State of Public Sector Cloud Computing

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EXECUTIVE SUMMARY

The Obama Administration is changing the way business is done in Washington and bringing a new sense of responsibility to how we manage taxpayer dollars. We are working to bring the spirit of American innovation and the power of technology to improve performance and lower the cost of government operations.

The United States Government is the world's largest consumer of information technology, spending over $76 billion annually on more than 10,000 different systems. Fragmentation of systems, poor project execution, and the drag of legacy technology in the Federal Government have presented barriers to achieving the productivity and performance gains found when technology is deployed effectively in the private sectors.

In September 2009, we announced the Federal Government's Cloud Computing Initiative. Cloud computing has the potential to greatly reduce waste, increase data center efficiency and utilization rates, and lower operating costs. This report presents an overview of cloud computing across the public sector. It provides the Federal Government's definition of cloud computing, and includes details on deployment models, service models, and common characteristics of cloud computing.

As we move to the cloud, we must be vigilant in our efforts to ensure that the standards are in place for a cloud computing environment that provides for security of government information, protects the privacy of our citizens, and safeguards our national security interests. This report provides details regarding the National Institute of Standards and Technology's efforts to facilitate and lead the development of standards for security, interoperability, and portability.

Furthermore, this report details Federal budget guidance issued to agencies to foster the adoption of cloud computing technologies, where relevant, and provides an overview of the Federal Government's approach to data center consolidation.

This report concludes with 30 illustrative case studies at the Federal, state and local government levels. These case studies reflect the growing movement across the public sector to leverage cloud computing technologies.

FEDERAL GOVERNMENT APPROACH

Cloud computing is still in its early stages and we have a long journey ahead. This report provides information on our approach to leverage cloud computing to help close the Government's technology gap. Specifically, this report presents:

- Definition of Cloud Computing
- Data Center Consolidation
- Standards Development
- Federal Budget Planning

Definition of Cloud Computing

As defined by the National Institute of Standards and Technology (NIST)[1], 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 management effort or service provider interaction. This cloud model promotes availability and is composed of essential characteristics, deployment models, and various service models.

Characteristics of the Cloud

- *On-demand self-service.* 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.
- *Broad network access.* Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs).
- *Resource pooling.* The 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, network bandwidth, and virtual machines.
- *Rapid elasticity.* Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale up and rapidly released to quickly scale down. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.
- *Measured Service.* 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.

Benefits of Cloud Computing

There was a time when every household, town, farm or village had its own water well. Today, shared public utilities give us access to clean water by simply turning on the tap; cloud computing works in a similar fashion. Just like the water from the tap in your kitchen, cloud computing

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[1] National Institute of Standards and Technology, "The NIST Definition of Cloud Computing," document posted October 2009, http://csrc.nist.gov/groups/SNS/cloud-computing/.

services can be turned on or off quickly as needed. Like at the water company, there is a team of dedicated professionals making sure the service provided is safe and available on a 24/7 basis. Best of all, when the tap isn't on, not only are you saving water, but you aren't paying for resources you don't currently need.

- *Economical.* Cloud computing is a pay-as-you-go approach to IT, in which a low initial investment is required to get going. Additional investment is incurred as system use increases and costs can decrease if usage decreases. In this way, cash flows better match total system cost.
- *Flexible.* IT departments that anticipate fluctuations in user load do not have to scramble to secure additional hardware and software. With cloud computing, they can add and subtract capacity as its network load dictates, and pay only for what they use.
- *Rapid Implementation.* Without the need to go through the procurement and certification processes, and with a near-limitless selection of services, tools, and features, cloud computing helps projects get off the ground in record time.
- *Consistent Service.* Network outages can send an IT department scrambling for answers. Cloud computing can offer a higher level of service and reliability, and an immediate response to emergency situations.
- *Increased Effectiveness.* Cloud computing frees the user from the finer details of IT system configuration and maintenance, enabling them to spend more time on mission-critical tasks and less time on IT operations and maintenance.
- *Energy Efficient*. Because resources are pooled, each user community does not need to have its own dedicated IT infrastructure. Several groups can share computing resources, leading to higher utilization rates, fewer servers, and less energy consumption.

Deployment Models
- *Private cloud.* The cloud infrastructure is operated solely for one organization. It may be managed by the organization or a third party and may exist on premises or off premises.
- *Community cloud.* The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premises or off premises.
- *Public cloud.* The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.
- *Hybrid cloud*. The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain 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).
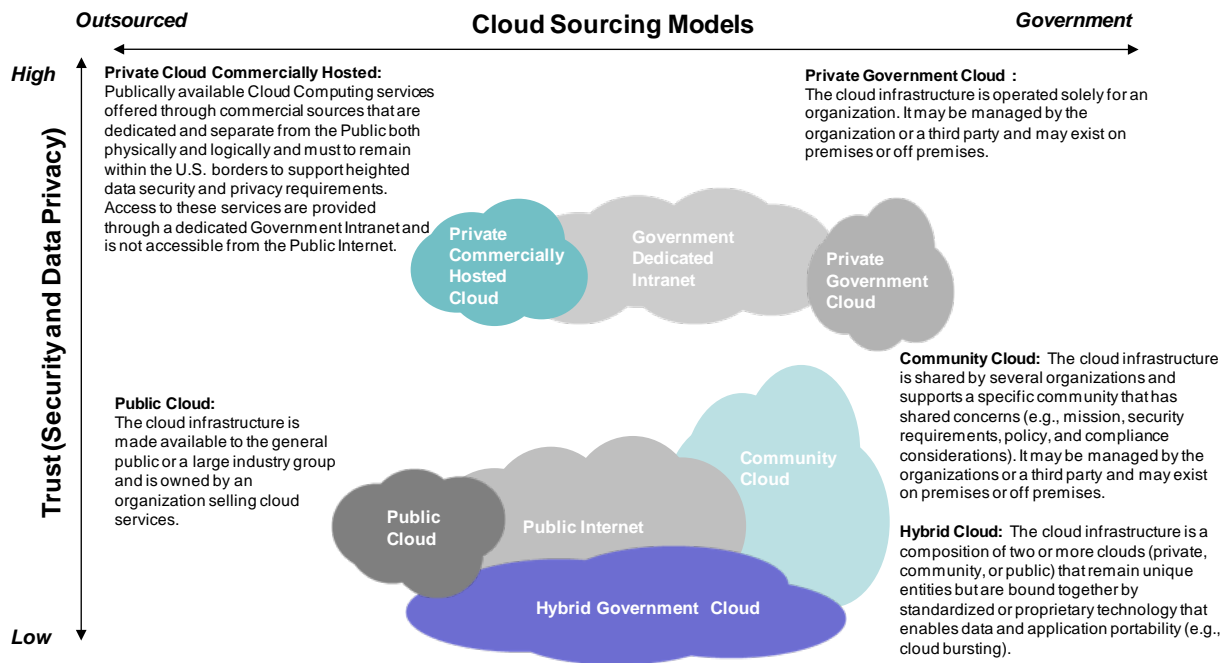
Outsourced

Government

High

Low

Trust (Security and Data Privacy)

Private Cloud Commercially Hosted:
Publically available Cloud Computing services offered through commercial sources that are dedicated and separate from the Public both physically and logically and must to remain within the U.S. borders to support heighted data security and privacy requirements. Access to these services are provided through a dedicated Government Intranet and is not accessible from the Public Internet.

