SANDIA REPORT
SAND2012-9716
Unlimited Release
Printed November 2012

Cloud Computing Strategic Framework (FY13 – FY15)

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Abstract

This document presents an architectural framework (plan) and roadmap for the implementation of a robust Cloud Computing capability at Sandia National Laboratories. It is intended to be a living document and serve as the basis for detailed implementation plans, project proposals and strategic investment requests.

ACKNOWLEDGMENTS

Special acknowledgement to the core Subject Matter Experts (SME's) that provided stakeholder input and laid the groundwork for this report.

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FOREWARD

Message from the Chief Information Officer (CIO)

I am pleased to present the SNL Cloud Computing Strategic Framework for Fiscal Years (FY) 2013-2015. This high-level plan provides a vision, goals & objectives, and a roadmap for implementation of a cloud computing capability for Sandia National Laboratories.

Our vision is to establish a "Cloud-of-Clouds" solution to deliver the optimal mix of cloud-based shared service offerings to enable customer success.

In this plan we have established four high-level goals designed to realize the benefits of cloud computing. The goals are:

1. Enable Sustainable, Cost-Effective Cloud Computing
2. Establish and Manage Governance
3. Drive Cloud Technology Innovation
4. Operate as a Service Provider

To achieve these goals, a roadmap was constructed as a series of tasks divided into three phases. The result will be an integrated "Cloud-of-Clouds" environment. The phases are:

1. Core Design and Initial Implementation
2. Cloud Service Delivery and Operation
3. Cloud Optimization and Integration

This plan supports and enables compliance with Federal, DOE and NNSA strategic and implementation plans. Sandia will work collaboratively with stakeholders and mission customers to determine actions required for mission success and to take positive steps to achieve IT innovation and leadership in the Cloud Computing frontier. In addition, Sandia is committed to working in partnership with DOE, NNSA, other related agencies and standards organizations to execute the roadmap and best leverage the services provided.

Mike Vahle
Chief Information Officer

NOMENCLATURE

2NV	NNSA Network Vision
API	Application Programming Interface
C2NV	Classified NNSA Network Vision
CEE	Common Engineering Environment
CIO	Chief Information Officer
CPU	Central Processing Unit
CSU	Computer Support Unit
DOE	Department of Energy
DR	Disaster Recovery
IaaS	Infrastructure as a Service
IT	Information Technology
ITIL	Information Technology Infrastructure Library
NNSA	National Nuclear Security Administration
NWC	Nuclear Weapons Complex
OMB	Office of Management and Budget
PaaS	Platform as a Service
PDP	Policy Decision Point
PEP	Policy Enforcement Point
R&D	Research and Development
SaaS	Software as a Service
SCM	Software Configuration Management
SNL	Sandia National Laboratories
UUR	Unclassified Unlimited Release
VM	Virtual Machine
WFO	Work for Others
XaaS	Anything as a Service

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EXECUTIVE SUMMARY

Cloud computing provides new methods for acquiring and delivering computing resources (infrastructure, platform and software). The adoption of cloud computing presents an opportunity to Sandia National Laboratories (SNL) leadership to address critical Information Technology (IT) issues including increased cost efficiency, provisioning speed, flexibility and scalability. Cloud computing offers the potential to bring multiple benefits to SNL (Sandia) due to economies of scale, commoditization of IT infrastructure, and a pay-per-use model. In addition, there are potential cloud computing benefits that can support and accelerate IT initiatives including data center consolidation, information sharing, collaboration, innovation, and sustainability.

To accelerate the adoption of cloud computing across the government, the Office of Management and Budget (OMB) made cloud computing an integral part of the 25 Point Plan to Reform Federal Information Technology Management. As part of the plan, OMB instituted a "Cloud First" policy requiring agencies to consider and evaluate a safe and secure cloud computing option before making new investments. While the adoption of the cloud computing paradigm offers multiple potential benefits, it also presents challenges and risks that must be considered when evaluating its use. This paradigm shift in technology changes the way applications, data and processes are deployed and managed. As with any technology paradigm shift, issues such as how the new technologies are used, secured, managed, and governed must be considered when weighing the benefits of adopting the new paradigm.

