloud, such as data normalization/tagging, transport protocols, and interfaces, will be developed to enable and encourage the adoption of enterprise solutions that navigate DoD away from custom, approaches. These standards, combined with the computing power offered by cloud, will allow the Department to function at a tempo never before seen, making informed, analytical decisions at machine speed.

3.3 Leverage Commercial Industry Best Practices

In addition to Cloud Smart-Data Smart, DoD must leverage commercial industry best practices in its approach. This includes:

- Leveraging commercial technology, capability, and innovation whenever possible
- Maximizing competition to ensure that DoD is getting the best technology and value
- Leverage industry open standards and best practices to avoid lock-in and provide maximum flexibility for future cloud advances
- Independently assessing the services delivered to ensure that the data remains secure.

The Department will leverage critical foundational technologies available in commercial cloud computing and storage, to enable innovation wherever possible, while eliminating considerable technical debt and security risk. DoD is positioning itself to get the best value in today's market of cloud computing capabilities to support warfighting and business requirements and to grow capability as industry evolves. In addition, DoD seeks to maximize competition, not only when awarding the pathfinder General Purpose cloud, but also by ensuring access to a variety of Software as a Service (SaaS) capabilities that are complementary to the General Purpose and Fit For Purpose clouds. The Department must take advantage of the advances that American private industry has made. All of this will be built into commercial pricing structures. If DoD can adopt this commercial mindset toward cloud computing, it can incorporate commercial industry lessons learned into future architecture decisions.

3.4 Create a Culture Better Suited for Modern Technology Evolution

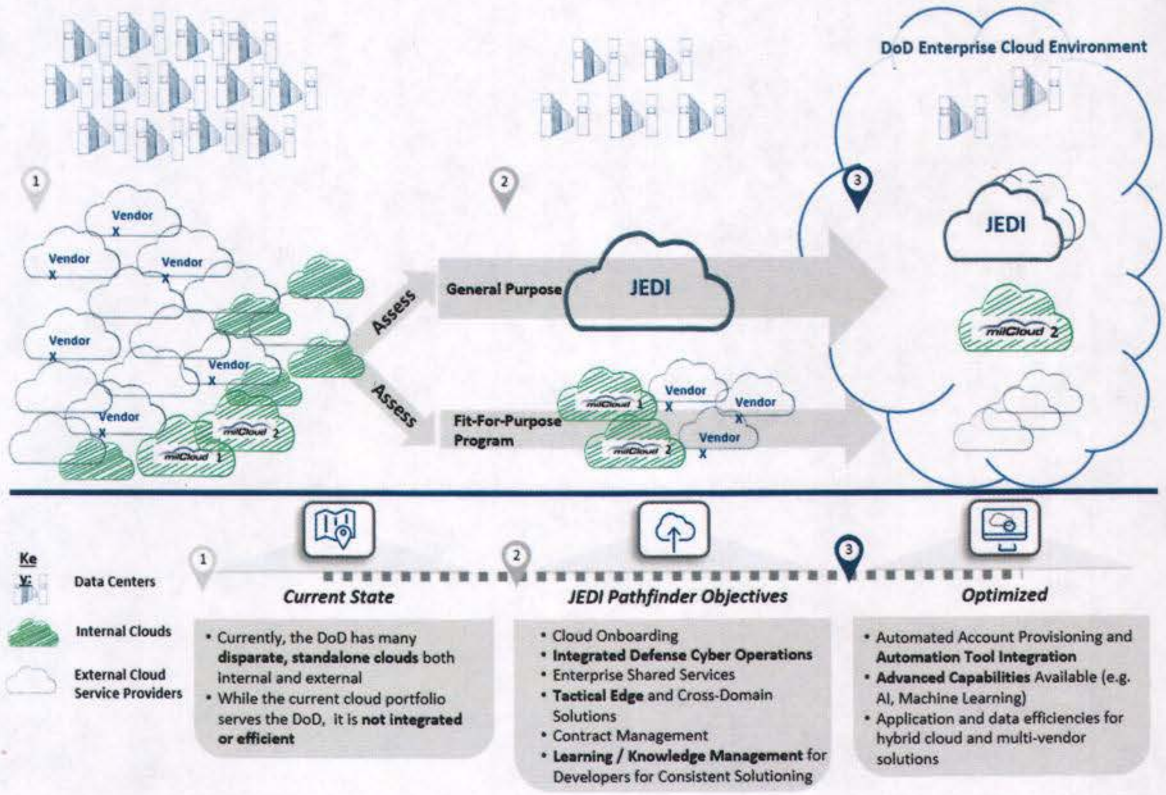
Finally, through this strategy, the Department seeks to create a culture that is better suited for adaptability and modern technology. This includes:

- Creating an environment where people can innovate iteratively
- Embracing enterprise solutions and navigating away from custom federated approaches
- Creating a sustainable culture and workforce that can effectively use what cloud provides
- Creating a culture that enables continuous learning from our cloud partners.