Private Government Cloud :
The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premises or off premises.

Private Commercially Hosted Cloud

Government Dedicated Intranet

Private Government Cloud

Public Cloud:
The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

Community Cloud: The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premises or off premises.

Hybrid Cloud: The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting).

Public Cloud

Public Internet

Community Cloud

Hybrid Government Cloud

Figure 1: Cloud Sourcing Models[2]

Service Models

- *Cloud Software as a Service (SaaS).* Provides the consumer the ability 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 e-mail). 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.
- *Cloud Platform as a Service (PaaS).* Provides the consumer the ability to deploy 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.
- *Cloud Infrastructure as a Service (IaaS).* Provides the consumer the ability to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to 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).

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[2] General Services Administration, "Cloud Sourcing Models" (government document, 2010).

Data Center Consolidation

The transition to cloud computing is also supported by Federal data center consolidation efforts. The consolidation of Federal data centers will reduce energy consumption, space usage, and environmental impacts, while increasing the utilization and efficiency of IT assets. Data center consolidation will also play an important role in meeting the goals of the Energy Security and Independence Act of 2007[3] and various executive orders directing increased energy efficiencies. The effort will promote shared Government-wide, cost effective, green, and sustainable Federal data centers in support of agency missions.

In February 2010, the Federal CIO issued data center consolidation guidance[4] to agencies regarding creation of agency data center consolidation plans. The guidance directed agencies to consider agency data center performance and utilization metrics, energy efficiency use data, physical facility, operational cost and asset information, best practices, open standards, and security. Agencies will develop their data center consolidation plans and incorporate them into their Fiscal Year 2012 budgets by August 30, 2010.

Standards Development

As we move to the cloud, we must be vigilant in our efforts to ensure the standards are in place for a cloud computing environment. As part of the Federal Cloud Computing Initiative, the National Institute of Standards and Technology (NIST)[5] is leading and facilitating the development of cloud computing standards which respond to high priority security, interoperability, and portability requirements.

Current cloud computing standards development activities, conducted by the NIST Information Technology Laboratory (ITL), include:

- **Special Publications:** In 2009, NIST made the widely adopted and referenced NIST Definition of Cloud Computing publicly available. NIST is in the process of developing a series of Special Publications (SP) related to cloud computing. These Special Publications are informed by the activities which are described below.
- **Standards Acceleration to Jumpstart Adoption of Cloud Computing (SAJACC):** The SAJAAC goal is to facilitate the development of cloud computing standards. SAJACC will include a publicly accessible NIST hosted portal which facilitates the exchange of verifiable information regarding the extent to which pre-standard candidate interface specifications satisfy key cloud computing requirements. The expectation is that SAJACC will help to accelerate the development of cloud computing standards and, as a bi-product of its information dissemination function, increase the level of confidence to enable cloud computing adoption.
- **Federal Risk and Authorization Management Program (FedRAMP):** NIST's role is to support the definition of a consistent technical process that will be used by FedRAMP to assess the security posture of specific cloud service implementations. NIST serves as a

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[3] U.S. Congress. *Energy Independence and Security Act of 2007.* H.R. 6. 110th Cong., 1st sess. (January 2007). http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h6enr.txt.pdf.
[4] Office of Management and Budget. "Federal Data Center Consolidation Initiative," CIO Council, government document posted February 2010, http://www.cio.gov/documents_details.cfm/uid/25A781B7-BDBE-6B59-F86D3F2751E5CB43/structure/OMB%20Documents%20and%20Guidance/category/Policy%20Letters%20and%20Memos.
[5] National Institute of Standards and Technology, "Summary of NIST Cloud Computing Standards Development Efforts" (government document, 2010).

technical advisor for the FedRAMP process that will be implemented by the Federal CIO Council.

Description of NIST Cloud Computing Standards Development Activities

NIST serves as the government lead, working with other government agencies, industry, academia, Standards Development Organizations (SDO), and others to leverage appropriate existing standards and to develop cloud computing standards where gaps exist. While cloud computing services are currently being used, security, interoperability, and portability are cited as major barriers to further adoption. The expectation is that standards will shorten the adoption cycle, enabling cost savings and an increased ability to quickly create and deploy enterprise applications. The focus is on standards which support interoperability, portability, and security to enable important usage scenarios.

NIST scientific expertise and its diverse group of NIST IT scientists yield a collective knowledge, research, and technical guidance capability which is aligned with the bureau's mission to support industry and advise government, acting impartially and providing credible technical insights.

Special Publications on Cloud Computing and Selected Topics

NIST plans to issue an initial SP on cloud computing. The purpose is to provide insight into the benefits and considerations, and the secure and effective uses of cloud computing. More specifically, the document will provide guidance on key considerations of cloud computing: interoperability, portability, and security. To present these issues, the document will use the broadly recognized and adopted NIST Definition of Cloud Computing as a basis, given informal models of the major cloud computing service categories (Software as a Service, Platform as a Service, and Infrastructure as a Service). The publication will outline typical terms of use for cloud systems, will synopsize future research areas in cloud computing, and will provide informal recommendations.

NIST is also in the process of developing an SP on securing virtualization solutions for servers and desktops which are widely used in cloud computing technologies. The publication will provide an overview of full virtualization technologies, discuss the security concerns associated with full virtualization for servers, and provide recommendations for addressing them. The publication will also give an overview of actions that organizations should perform throughout the lifecycle of a server virtualization solution.