The purpose of this document is to define a strategy to capture cloud computing benefits, and to establish the strategic framework to maintain a secure, reliable and cost effective IT environment in support of Sandia missions.

WHAT IS CLOUD COMPUTING?

Cloud computing, as defined by National Institute of Standards and Technology (NIST), is "a model for enabling ubiquitous, 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 management effort or service provider interaction".[1] This model allows end user access to cloud-based application through a web browser or a light-weight desktop or mobile application while the business software and user's data are stored on servers at a remote location.

The NIST cloud model identifies essential characteristics, service models, and deployment models as key components towards establishing robust cloud architectures. For example, the essential characteristics which define a cloud implementation are:

1. On-demand self-service
2. Broad network access
3. Resource pooling
4. Rapid elasticity
5. Measured service

Once the cloud infrastructure (hardware and software) is established, there are several service models that define the services being deployed. The most common service models (those identified by NIST) are:

1. Software as a Service (SaaS)
2. Platform as a Service (PaaS)
3. Infrastructure as a Service (IaaS)

Many other service models have been identified and are used commonly. These include:

4. Storage as a Service (STaaS)
5. Security as a Service (SECaaS)
6. Desktop as a Service (DaaS)
7. Data/Database as a Service (DBaaS)
8. Anything as a Service (XaaS)

Cloud infrastructure can be deployed, according to NIST, using the following four deployment models:

1. Private cloud
2. Community cloud
3. Public cloud
4. Hybrid cloud

Sandia's cloud roadmap addresses these architectural components and lays the groundwork from which a robust cloud computing environment can be established.

1. INTRODUCTION

Sandia is a multi-program national security laboratory that plays a vital role in ensuring that our country maintains science and engineering superiority. To continue to meet this role, the office of the Chief Information Officer (CIO), is embarking on an aggressive cloud computing implementation which is guided by this strategic framework and roadmap. This strategic framework focuses on supporting mission goals and priorities with effective and responsive information technology solutions. The plan is grounded in practical infrastructure and service delivery projects that will establish the foundation for sustainable, cost effective cloud computing capabilities at Sandia and across the complex. The planning horizon for this framework is three years with elements of it being updated regularly. This timeframe reflects the need for Sandia to keep current with the ever-changing cloud computing landscape.

This plan supports and enables compliance with the Federal CIO 25-Point Implementation Plan[2], Federal Cloud Computing Strategy[3], Shared Services Plan ("Shared-First")[4] and National Nuclear Security Administration's (NNSA) 2012-2016 Information Management Implementation Plan[5], specifically it addresses *"Strategic Goal 1-3: Leverage the Power of the Cloud to Enable a Low-Cost, Shared Services Model".* This high-level plan provides a vision, a business case, goals & objectives, and an initial roadmap for implementation of a cloud computing capability for Sandia. Follow-on documentation will detail the design and implementation plans and result in project proposals and investment requests.

2. VISION

Sandia's vision is to establish a "Cloud-of-Clouds" solution to deliver the optimal mix of cloud-based shared service offerings to enable customer success. This vision, whose aim is to modernize and "right-size" IT for Sandia, will be guided by the following strategic principles:

- Rapid, automated self-service provisioning
- Elastic, usage-based delivery of pooled computing resources
- Usage of commodity resources, open standards and automated processes
- Seamless integration of services, regardless of provider or location
- Reduced footprint and environmental impact
- Secure, ubiquitous web-based access to services
- Maintain security and privacy of data throughout its lifecycle

Sandia is committed to working in partnership with Department of Energy (DOE), NNSA and other related agencies and contractors to better leverage the services identified herein and to execute the identified goals. In addition, Sandia will work collaboratively with all stakeholders to determine actions required for mission success and to take positive steps to achieve IT innovation and leadership in the cloud computing frontier.