Iterative innovation is essential for successfully adapting modern technologies in an evolutionary fashion. To achieve this, DoD will embrace the use of leading modern technology quickly and more rapid prototyping of new systems. Examples include developing and deploying capabilities for DevSecOps in the cloud environment to securely develop and test software for use in the cloud and using commercial clouds to enable small and medium size companies to more effectively secure Controlled Unclassified Information (CUI). To achieve this innovation and create a culture better suited for adaptability and modern technology, the DoD workforce must change its culture. The Department must develop a cadre of technical professionals, as well as encourage technical proficiency throughout the entire Department. The Department has never built or implemented an enterprise cloud solution and therefore, recognizes the importance of finding a commercial partner to help begin the process of enterprise learning and the development of technical cloud proficiency.

4 Implementation

DoD is driving toward an enterprise cloud environment that is composed of a General Purpose cloud and multiple Fit For Purpose clouds. In addition, it should be recognized that the Department will still need non-cloud data center capability for applications that are not suited for the cloud. Over time, with the adoption of an enduring enterprise cloud strategy, the non-cloud environment should become smaller. There are two fundamental types of work that must be considered in any cloud implementation. The first is a set of fundamental activities that are required to stand up a cloud platform, ready to receive applications, data, or infrastructure for cloud deployment. The second set of activities is the ongoing work to migrate existing applications or to construct new applications onto the cloud platform. Appendix A of this document is a detailed implementation plan that lays out the lines of effort that must be accomplished to fully realize the benefits of cloud computing and to effectively operate on the 21st century battlefield.



- Currently, the DoD has many **disparate, standalone clouds** both internal and external
- While the current cloud portfolio serves the DoD, it is **not integrated or efficient**

- Cloud Onboarding
- **Integrated Defense Cyber Operations**
- Enterprise Shared Services
- **Tactical Edge** and Cross-Domain Solutions
- Contract Management
- **Learning / Knowledge Management** for Developers for Consistent Solutioning

- Automated Account Provisioning and **Automation Tool Integration**
- **Advanced Capabilities** Available (e.g. AI, Machine Learning)
- Application and data efficiencies for hybrid cloud and multi-vendor solutions

Figure 1: DoD Pathfinder to Hybrid Cloud Environments and Multiple Vendors

**JEDI- Joint Enterprise Defense Infrastrucure*

5 Conclusion

Information is a fundamental enabler for advantage on a 21st century battlefield and will enable a more lethal, resilient, and innovative Joint Force. Today, the DoD information environment is made up of multiple disjointed and stove-piped systems distributed across modern and legacy infrastructure around the globe. The data that flows through these systems is growing at an exponential rate. This has caused a litany of problems that impact warfighters', decision makers', and DoD staff's ability to capitalize on critical information to make timely, data-driven decisions. To address these challenges, DoD has implemented a number of cloud solutions; however, they have been built in a disjointed manner. Furthermore, DoD is starting to leverage emerging technologies, such as AI, to help manage the understanding of all the Department's data. However, the critical infrastructure that AI is being built on top of is disparate and disjointed.