Standards Acceleration to Jumpstart Adoption of Cloud Computing (SAJACC)

There is often a gap between the time when formal standards for a new technology are needed and when they become available. The development of standards is inherently dependent on the time consuming process of consensus building through broad participation. There is also a need to ensure due diligence in producing a standard of quality and completeness such that it will be effective and broadly adopted.
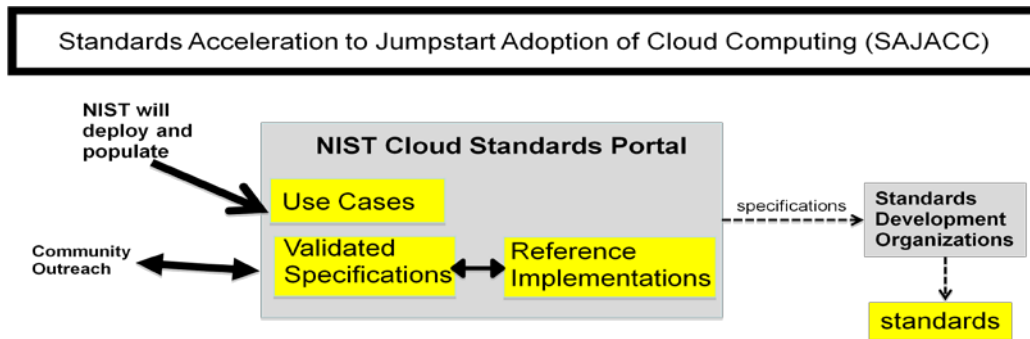
Figure 2: Standards Acceleration Overview[6]

The SAJAAC strategy and approach is to accelerate the development of standards and to increase the level of confidence in cloud computing adoption during the interim period before cloud computing standards are formalized. SAJACC will provide information about interim specifications and the extent that they support key cloud computing requirements through a NIST hosted SAJACC portal.

More specifically, SAJACC will provide a public Internet-accessible repository of cloud computing usage scenarios (i.e., use cases), documented cloud system interfaces, pointers to cloud system reference implementations, and test results showing the extent to which different interfaces can support individual use cases.

The project is in the process of formulating an initial set of draft use cases and vetting these with cloud computing stakeholders in academia, government, and industry. The use cases are being developed to demonstrate portability, interoperability, and achievable security for users of cloud systems. After the use cases have been refined, they will be published on the portal. The project will then identify candidate legacy cloud system interfaces, along with their reference implementations, for validation against the use cases. After an initial set of legacy interfaces have been identified, NIST will conduct validation tests and publish the results. The process of identifying new interfaces (with corresponding reference implementations) and new use cases will be ongoing.

SAJACC leverages, coordinates, and is heavily dependent on input from all stakeholders with an interest in cloud computing standards.

Federal Risk and Authorization Management Program (FedRAMP)

NIST, in the technical advisory role to the interagency Federal Cloud Computing Advisory Council (CCAC) Security Working Group will define an initial technical approach and process for FedRAMP consistent with NIST security guidance in the context of the Federal Information System Management Act (FISMA). To clarify the role of NIST with respect to FedRAMP, while NIST is supporting the definition of the FedRAMP process from a technical perspective, NIST is not the implementing organization. The governance and operational implementation of FedRAMP will be completed under the auspices of the Federal CIO Council.

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[6] National Institute of Standards and Technology, "Summary of NIST Cloud Computing Standards Development Efforts" (government document, 2010).

NIST FedRAMP Technical Advisory Function:
Lead definition of a FedRAMP technical process to leverage security authorizations of shared Cloud Computing services, in the context of the NIST Risk Management Framework
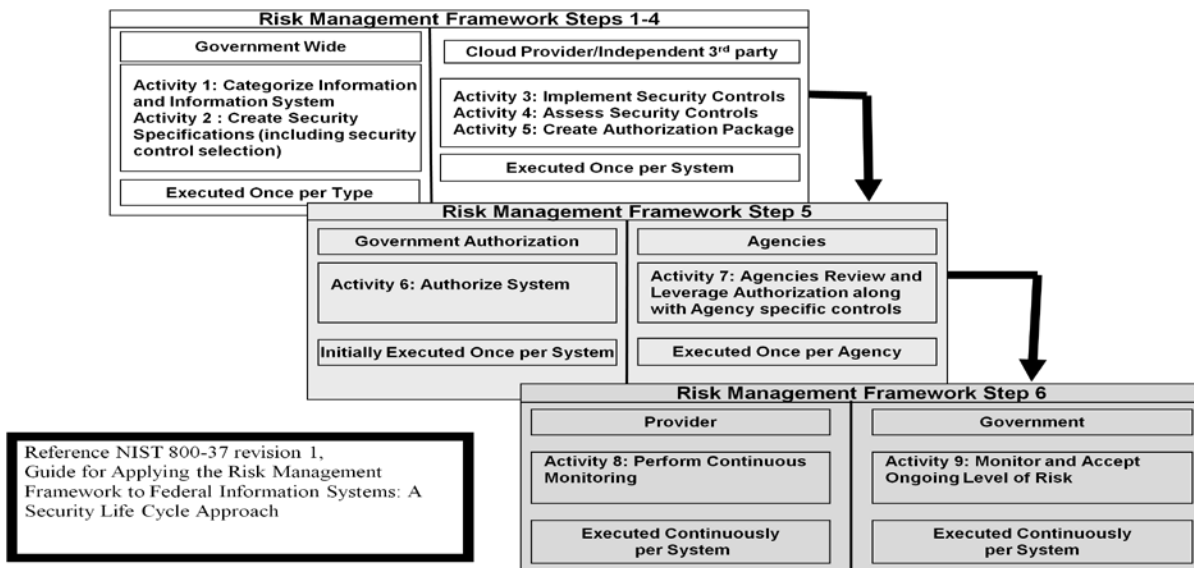
Risk Management Framework Steps 1-4

Government Wide	Cloud Provider/Independent 3rd party
Activity 1: Categorize Information and Information System	Activity 3: Implement Security Controls
Activity 2 : Create Security Specifications (including security control selection)	Activity 4: Assess Security Controls
	Activity 5: Create Authorization Package
Executed Once per Type	Executed Once per System

Risk Management Framework Step 5

Government Authorization	Agencies
Activity 6: Authorize System	Activity 7: Agencies Review and Leverage Authorization along with Agency specific controls
Initially Executed Once per System	Executed Once per Agency

Risk Management Framework Step 6

Provider	Government
Activity 8: Perform Continuous Monitoring	Activity 9: Monitor and Accept Ongoing Level of Risk
Executed Continuously per System	Executed Continuously per System

Reference NIST 800-37 revision 1, Guide for Applying the Risk Management Framework to Federal Information Systems: A Security Life Cycle Approach

Figure 3: FedRAMP Overview[7]