3. WHY CLOUD?

Sandia IT provides support for traditional core IT capabilities covering a wide range of mission needs (from computing clients to basic infrastructure to high performance computing). However, the high cost of providing these capabilities and the lack of agility in providing them is hampering the IT organizations ability to assist in accomplishing the mission efficiently and effectively, leading to a do-it-yourself mentality across the organization, even within IT. A transformation to cloud can help "right-size" costs and provide higher-value services agile enough to meet the needs. One analogy for cloud is rental vehicles. Some customers have occasional needs such as a large truck or moving van for occasional hauling. Others may have seasonal or event-driven needs, such as bussing a football team and cheerleaders to a game. Renting a vehicle may be a better option based on total cost of ownership over time for a needed feature set and the risk and overhead associated with owning a vehicle (insurance, parking/storage, maintenance, fuel, etc.).

Being able to scale the necessary resources to the size of the job is important in order to pay for only what you need, when you need it. Otherwise, you end up paying for extra capacity that remains unused, which lowers the value of the provided service. Flexible cloud models that can support pay-per-use or subscriptions or reserved capacity (for known, stable sets of workloads) can pass economies-of-scale savings on to the customer, as cloud providers can often provide service much cheaper than the do-it-yourself option, can deliver features that aren't available otherwise, and also allows a customer to opt into or out of a service without requiring large investments or incurring large fees.

In addition, industry statistics point to a massive movement to cloud computing. Public IT cloud services set to exceed $40 billion in 2012, reach nearly $100 billion by 2016, and are growing at four to five times the rate of the overall IT market, according to research firm IDC[6]. This means a significant chunk of IT spending is moving to a cloud model, supporting a rich and diverse set of cloud services and tools for customers to choose from. This implies that cloud computing is no flash-in-the-pan and is delivering real value to companies adopting it, but also implies that many vendors may switch to a cloud model entirely, no longer supporting "legacy" applications and infrastructure. A Forbes article, discussing research performed by Gartner, notes that: "Enterprises are beginning to change their buying behaviors based on the deployment speed, economics and customization that cloud-based technologies provide. The best results are being attained by enterprises that focus on a very specific strategy and look to cloud-based technologies to accelerate their performance…Leading with a strategic framework of goals and objectives increases the probability of cloud-based platform success. Those enterprises that look to cloud platforms only for cost reduction miss out on their full potential."[7]

The figure below shows the transformation from a physical environment towards an automated cloud environment, highlighting the changes that occur and the benefits realized. Sandia's current infrastructure state is a maturing virtual environment. A planned and coordinated effort with significant investment and backing is required to achieve an optimized cloud environment.