To overcome these challenges, DoD will utilize this guiding strategy to further develop a detailed enterprise approach for managing its data, infrastructure, and application landscape. The advent of commercial cloud has provided a powerful opportunity to address these problems. To best take advantage of the opportunity presented by commercial cloud, the Department must implement an enterprise cloud strategy. The appropriate strategy for the DoD will be to leverage a combination of General Purpose and Fit For Purpose clouds along with the advantages of multiple commercial cloud providers. To achieve the objectives outlined above, the Department will pursue a set of interrelated strategic approaches: Warfighter First, Cloud Smart-Data Smart, Leverage Commercial Industry Best Practices, and Create a Culture Better Suited for Modern

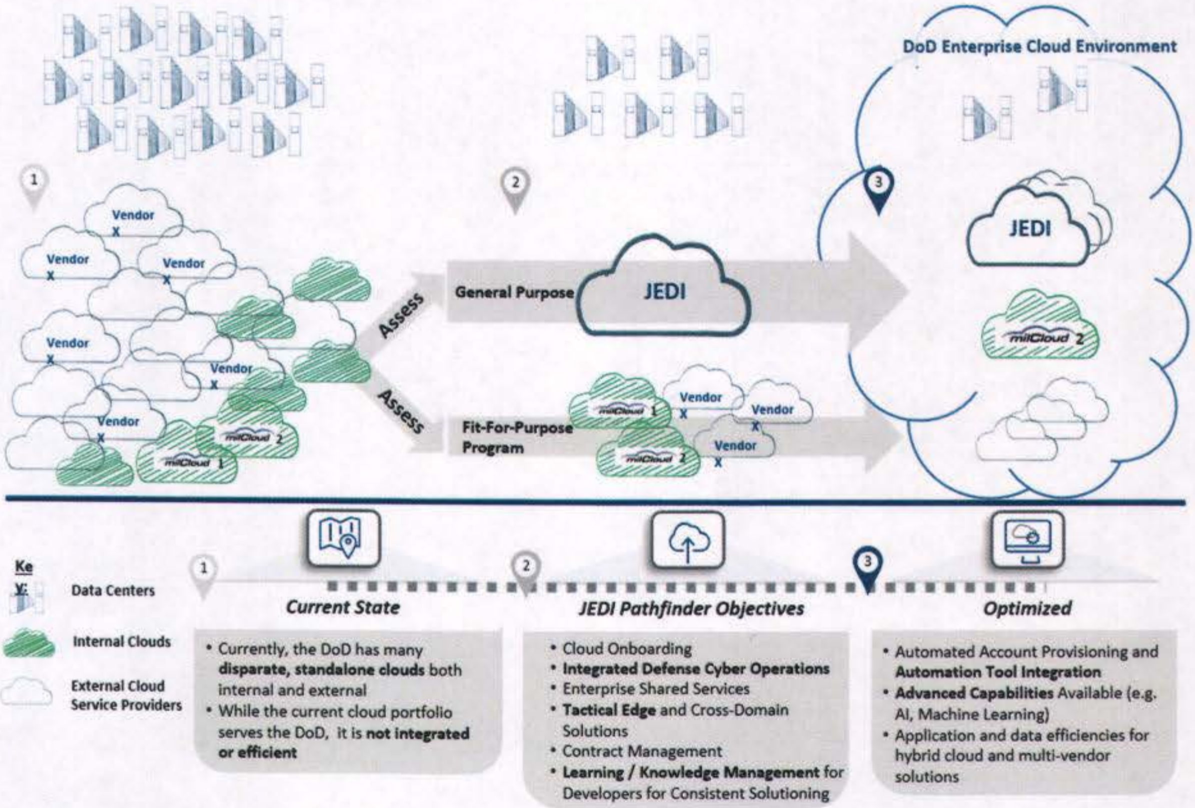
Technology Evolution. DoD needs to develop an organizational construct that insures adoption of the enterprise cloud.

The time is now. DoD can no longer afford to delay its technological and cultural shift to truly modern technologies. Rapidly providing DoD access to underlying foundational technologies, like cloud computing and data storage, on a global scale is critical to national defense and in preparing DoD to fight and win wars. If the Department wants to maintain its overmatch, it will need to leverage technologies such as AI and therefore, it must urgently create an enterprise cloud environment. The strategy outlined in this document provides the approach for moving forward.

Appendix A: Implementation Details

The Department of Defense is driving towards an enterprise cloud environment that is composed of a General Purpose cloud and multiple Fit For Purpose clouds. In addition, it should be recognized that the Department will still need non-cloud data center capability for applications that are not suited for the cloud. Over time, with the adoption of an enduring enterprise cloud strategy, the non-cloud environment should become smaller.

The Department's Enterprise Cloud Environment components and important considerations- migration, governance, and workforce- are described in detail below.