As part of its Technical Advisory effort NIST will:
- Provide technical support and leadership to the working groups supporting the Federal CIO Council
- Create guidance to facilitate leveraged Government authorization of cloud systems and on the application of FISMA and 800-53 to cloud computing

Federal Budget Planning

The President's FY 2011 Budget highlights cloud computing as a major part of the strategy to achieve efficient and effective IT. Federal agencies are to deploy cloud computing solutions to improve the delivery of IT services, where the cloud computing solution has demonstrable benefits versus the status quo. OMB, as part of the FY 2011 Budget Process, requested all agencies to evaluate cloud computing alternatives as part of their budget submissions for all major IT investments, where relevant. Specifically:

- By September 2011 – all newly planned or performing major IT investments acquisitions must complete an alternatives analysis that includes a cloud computing based alternative as part of their budget submissions.
- By September 2012 – all IT investments making enhancements to an existing investment must complete an alternatives analysis that includes a cloud computing based alternative as part of their budget submissions.
- By September 2013 – all IT investments in steady-state must complete an alternatives analysis that includes a cloud computing based alternative as part of their budget submissions.

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[7] National Institute of Standards and Technology, "Summary of NIST Cloud Computing Standards Development Efforts" (government document, 2010).

ILLUSTRATIVE CASE STUDIES

Cloud computing provides tremendous opportunities for the public sector to improve the delivery of services to the American people, reduce the cost of government operations and make more effective use of taxpayer dollars, and lower energy consumption. While the public sector is just at the beginning of the journey to cloud computing, we are already seeing innovative examples at all levels of government.

For example, on April 26, 2010, Recovery.gov became the first Government-wide system to migrate to a cloud-based environment. With the cost savings gained from using a cloud computing infrastructure, the Recovery Board plans to redirect more than $1 million in computer equipment and software to its accountability mission to help identify fraud, waste, and abuse. The City of Los Angeles is anticipating savings of $5.5 million over five years as a result of moving e-mail and productivity tools to the cloud for over 34,000 City employees, and the State of Wisconsin's Department of Natural Resources is increasing collaboration through a hosted online meeting space that supports conference calls, interactive meetings, and information sharing.

These are a handful of illustrative examples that are part of a larger movement to leverage cloud computing across the public sector.

FEDERAL CLOUD COMPUTING CASE STUDIES

The following case studies provide recent examples of how Federal agencies are using cloud computing technologies.

- Department of Defense (United States Army) - Army Experience Center
- Department of Defense (Defense Information Systems Agency) - Rapid Access Computing Environment
- Department of Defense (Defense Information Systems Agency) - Forge.mil
- Department of Defense (United States Air Force) - Personnel Services Delivery Transformation
- Department of Energy (Lawrence Berkeley National Labs) - Cloud Computing Migration
- Department of Health and Human Services - Supporting Electronic Health Records
- Department of the Interior - Agency-wide E-mail
- General Services Administration (Office of Citizen Services) - USA.gov
- General Services Administration - Agency-wide E-mail
- National Aeronautics and Space Administration (Ames Research Center) - World-Wide Telescope
- National Aeronautics and Space Administration (Jet Propulsion Laboratory) - Be A Martian
- National Aeronautics and Space Administration - Enterprise Data Center Strategy
- Social Security Administration - Online Answers Knowledgebase
- Federal Labor Relations Authority - Case Management System
- Recovery Accountability and Transparency Board - Recovery.gov Cloud Computing Migration
- Securities and Exchange Commission - Investor Advocacy System

Department of Defense

Project: Army Experience Center
(United States Army)

The Army Experience Center (AEC), located in Philadelphia, PA, is an Army pilot program designed to explore new technologies and techniques that the Army can leverage to improve the efficiency and effectiveness of its marketing and recruiting operations. The AEC uses touch screen career exploration kiosks, state-of-the-art presentation facilities, community events, virtual reality simulators, and social networking to help potential recruits learn about the Army and make informed decisions about enlisting. The Army required a customer relationship management system that would track personal and electronic engagements with prospects and would help recruiting staff manage the recruiting process.

Improving communications and relationship management with potential recruits through a cloud-based CRM solution

Army's legacy proprietary data system, the Army Recruiting Information Support System (ARISS), was over 10 years old. Despite regular upgrades over the years, it was infeasible to modify ARISS to meet the AEC's requirements; including integration with Social Networking and other Web 2.0 applications, real time data access from multiple platforms including handheld devices, ability to track AEC visitor and engagement data, and integration of marketing and recruiting data. Initial bids from traditional IT vendors to provide required functionality ranged from $500,000 to over $1 million.

Instead, the Army chose a customized version of the cloud-based Customer Relationship Management tool Salesforce.com as its pilot solution to manage recruiting efforts at the Army Experience Center. The Army is piloting this cloud-based solution at an annual cost of $54,000. With the new system, the Army is able to track recruits as they participate in multiple simulations at the Army Experience Center. The solution integrates directly with e-mail and Facebook, allowing recruiters to connect with participants more dynamically after they leave the Army Experience Center. By using Salesforce.com's mobile solution, Army recruiters can access recruit information from anywhere.

The Army is currently in the second year of a two year pilot of the customized Salesforce.com application. Using the cloud-based solution, the Army was able to have fewer recruiters handle the same workload as the five traditional recruiting centers the Army Experience Center replaced. The cloud application has resulted in faster application upgrades, dramatically reduced hardware and IT staff costs, and significantly increased staff productivity.[8,9]

Project: Rapid Access Computing Environment
(Defense Information Systems Agency)

The Defense Information Systems Agency (DISA) provides Information Technology support to the Department of Defense (DoD). DISA began leveraging cloud computing in 2008 by creating its own secure private cloud, the Rapid Access Computing Environment (RACE).

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[8] Jeff Erlichman, *"Cloud Recruiting," On the Frontlines: Shaping Government Clouds*, Winter 2010. http://www.mygazines.com/issue/5865.
[9] United States Army G-1, May 2010.

RACE, which uses virtual server technology to provide on-demand server space for development teams, aims to be more secure and stable than a traditional public cloud.

RACE consists of many virtual servers inside a single physical server. By using virtualization technologies, DISA has divided the costs of provisioning and operating a single physical server among the users of the various virtual servers. This system passes cost savings on to individual teams. Within this virtual environment, users can use a self-service portal to provision computing resources in 50 GB increments with the guarantee that the environment will be secure to DoD standards. At DoD, a dedicated server environment used to take three to six weeks to provision due to lengthy procurement processes. However, RACE is able to provision functional server space to users in 24 hours. The cost for a user to obtain an environment on RACE is reasonable and can be set up with an approved Government credit card.