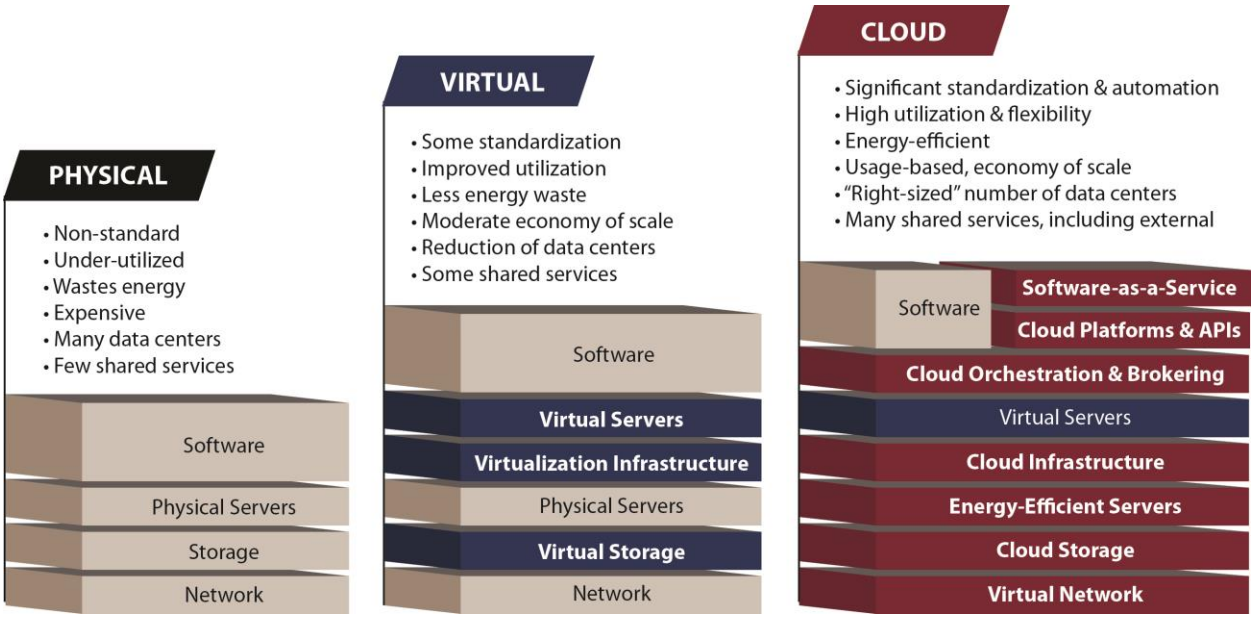

Figure 1: Transformation from Physical to Cloud Environment

Drivers for this change include increasing complexity, rapid changes in the IT industry and in mission programs, heightened security, rising costs, internal and external collaboration needs, recent federal legislation and direction, and the need for technology innovation to bring Sandia IT to the forefront of advanced computing capability. Cloud computing solutions address these needs by taking a services-first, automated, virtualized resources approach, allowing IT to better scale and configure the infrastructure while giving customers greater flexibility, lower costs, and increased access to computing resources. By applying the strategic principles to this transformation, additional benefits are realized:

- Rapid, automated self-service provisioning of resources decreases time to solution deployment while increasing speed and reliability through standardized build processes.
- Elastic, usage-based delivery of pooled computing resources improves asset utilization, builds in economies of scale, and increases responsiveness to meet changing customer needs. Costs are shifted from a fixed model to one based on actual usage.
- Usage of commodity resources, open standards and automated processes reduce investment and support costs, increases availability of replacement or upgraded components (from memory and CPUs up to entire server racks), and better guards against vendor lock-in. Integration of new capabilities into the environment is easier and provides an upgrade path. Automation reduces errors while increasing speed and value.
- Seamless integration of services, regardless of provider or location allows integration of disparate services deployed internally and externally. Increases the number of service options and extends support for service level options such as disaster recovery and high-availability.

- Reduced footprint and environmental impact enables data center consolidation and improvements in energy efficiency, reducing labor and resource costs through improved asset utilization and deployment of new technologies.
- Secure, ubiquitous web-based access to services allows end-users to access services remotely with a wide variety of devices while controlling and monitoring access via standard security mechanisms.
- Maintaining security and privacy of data throughout its lifecycle ensures that data stored in the cloud is protected according to all applicable requirements. This reduces risk when the cloud computing solution is configured, deployed, and managed accordingly.

4. SNL CLOUD OF CLOUDS

Sandia's cloud computing architecture must address computing in both unclassified and classified environments where appropriate Need-to-Know security measures and controls are employed within a framework of information sharing and collaboration. Also required is delivering computing resources appropriate for the expected workloads (e.g., transaction processing, data analytics, scientific computing, big data, etc.).