Current State

- Currently, the DoD has many **disparate, standalone clouds** both internal and external
- While the current cloud portfolio serves the DoD, it is **not integrated or efficient**

JEDI Pathfinder Objectives

- Cloud Onboarding
- **Integrated Defense Cyber Operations**
- Enterprise Shared Services
- **Tactical Edge** and Cross-Domain Solutions
- Contract Management
- **Learning / Knowledge Management** for Developers for Consistent Solutioning

Optimized

- Automated Account Provisioning and **Automation Tool Integration**
- **Advanced Capabilities** Available (e.g. AI, Machine Learning)
- Application and data efficiencies for hybrid cloud and multi-vendor solutions

Figure A: DoD Pathfinder to Hybrid Cloud Environments and Multiple Vendors

General Purpose Cloud: Joint Enterprise Defense Infrastructure

The Department will implement a commercial General Purpose enterprise-wide cloud solution, Joint Enterprise Defense Infrastructure (JEDI), for the majority of systems and applications. This General Purpose cloud will allow for the Department to take advantage of economies of scale, broadly provide common core services, and ensure information superiority through data aggregation and analysis.

To implement the Department's General Purpose cloud, an industry partner will be required. The complexity of this endeavor and the Department's lack of large-scale, enterprise, commercial cloud experience means that this partnership is critical to the successful standup of the enterprise General Purpose cloud.

The implementation of General Purpose cloud needs to comprehend four key tenets:

- Offer Infrastructure as a Service (IaaS) and Platform as a Service (PaaS)
- Offer separate environments at all classification levels
- Centralized computing to tactical edge computing for the warfighter
- Enable emerging technologies, such as AI

The JEDI Cloud Program will be the foundational approach to deliver the benefits of a General Purpose enterprise cloud for DoD while embracing the four tenets above. The setup of and migration to the JEDI Cloud requires the steps outlined in the Migration section. A key implementation imperative is that mission owners will be able to rapidly onboard and control their environments, but with common implementation governance supported by a contract.

Fit-for-Purpose

In situations where a General Purpose cloud solution is not capable of supporting mission needs, the Department may use a Fit For Purpose commercial solution or an on-premises cloud solution. Two examples are described here:

1. Software as a Service (SaaS): DoD software applications (e.g., email, chat, collaboration, etc.) over time will migrate to a subscription service where an industry partner will be leveraged for both applications and infrastructure.
2. The Department's milCloud 2.0 environment, a cloud-services product portfolio managed by the Defense Information Systems Agency (DISA), features an integrated suite of capabilities designed to drive agility into the development, deployment, and maintenance of secure DoD applications.

The primary implementation bias for DoD will be to utilize General Purpose cloud computing. Only when mission needs cannot be supported by General Purpose will Fit For Purpose alternatives be explored. In such a case, a mission owner will be required to submit for approval an Exception Brief to the Office of the DoD CIO describing the capability and why the General Purpose cloud service does not support their mission.

As Fit For Purpose solutions are justified, approved, and established, each Fit For Purpose cloud environment will be enacted with enterprise capabilities and scalability in mind. They should still support networking with the General Purpose cloud environment as well as with other Fit For Purpose solutions through modern commercial cloud capabilities for both inter-cloud and cross-domain communication. Secure network peering will allow for data sharing and increased visibility where required.

The Department recognizes that the commercial cloud marketplace will continue to evolve. DoD expects that cloud technology and offerings will continue to become more interoperable and seamlessly integrated, enabling lower transaction costs and better inter-cloud security features across multiple providers. DoD is best served by a robust, competitive, and innovative technology industrial base.

Cloud Migration

There are two fundamental types of work that must be considered in any cloud implementation. The first is a set of fundamental activities that are required to stand up a cloud platform, ready to receive applications, data, or infrastructure for cloud deployment. The second set of activities is the ongoing work to migrate existing applications or to construct new applications onto the cloud platform. The migration activities will need to be overseen by an ongoing governance process that assures security, application development, and data and infrastructure standards.

The fundamental activities required to stand up a cloud environment are composed of five lines of effort:

1. Technical Build – create network connectivity, encryption, data sourcing, and security services (e.g., authentication and ongoing red team engagement) on an enduring basis.
2. Governance – create stakeholder forums, policies, roadmaps, technical standards (architecture and application development), data connectivity standards, resiliency and failover standards, and migration approaches.
3. Automated Provisioning and Billing – automate the ability to quickly provision cloud resources (storage, compute, and application development) and ensure cloud costs are appropriately captured to provide financial transparency.
4. Migration Capability – create repeatable migration process, backed with qualified staff and playbooks for onboarding tenants.
5. Workforce Development – identify, train, and engage resources to create a robust and sustainable cloud workforce.