According to DISA, personnel can expect the same level of service and availability when using RACE over a traditional environment. Additionally, for security purposes RACE has built-in application separation controls so that all applications, databases and Web servers are separate from each other. DISA also has a strict data cleansing process for when an application needs to be removed completely from the RACE platform. Since the inception of this cloud-based solution, hundreds of military applications including command and control systems, convoy control systems, and satellite programs have been developed and tested on RACE.[10]

Project: Forge.mil
(Defense Information Systems Agency)

Typical implementation of new software and systems at DoD requires large amounts of time and money due to licensing, acquisition, and support demands. Non-cloud based software development does not typically allow for the utilization of economies of scale, ubiquitous delivery, or cross collaboration on projects. Recognizing that such benefits can be found in the cloud, DISA established the software development environment Forge.mil. Through Forge.mil, DISA provides the entire Department of Defense with the tools and services necessary for rapid development, testing, and deployment of new software and systems.

Forge.mil teamed with cloud provider CollabNet to provide for a software development platform to allow users to reuse and collaborate on software code. Currently, Forge.mil has over 5,000 users, with over 300 open source projects, over 500 file release posts, and over 30,000 downloads. Forge.mil's collaborative environment and open development platform allow DISA to avoid large start-up costs and enable additional return on investment (ROI) through software reuse.

With rapid project start-ups at minimal cost, Forge.mil estimates new projects developed in its environment save DISA between $200,000 and $500,000 per project. Also, DISA estimates about $15 million in cost avoidance by utilizing an open source philosophy that allows for software reuse and collaborative development. This open source

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[10] Defense Information Systems Agency, May 2010.

philosophy of Forge.mil not only saves money on licensing and support, but provides improved software by giving version control, traceability, and having multiple stakeholders from various projects work on the same software code.

Forge.mil hosts an array of projects for different areas of DoD including the Army, Navy, Air Force, Marine Corps and the Joint Chiefs, all within a secure environment that appropriately protects DoD software assets. Forge.mil allows DISA and its customers to reduce their costs and shorten the time required to develop new software and systems by using a cloud environment that promotes collaboration, reuse of developed software, rapid delivery, and shortened time-to-market for projects.[11]

Project: Personnel Services Delivery Transformation (PSDT) (United States Air Force)

Faced with a mandate to reshape the personnel community, the Air Force Personnel Center needed to reduce the time spent searching for documentation and allow personnel to support war-fighting missions. The Air Force Personnel Center created a program to transform the way Human Resource tools and services were delivered. The primary goal was to create a better customer experience by providing self-service solutions and tracking customer service needs.

Improving operations of human resources management through a cloud-based CRM solution that includes knowledge management, case tracking, contact center tracking and customer survey tools

The Air Force implemented the Software as a Service (SaaS) solution by RightNow to support its knowledge management, case tracking, contact center tracking and customer survey mission needs. Using tools available in the RightNow solution the Air Force focused on solving fundamental problems, with the way information was organized.

RightNow empowered the Air Force to complete its manpower reduction initiative and save over $4 million annually. Searches on the knowledge base have increased to nearly 2 million per week and customer engagement has increased 70 percent. By using a cloud-based solution, the site has been able to scale to meet fluctuating demand without compromising the customer experience. Customers can now find answers from over 15,000 documents within two minutes, an improvement on the 20 minute wait they faced before the implementation of this solution.[12]

Department of Energy

Project: Cloud Computing Migration (Lawrence Berkeley National Labs)

The Department of Energy is exploring cost and energy efficiencies that can result from leveraging cloud computing. This initiative explores how to use cloud computing to address needs across the enterprise, in specific business services, and in scientific study. Although started in 2009, these efforts at Lawrence Berkeley National Labs (LBL) are already showing promise.

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[11] Defense Information Systems Agency, May 2010.
[12] Air Force Office of the Chief Information Officer, May 2010.

LBL has already deployed over 2,300 mailboxes on Google Federal Premier Apps, and will end up with 5,000 e-mail accounts deployed by August 2010. This solution uses a LBL Identity Management System to provide authentication. Additionally, Google Docs and Google Sites have already been deployed and are being used by small and medium-sized scientific research teams to foster collaboration and community documentation.

Presently, LBL is evaluating the use of Amazon's EC2 to handle excess capacity for mid-range computers during peak usage periods. LBL is also investigating the use of a federated identity to provide access for the scientific community to a wide range of cloud computing offerings. LBL estimates they will save $1.5 million over the next five years in hardware, software and labor costs from the deployments they have already made.[13,14]

Department of Health and Human Services

Project: Supporting Electronic Health Records

The Department of Health and Human Services (HHS) is leveraging cloud computing to support the implementation of Electronic Health Records (EHR) systems. HHS is planning for 70 Regional Extension Centers which will assist over 100,000 Primary Care Practitioners. To coordinate healthcare providers' implementation of new EHR systems, HHS is deploying a cloud-based customer relationship and project management solution provided by Salesforce.com. The solution will support HHS's Regional Extension Centers in the selection, implementation, and meaningful use of EHRs. Various implementation approaches can be analyzed to quickly identify best practices for EHR implementation as they emerge.

After reviewing internal and cloud-based solutions, the Office of the National Coordinator (ONC) decided that Salesforce.com offered the best CRM solution for a quick, inexpensive, and rapidly scalable implementation. The review process concluded that it would have taken over a year to implement an internally-based system. Leveraging the cloud solution, ONC was able to stand up the first phase of the Salesforce solution in less than three months after the award.

One of the advantages ONC anticipates from deploying a cloud-based CRM system is the ability to update the system as Regional Extension Centers start using it. More implementation phases are already planned to ensure that users' needs are met. ONC expects to be able to quickly update future phases of the system in substantially less time, while doing it collaboratively with end users.[15]

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[13] Department of Energy Office of the Chief Information Officer, May 2010.
[14] Lawrence Berkeley National Labs Office of the Chief Information Officer, May 2010.
[15] Department of Health and Human Services, May 2010.

Department of the Interior

Announced Project: Agency-wide E-mail

The Department of the Interior is pursuing a Software as a Service (SaaS) cloud computing model for e-mail. DOI has 80,000 e-mail users who are widely dispersed across the United States. They are currently supported by a very complex messaging infrastructure comprised of more than a dozen different e-mail systems. The Department had already determined that a single e-mail infrastructure would reduce the complexity of the overall system and improve the level of service provided to their users when it decided to explore cloud-based solutions.