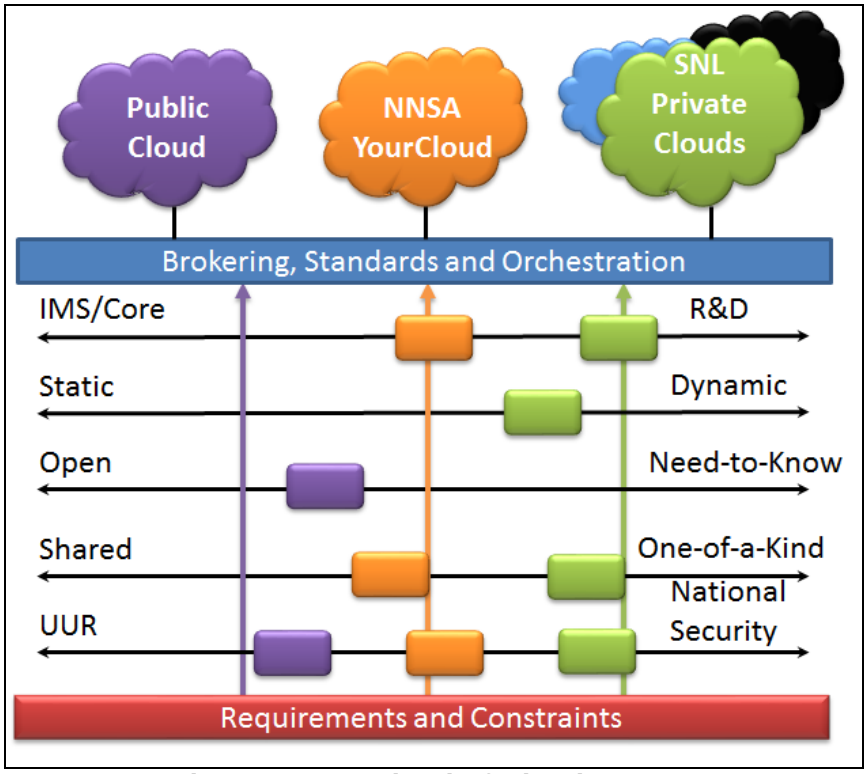

Figure 2: SNL Cloud-of-Clouds

Because of this variety of needs, what becomes clear is that one size cloud does not fit all, requiring Sandia to use multiple clouds to perform its mission effectively. This concept is known as the *"Cloud of Clouds"* architecture. The Figure above describes a scale on which cloud computing needs for different areas can be plotted. The results will map the needs to the appropriate cloud solutions or help define new cloud solutions.

As multiple clouds evolve, cloud brokering, orchestration and standards will provide end users with best-of-breed cloud computing capabilities. For example, a cloud broker would help determine which cloud within the Cloud of Clouds would best suit the need. The following notional criterion describes the cloud selection process.

Notional Cloud Selection Criterion

- Public cloud: UUR data; low-risk or publicly accessible content; technology testing (non-production, no "real" data)

- Private internal clouds: sensitive data; classified data; performance sensitive processing; in-place processing (data created/collected locally); Sandia-local applications (Sandia Corp, division through departmental apps, non-NW WFO)
- Private external cloud (e.g. 2NV YourCloud): sensitive data; shared commodity processing/apps; collaboration across NWC
- Private external classified cloud (e.g. C2NV): highly sensitive data; shared processing
- Hybrid: case-by-case basis (need-based) where workloads have overlap or must meet specific architectural needs

Policy and process guidance will direct end users to the appropriate cloud solution(s) while hiding the complexity of the technologies deployed at various locations. This concept is illustrated in Figure 3.