After the standup of the cloud environment and the conclusion of fundamental activities, the ongoing activities of migrating applications will take over. The magnitude of effort required to stand up a General Purpose cloud at the scale and complexity of the Department is initially best served through a single provider that will allow DoD to maximize pace and minimize risk. The effort required to migrate applications will vary greatly from system to system. Migrating to a cloud environment is not typically as simple as "lift and shift." The migration process will be defined in the DoD's Cloud Migration Playbook and will include the many different paths to realize cloud. The Department will closely monitor the initial efforts to migrate into the Department's General Purpose enterprise cloud. The lessons learned from the various migrations will inform the regular refinement of the playbook, which will provide a consistent and repeatable process for mission owners to apply to their respective systems and applications.

Organizations within DoD that have previously implemented their own cloud will work with the Office of the DoD CIO to determine the best way to integrate their efforts with the Department's enterprise cloud strategy. Where it makes sense that a standalone cloud environment should be migrated to the Department's General Purpose cloud, a thoughtful migration approach will be developed that does not disrupt existing contracts. If it is determined that an existing standalone cloud should be retained, it will be given a formal Fit For Purpose designation and will be expected to adhere to the DoD's enterprise cloud policies.

Governance and Organization

Oversight and governance for the initial build out of this enterprise cloud strategy will be led by the Office of the DoD CIO. At some future date, once the General Purpose cloud environment is fully implemented and Fit For Purpose implementations have matured, it is possible that overall leadership could be transitioned to a different organization inside DoD. The DoD CIO will establish an enterprise cloud organization with appropriate leadership and the required governance forums to ensure that overall objectives and implementation plans as described in this strategy are enacted. The DoD CIO will leverage existing governance forums to the greatest extent possible.

The DoD CIO will organize forums that bring together all lessons learned and find ways to integrate into DoD policies, procedures, and acquisition strategies moving forward. These forums will allow the Department to do regular checks on cloud adoption progress and course correct quickly. The forums will develop detailed implementation plans on rationalization, assessment, planning, and budgeting for accelerating the digital environment to migrate into the enterprise cloud solution.

These forums must be the catalyst to aggressively move the Department to embrace the use of cloud. The DoD CIO in conjunction with the governance forums will provide written guidance on the process and what factors are key to assessing a system for General Purpose or Fit For Purpose hosting. The Department must strive for a Cloud First bias on all future application development/implementations. Organizations should move toward modernization by implementing "cloud native" applications, meaning that the architecture of the system can make use of the scalable, dynamically elastic, distributed nature of cloud computing platforms. Leaving systems running on legacy infrastructure or using other legacy technology must be the exception, not the standard.

Additionally, these forums will work through the Office of the Under Secretary of Defense for Acquisition and Sustainment (A&S) to address current regulations that govern acquisitions to fully take advantage of modern utility/consumption-based services and to enhance contracting capabilities and ATO processes to enable reuse of PaaS/SaaS and cloud-based applications. Working through Cost Assessment and Program Evaluation (CAPE), the forums will provide early insight into annual Planning, Programming, Budgeting, and Execution (PPBE) for cloud activity in the Department. Additionally, these forums will work with the Office of Chief Management Officer (CMO) for application of relevant data standards and governance processes in cloud activities.

As JAIC matures, a key organizational imperative will be to ensure that the requirements of JAIC and enterprise cloud are being jointly integrated.

Workforce Considerations

In today's world, our adversaries are working to develop new capabilities that leverage the advantages of cloud. Therefore, we must ensure, that as we migrate and become more dependent on the cloud, that we are organically growing our cloud technical skills to outpace our adversaries. We can never lose sight that cloud is a key enabler for emerging technologies, such as AI. The future DoD cloud workforce must grow organic technical capabilities by building a more diverse and balanced workforce among military and civilian components. DoD's workforce must obtain a basic level of cloud proficiency in order to most effectively exploit the benefits of cloud. Just as every Marine is a rifleman, every DoD employee must have basic cloud awareness to effectively operate on the 21st century battlefield.