Migrating 80,000 mailboxes (from 13 specific systems) to one unified cloud provider

When considering how best to deliver a single e-mail system, the Department analyzed the opportunities for cost savings presented by cloud computing. The numbers were compelling: by implementing e-mail using an external commercial SaaS model, the Department expects to provide improved service to its 80,000 users for one-third the amount of money that it spends today. The Department is moving forward with this project with a completion date in Fiscal Year 2011.[16]

General Services Administration

Project: USA.gov
(Office of Citizen Services)

As the Federal Government's primary information portal, USA.gov, presents the American people with a vast body of information and resources including topics like benefits and grants, taxes, jobs, education, health, voting, technology, and business and nonprofit guides.

As the Federal Government encourages citizens to become more involved and active with local, state, and federal politics, key sites like USA.gov see vastly increasing and decreasing website traffic as key issues are debated in the national public forum, natural disasters come and go, and voting season approaches. These spikes in traffic made a cloud computing-based solution very attractive, as a cloud infrastructure is much better able to deal with on-demand scalability than most traditional IT infrastructures. This increased flexibility positions USA.gov to better serve emerging needs.

Reducing costs and improving service by moving USA.gov to a cloud-based hosting environment

By moving to Terremark's Enterprise Cloud service, the General Services Administration (GSA) reduced site upgrade time from nine months (including procurement) to a maximum of one day. Monthly downtime moved from roughly two hours with the traditional hosting setup to near zero with the cloud solution (99.9 percent availability). With its legacy setup, GSA paid $2.35 million annually for USA.gov, including total hardware refresh and software relicensing costs of $2 million, in addition to personnel costs of $350,000. By moving to a cloud service, GSA now pays an annual total of $650,000 for USA.gov and all associated costs, a costs savings of $1.7 million, or 72 percent.[17]

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[16] Department of the Interior Office of the Chief Technology Officer, April 2010.
[17] General Services Administration, May 2010.

Announced Project: Agency-wide E-mail

GSA's current environment lacks the level of integrated features commercially available. GSA requires a greater use of features such as integrated messaging and collaborative tools to support its mission. E-mail archiving is currently implemented inconsistently, is difficult to use, and does not meet information retrieval (e-discovery) requirements. The storage associated with e-mail archiving continues to grow and is costly to manage. Recent regulations for handling e-mail litigation hold and discovery demand that GSA implement a more effective and expedient process. Additionally, GSA is seeking a solution that will reduce it's in-house system maintenance burden and provide GSA users with more timely implementations of new versions and features.

Migrating over 15,000 mailboxes to a cloud solution with features commonly available in commercially solutions

GSA's e-mail effort will migrate over 15,000 mailboxes to a cloud-based solution, eliminating the redundant and disparate infrastructure presently housed at 17 different locations around the world.

Although still in the information gathering phase, initial estimates indicate that over the first two years, GSA will realize a 30 percent cost savings.[18]

National Aeronautics and Space Administration

Project: World-Wide Telescope
(Ames Research Center)

Nebula, NASA's cloud-computing platform, is helping NASA to engage the public through the viewing and exploration of the Moon and Mars in unprecedented resolution. Nebula allows NASA to process, store and upload thousands of high-resolution images and over 100 terabytes of data. In a traditional IT environment, it would have taken several months to procure new infrastructure and another one to two months of full-time work by two full-time employees to configure the new equipment to handle this data. By utilizing Nebula, NASA saved four to five months of time and roughly 800 hours of labor, allowing the agency to focus on expanding the content accessible to the public instead of building IT infrastructure.

Using NASA's Nebula cloud platform to store, process and provide access to high-resolution images of the Moon and Mars

The nature of NASA's activities requires strict security policies, creating a challenge in providing a collaborative environment to share data with outside partners or the public. Nebula's architecture is designed from the ground up for interoperability with commercial cloud service providers, offering NASA researchers the ability to port data sets and code to run on commercial clouds. Nebula provides a secure way for NASA to make its data accessible to partners, avoiding the need to grant access to internal networks. Each researcher needs a varying amount of storage space and compute power to process his or her data sets. In the old operational model, these resources took months to procure and configure and required constant monitoring and frequent upgrades. Using Nebula's cloud computing infrastructure, researchers will be able to provision these services in just a matter of minutes.

NASA space exploration missions can take over 10 years to develop and the resources needed to process the data coming back are usually scheduled and procured well before launch.

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[18] General Services Administration, May 2010.

Missions, however, have a varying degree of success: some are delayed at a late stage, some are cancelled altogether, and some last much longer than originally anticipated. Nebula's cloud services allow NASA to be much more flexible and responsive to actual mission needs, scaling resources up or down as the actual requirements of the mission develop. In addition to supporting NASA's missions, the Nebula cloud-computing platform has demonstrated additional versatility and has become the home of the Federal Government's flagship transparency website USAspending.gov. USAspending.gov 2.0 was completely reengineered to leverage the cloud-computing platform at Nebula, and growing the amount of storage as Federal spending data grows will now be a quick and easy process.[19,20]

Project: Be A Martian
(Jet Propulsion Laboratory)

NASA's Jet Propulsion Laboratory (JPL) brings science to the American people by inspiring interest in the planet Mars. The laboratory sought to increase the impact of its education and outreach program by using technology. It wanted not just to give Mars data to the public, but rather to excite the public about Mars.

To meet this challenge, JPL developed an interactive website, BeAMartian.jpl.nasa.gov, using the Microsoft Azure cloud computing platform. An application programming interface (API) connects website visitors with 250,000 pictures of Mars, available without having to store any additional data on JPL computers. On the cloud, individuals can virtually explore the planet by browsing pictures, watching videos, and creating tags. They can post questions, read responses, and send messages to Mars. The more content a visitor contributes to the site, the more reputation points they earn in their account. For participants, this is a fun way to learn more about Mars.

Engaging the public in citizen science with social media and crowd-sourcing on a scalable cloud platform

"JPL chooses to keep it real through early exploration of multiple clouds." said Tom Soderstrom, Chief Technology Officer of NASA's JPL. "In other words, JPL wants to be an intelligent user of clouds and the only way we can do that is by being proactive and trying them out, end-to-end with real mission data. We've been exploring the clouds by partnering with JPL missions and industry partners for about two years now and have several very good use cases and stories."