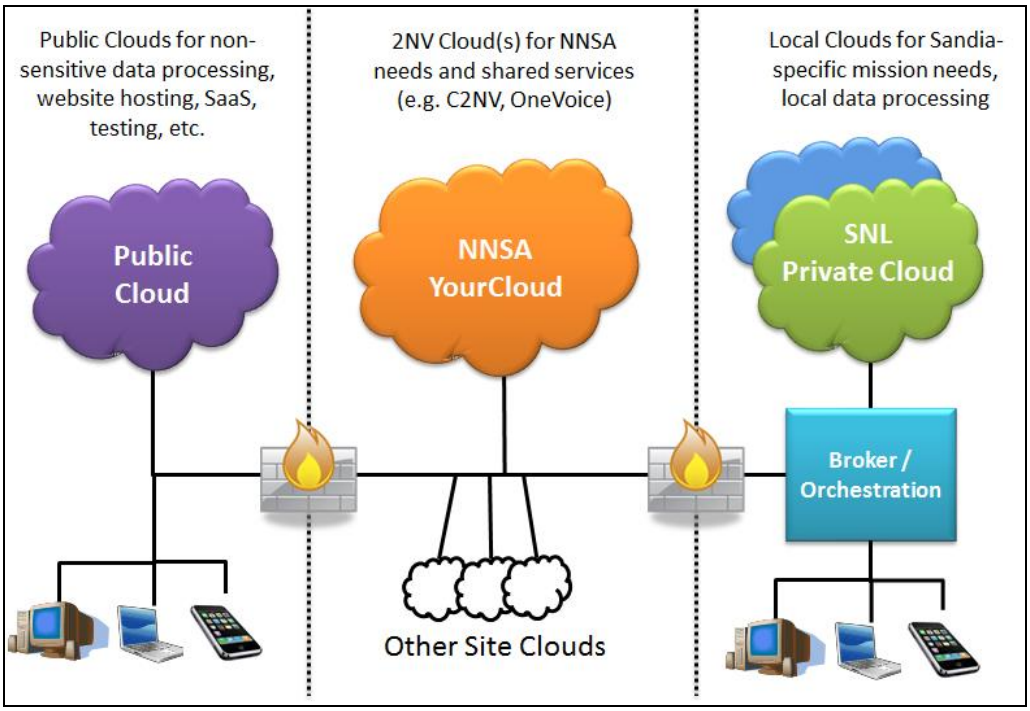

Figure 3: Cloud Complexities Hidden from End Users

Because cloud computing brings with it new privacy and security challenges, it is essential to govern and manage how cloud providers secure and maintain Sandia's computing environments. While deployment of cloud computing services simplifies resource acquisition, it does not alleviate the need for governance; instead, it has the opposite effect, amplifying that need. Cloud service providers must go through an approval process prior to providing services. Processes will be established by which internal entities acquire or deploy cloud based solutions to ensure that Sandia's policies and procedures for privacy, security, and oversight are not overlooked, placing Sandia data at risk.

5. GOALS AND OUTCOMES

The benefits of cloud computing will be realized by the establishment of goals and outcomes that maximize efficiencies and reduce the cost of providing computing services to IT customers, while reducing our footprint. IT services are currently being maintained by various organizations throughout the Laboratory requiring duplications of data storage, administration, infrastructure, and software. Consolidating common services and virtualizing where possible will reduce maintenance efforts and enable sustainable, cost effective cloud computing.

Responsive, manageable governance policies will enable our enterprise cloud architecture to reduce internal IT stove pipes and enterprise risk. The result will enable enterprise IT to have greater flexibility without compromising accountability.

Leveraging cheaper processors, faster networks, mobile devices and cloud aware applications will enable Sandia to become an innovator in cloud technology and position it as a service provider of choice to the greater NWC community.

The table below presents a condensed view of the strategic goals and outcomes. Key performance indicators will follow that enable management to monitor success and effectiveness.

SNL Cloud Computing Goals and Outcomes
Goal 1: Enable Sustainable, Cost-Effective Cloud Computing ***Outcome:*** The future infrastructure will be more agile and deliver greater value. Dynamic scalability and self-healing will support performance, business continuity, and disaster recovery. This will reduce risk, lower costs, and increase operational effectiveness while reducing the IT footprint by supporting data center consolidation.
Goal 2: Establish and Manage Governance ***Outcome:*** The future infrastructure will ensure efficient and effective governance by integrating policies and procedures into the service lifecycle. The result will be a standardized, integrated and secure infrastructure enabling greater flexibility without compromising accountability.
Goal 3: Drive Cloud Technology Innovation ***Outcome:*** The future infrastructure will place Sandia at the forefront of cloud technology by leveraging advances in networking, virtualization, storage, server and processing platforms, applications, and mobile computing to enable the delivery of required capacity and services when and where needed.
Goal 4: Operate as a Service Provider ***Outcome:*** The future infrastructure will enable a fundamental shift in how we serve enterprise IT and mission customers, also positioning Sandia as a complex-wide provider of choice. Our features and service offerings will be delivered in an agile, reliable and secure manner to meet customer requirements.

Table 1: Cloud Computing Goals and Outcomes

6. ROADMAP

The cloud roadmap is broken into three phases. The first phase, *Core Design and Initial Implementation*, establishes the core hardware/software infrastructure design, cost model, provisioning model and governance infrastructure and begins to deliver Infrastructure-as-a-Service capabilities.