With this cloud computing solution, NASA has successfully engaged a crowd of users. Users have created over 2,000 pieces of social media and inspired 200 stories on TV, radio, and in print. There have been 2.5 million API queries from NASA crowd-sourcing applications and 500,000 API queries from developers. The Town Hall area of the website has received over 40,000 votes and 5,000 individuals and teams have registered for a NASA sponsored competition. This crowd has also helped NASA identify craters and other features of the Martian surface. JPL has benefited from this outreach by having engaged users and by exploring and learning about new cloud-based technologies.[21]

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[19] National Aeronautics and Space Administration, May 2010.
[20] National Aeronautics and Space Administration Office of the Chief Technology Officer, "WWT Case Study" (government document, 2010).
[21] National Aeronautics and Space Administration Jet Propulsion Laboratory Office of the Chief Technology Officer, May 2010.

Announced Project: Enterprise Data Center Strategy

NASA recently announced that it is re-evaluating its enterprise data center strategy and has halted a request for proposals that would have yielded an indefinite delivery/indefinite quantity contract with a maximum value up to $1.5 billion for outsourced data center services over multiple years.

Concurrently, a number of organizations within NASA are evaluating the use of Nebula, NASA's scientific cloud solution for possible application in satisfying their mission data center needs:

The Flight Vehicle Research & Technology Division at Ames Research Center is exploring using Nebula for their Message Passing Interface (MPI) implementation. This group performs flight vehicle air flow computation. Data from each piece of the aircraft surface runs on a different compute node and each node communicates edge conditions to its neighboring nodes using MPI. Currently, it takes a very expensive suite of equipment to do that work: NASA's 60000-core Pleiades computer. Although Nebula does not compete on performance with Pleiades, the setup time and money saved by self-provisioning compute power makes Nebula an attractive alternative.

Cancelled proposal requests that would have yielded up to $1.5 billion in enterprise data center contracts and now exploring cloud alternatives

A second mission organization with enormous memory and storage requirements is interested in Nebula because the Infrastructure as a Service (IaaS) beta version, scheduled for release June 2010, will allow them to specify the amount of memory and storage needed for their virtual machines. One of the group's storage-heavy applications requires 12 GB of memory, which can be accommodated on the Nebula IaaS cloud solution.

A third organization is evaluating Nebula to create virtual workstations for software developers to write and test-compile their code. Nebula would give them more fine-grained control over the development environment and allow developers to share the many modules and libraries currently running on their local desktops.

And yet another organization is evaluating Nebula as a service platform for interaction with non-NASA partners. Nebula would enable anonymous but controlled FTP for large file transfers and run an in-house, web-based java application that analyzes and visualizes data produced by NASA's Airspace Concept Evaluation System.[22]

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[22] National Aeronautics and Space Administration Office of Legislative and Intergovernmental Affairs, May 2010.

Social Security Administration

Project: Online Answers Knowledgebase (SOASK)

The Social Security Administration (SSA) handles millions of questions and inquiries from citizens every year. For example, inquirers want to know what they can do online, or how to get a social security number, file for benefits, locate a field office, get a retirement estimate, or request a proof of income letter. In order to provide the public with a convenient means to answer to their questions, anytime and anywhere Internet access is available, the agency provides an online database of Frequently Asked Questions.

Helping the public easily and efficiently find answers to questions through cloud-based knowledge management and CRM tools

The SSA is leveraging a cloud-based solution from RightNow Technologies to provide this service. Visitors to socialsecurity.gov can search for answers by category, keyword or phrase, which helps them quickly find the information they are looking for. Over a thousand questions and answers are included in the knowledge base. SSA keeps the information contained in the knowledgebase up-to-date and relevant, eliminating the need to call or visit SSA for basic information.

In 2009, the number of answers provided through SSA's Frequently Asked Questions grew to over 34 million. Given current agency staffing levels, it would not have been possible for office staff and 800-number agents to answer even 10 percent of these additional inquiries. By contrast, the Internet solution is highly scalable, allowing SSA to meet increasing demand for online information without impacting service in the office and on the phone.[23]

Federal Labor Relations Authority

Project: Case Management System

The Federal Labor Relations Authority (FLRA) recognized that its decade-old case management system was not supporting its mission to the fullest extent possible. FLRA's users regularly experienced delays in searching and the system couldn't keep up with expected growth. Additionally, the internal system had expensive software licensing costs.

Providing efficient and cost-effective access to case information by migrating the legacy, in-house case management system to a cloud-based platform

Strategically, FLRA wanted to implement a shared electronic case management tracking system that would allow citizens to file cases and obtain documents electronically and then check the status of their cases. By using the cloud, FLRA intended to improve infrastructure and make existing IT and operations support more responsive to business needs while meeting regulatory compliance.

The FLRA selected Intuit's Quickbase system as its platform to implement this new system. From requirements-gathering to completed development, the project took less than 10 months to implement. The cloud-based solution has provided FLRA with more rapid development at 25 percent of the original time to deploy. Users now use a modern browser-based user interface, and information collaboration capabilities

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[23] Social Security Administration, May 2010.

have improved work efficiency. FLRA estimates that the total cost of ownership of its case management system has been reduced by nearly $600,000 over five years.[24]

Recovery Accountability and Transparency Board

Project: Recovery.gov Cloud Computing Migration

Launched in February of 2009 after the passage of the American Recovery and Reinvestment Act (Recovery Act), Recovery.gov is designed to "foster greater accountability in the use of funds made available by this Act."[25] The Recovery Accountability and Transparency Board created this public-facing site to allow citizens to track how stimulus funds are spent. The site includes a number of tools including graphs, charts, and maps which are continuously updated and refined to properly reflect stimulus spending. As such, a Government-wide system relies on an agile and substantial infrastructure to ensure that information is accessible, secure, and easy to update with current information.

Leveraging a commercial cloud computing provider to ensure accessibility, security and scalability

On April 26, 2010, Recovery.gov became the first Government-wide system to migrate to a cloud-based environment. The Amazon EC2 infrastructure will provide added security, as the vendor's security will supplement existing measures previously put in place by the Board. The elastic nature of this commercial cloud system means that Recovery.gov is a fully scalable site, ready to handle spikes in usage as needed. In-house personnel currently dedicated to management of the site's associated data center and corresponding hardware will be able to redirect their resources to oversight and fraud detection.