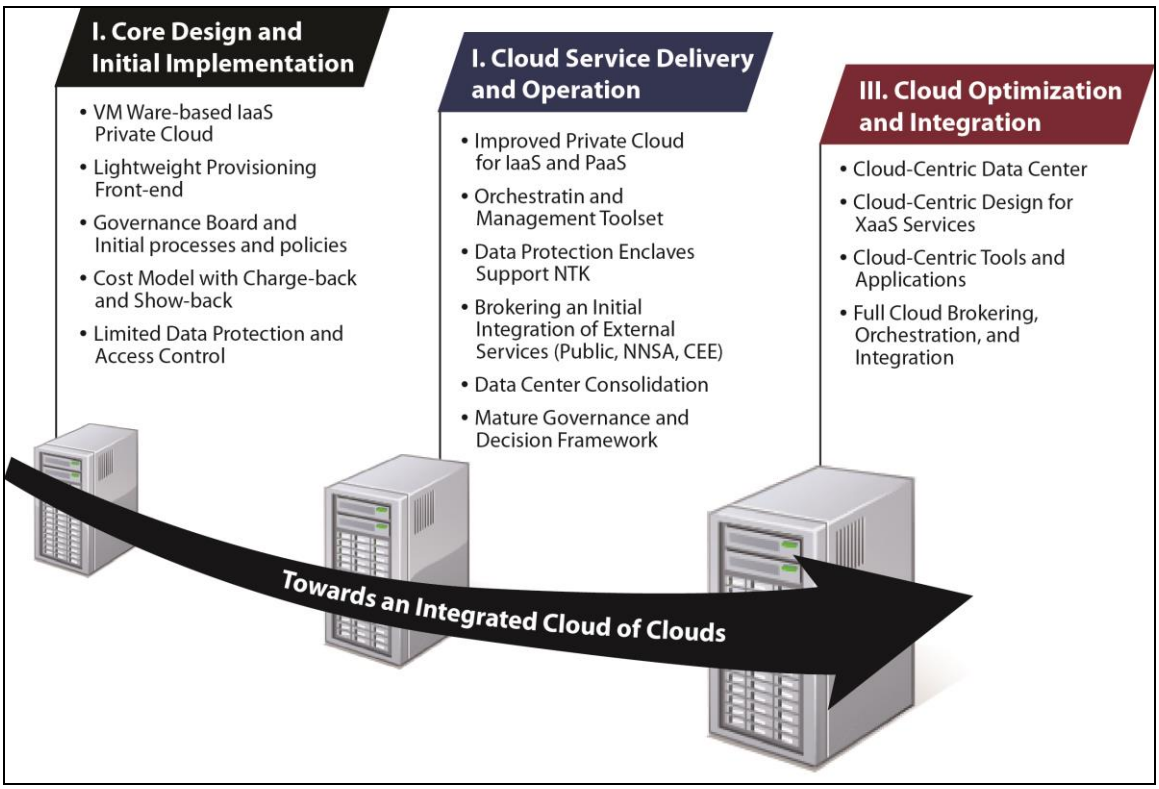

Figure 4: Roadmap – Toward an Integrated Environment

The second phase, *Cloud Service Delivery and Operation*, establishes the cloud-of-clouds processes required for multi-cloud brokering, orchestration, data protection/security, and enables significant consolidation of data center resources. In addition, it allows for the entire service portfolio to be offered up on cloud resources (e.g., Anything-as-a-Service (XaaS) capability).

The last phase, *Cloud Optimization and Integration*, establishes a cloud-centric way of thinking, where we utilize cloud-centric tools to design cloud-aware applications, running on cloud infrastructure within a cloud-optimized data center.

Cloud implementation will be coordinated by the CIO and will utilize IT resources from throughout the Laboratories. These resources will develop documentation (design and implementation plans, project proposals and investment requests) based on the work package information below.

7. WORK PACKAGE INFORMATION

#	Task	I.	II.	III.
1	**Service Design and Service Ordering**			
1.1	Identify customer needs			
1.2	Develop and manage requirements			
1.3	Develop and apply ITIL service design process			
1.4	Execute ITIL service level management process			
1.5	Create front-end for provisioning services with service level options			
1.6	Iterate for additional service offerings			
2	**Financial Model**			
2.1	Determine “computing units” and cost per unit			
2.2	Establish infrastructure metering capability based on “computing units”			
2.3	Determine cost allocation for shared resources			
2.4	Chargeback, show-back, billing			
2.5	Develop method for customer to do cost estimation/projection			
3	**Implementation (Infrastructure and Middleware Layer)**			
3.1	Design documentation and configuration documentation			
3.2	Acquire hardware components			
3.3	Acquire software components			
3.4	Acquire network components			
3.5	Build and deploy cloud (IaaS)			
3.6	Create standardized, automated build process and templates (e.g., COE-like for services)			
3.7	Build and deploy cloud (PaaS)			
3.8	Build and deploy cloud (SaaS)			
3.9	Iterate for additional clouds and cloud services			
4	**Governance Model**			
4.1	Establish governance board			
4.2	Develop governance processes and policies for acquiring and deploying secure cloud services			
4.3	Develop criteria and guidance for cloud selection			
4.4	Establish cloud standards			
4.5	Create decision framework for cloud investment and sustainment			
4.6	Measure value and perform risk assessment			

5	**Operational Model**			
5.1	Perform cloud management and monitoring			
5.2	Maintain and refresh hardware			
5.3	Software maintenance and licensing			
5.4	ITIL service desk			
6	**Security Model**			
6.1	Integrated data protection (multi-tenant)			
6.2	Access management (administrative, user, system)			
6.3	PEP/PDP integration (Policy Enforcement Point/Policy Decision Point)			
7	**Cloud of Clouds Brokering and Integration**			
7.1	Single service provisioning interface (brokering)			
7.2	Create an architecture map of the "Cloud of Clouds"			
7.3	Orchestration tool			
7.4	Cross-cloud management and monitoring			
8	**On-board Service Providers (IT Solution Development Teams)**			
8.1	CSU Special Projects (affects IaaS)			
8.2	Cloud training			
8.3	Software development (potentially affects all service models)			
9	**Data Center Consolidation**			
9.1	Identify environments to consolidate			
9.2	Begin migrating hardware to cloud infrastructure			
9.3	Design and implement cloud data center for energy efficiency			
10	**Platform Consolidation (e.g., Java, .NET, RoR)**			
10.1	Migrate selected software platforms to the cloud			
10.2	Integrate with application lifecycle management tools (e.g., build & deploy, SCM, etc.)			
10.3	Integrate with system health monitoring, DR			
10.4	Develop usage guide and training for critical cloud platform skills			

11	Advanced Projects			
11.1	Big data cloud (e.g. Hadoop)			
11.2	Desktop-as-a-Service (role-based, packaged bundles, etc.)			
11.3	Cloud storage for archiving and DR			
11.4	Cloud storage for persons & projects (e.g. Dropbox, Skydrive, Box.net, etc.)			
11.5	Cloud software development and testing lab (see platform consolidation)			
11.6	Software-as-a-Service deployments (business & mission applications, collaboration tools, etc.)			
11.7	High-security cloud(s)			
11.8	Cloud-based long-term digital archive environments			
11.9	Develop API-accessible XaaS resources			

Table 2: Work Package Information

8. REFERENCES

1. Peter Mell and Timothy Green, National Institute of Standards and Technology (NIST), *Special Publication 800-145: The NIST Definition of Cloud Computing"*, Retrieved October 16, 2012, from http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf

2. Vivek Kundra, *25 Point Implementation Plan to Reform Federal Information Technology Management*, U.S. Chief Information Officer, December 2010.

3. Vivek Kundra, *Federal Cloud Computing Strategy*, U.S. Chief Information Officer, February 2011.

4. Steven VanRoekel, *Federal Information Technology Shared Services Strategy*, OMB, May 2012.

5. Thomas D'Agostino and Robert Osborn, *NNSA Information Management Implementation Plan 2012-2016*, Office of the Associate Administrator for Information Management and Chief Information Officer, 2012.

6. Frank Gens et al., International Data Corporation (IDC), *Worldwide and Regional Public IT Cloud Services 2012-2016 Forecast*, Retrieved October 16, 2012, from http://www.idc.com/getdoc.jsp?containerId=236552

7. Louis Columbus, Forbes, *Hype Cycle for Cloud Computing Shows Enterprises Finding Value in Big Data, Virtualization*, Retrieved October 16, 2012, from http://www.forbes.com/sites/louiscolumbus/2012/08/04/hype-cycle-for-cloud-computing-shows-enterprises-finding-value-in-big-data-virtualization/

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