Moving Recovery.gov to the cloud means a projected cost savings of $334,800 in FY 2010 and $420,000 in FY 2011. This represents 4 percent of the Board's $18 million total budget provided by Congress. Additionally, the Board plans to reallocate more than $1 million worth of hardware and software to its accountability mission to help identify fraud, waste, and abuse. Relocating Recovery.gov to the cloud ensures nearly 100 percent uptime and the ability to continuously backup site information. By implementing cloud technologies, the Board better meets its obligations laid out under Section 1526 of the Recovery Act, and is able to refocus efforts on its mission of transparency and accountability.[26]

Securities and Exchange Commission

Project: Investor Advocacy System

The Office of Investor Education and Advocacy (OIEA) serves individual investors who complain to the SEC about investment fraud or the mishandling of their investments by securities professionals. The staff responds to a broad range of investor contacts through phones, email, web-forms, and US mail with volumes close to 90,000 contacts annually. Case files were previously tracked in a 10 year old in-house system. Like many older systems

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[24] Federal Labor Relations Authority, April 2010.
[25] U.S. Congress. *American Recovery and Reinvestment Act of 2009.* H.R. 1. 111th Cong., 1st sess. (January 2009). http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_bills&docid=f:h1enr.pdf.
[26] Recovery Accountability and Transparency Board, "Recovery.gov Moves to Cloud Computing Infrastructure," May 2010. http://www.recovery.gov/News/mediakit/Pages/PressRelease05132010.aspx.

there were several limitations including the inability attach documents, handle paper files, and provide accurate reports. The older system was also intermittent in regards to up-time and system speed.

To address these issues, the SEC implemented a cloud-based CRM tool called Salesforce.com. The implementation of Software as a Service (SaaS) solution that took less than 14 months from inception to deployment. Since the implementation of OIEA, the SEC has realized improvements in system reliability, efficiency and accuracy. Paper files are scanned into the system and worked electronically. All investor contact channels (email, web-form, US mail, fax, and phone) are brought into a single queue to be assigned and worked electronically. All documentation can now be attached to case files, which allows staff member to build complete chronology of events.

Improving service for over 90,000 consumer contacts annually by migrating 10-year old legacy investor advocacy system to cloud-based CRM solution

Using this new paperless environment, the time required to complete files has significantly been reduced. In many cases it was decreased up to 75 percent. Lifecycle tracking is now also available, allowing management the ability see at what stage and the chain of events for every case file. The system now also tracks information that is useful for assisting investors as well as reporting on data that is valuable to other SEC divisions.

Having this new solution better equips SEC in assisting investors efficiently and accurately, which is even more important as we are still dealing with the financial crisis.[27]

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[27] Securities and Exchange Commission Office of Investor Education and Advocacy, May 2010.

STATE AND LOCAL CLOUD COMPUTING CASE STUDIES

The following case studies provide recent examples of how state and local governments are using cloud computing technologies.

- State of New Jersey (New Jersey Transit Authority) - Customer Relationship Management
- State of New Mexico (Attorney General's Office) - E-mail & Office Productivity
- Commonwealth of Virginia (Virginia Information Technologies Agency) - Application Development Platform
- State of Wisconsin (Department of Natural Resources) - Collaboration
- State of Utah (Department of Technology Services) - Cloud Computing Services
- City of Canton, Georgia- E-mail
- City of Carlsbad, California - Communication & Collaboration Services
- City of Los Angeles, California - E-mail & Office Productivity
- City of Miami, Florida - 311 Service
- City of Orlando, Florida - E-mail
- Klamath County, Oregon - Office Productivity
- Prince George's County, Maryland - School District E-mail
- State of Colorado (Office of Information Technology) - Launching an Enterprise Cloud
- State of Michigan (Department of Technology Management and Budget) - MiCloud

State of New Jersey

Project: Customer Relationship Management
(New Jersey Transit Authority)

NJ Transit is the nation's largest statewide public transportation system providing bus, rail, and light rail services of over 900,000 daily trips on 247 bus routes, 26 bus stations, 11 commuter rail lines, and three light rail lines. NJ Transit links major points in New Jersey, New York, and Philadelphia, serving 164 rail stations, 60 light rail stations and 19,800 bus stops. NJ Transit relies upon its ability to field and respond to customer feedback, and requires a robust customer service system. The agency transformed its customer feedback process from one where issues went unresolved, with no tracking and, in some cases, with multiple executives seeing and responding to the same inquiry to a streamlined, faster, more accurate, and more efficient response system. The legacy infrastructure for tracking customer information and inquiries had limited functionality and not all customer inquiries were properly documented for future use. In addition, customer service representatives were responsible for a wide variety of inquiries, limiting the depth of knowledge they could apply to any given inquiry.

When NJ Transit began the search for a new customer system, the organization found that a hosted CRM system from Salesforce.com service fit its needs. To take full advantage of the

Improving responsiveness to citizen inquiries through cloud-based CRM tools

software's capabilities, NJT realigned its customer service department to make each member of the staff the expert for a specific customer service area, which decreased communications overhead and improved productivity. The cloud-based system provides workflow rules that route incoming customer questions to the subject area experts. It also enabled customers and internal users the ability to ask questions and submit issues on the existing site via an online "Contact Us" web form, which flows into the solution's central customer information warehouse. The system's applications are linked to a data warehouse, employee information, an e-mail management system, and a data quality system.

Under the new system, the same number of staff handled 42,323 inquiries in 2006, compared with 8,354 in 2004. During its use, and without an increase in staff, the average response time to inquiries dropped by more than 35 percent and productivity increased by 31 percent. The web form cut down on the time spent handling free-form e-mail; approximately 50 percent of all customer feedback is captured via the online form. Salesforce has allowed NJ Transit to make significant improvements in their customer service capabilities while simultaneously reducing cost, infrastructure, and response time.[28,29]

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[28] Tom C. Feeney, "NJ Transit to test online suggestion box for riders," *Nj.com*, May 2008.
http://www.nj.com/news/index.ssf/2008/05/nj_transit_to_test_online_sugg.html.
[29] New Jersey Transit, May 2010.

State of New Mexico

Project: E-mail & Office Productivity Tools
(Attorney General's Office)

The New Mexico Attorney General's Office (NMAGO) has nearly 200 full-time employees, including 120 attorneys. Most work in the office revolves around creating, storing, and accessing documents in a secure IT environment. The office had historically relied upon the case management functionality of its e-mail system to track official documents ranging from legal briefs to news releases. However, this system did not offer a secure back-up function, leaving vital and sensitive documents exposed to possible loss in case of a server failure. One possible solution, migrating to a system of in-house servers, was cost-prohibitive in the short and long term, with the upfront investment calculated at $300,000. For this reason, the office explored alternative IT upgrades.

Providing 120 attorneys and 200 full-time employees cloud-based e-mail

When investigating alternative email systems, NMAGO selected Google Apps Premier Edition to meet its needs. This solution provides the necessary backup capabilities, and the mail search function also eases the difficulty of locating specific files. Without the need for in-house hardware, employees now have an unlimited ability to access, save, and archive their emails and documents. This transition has also been beneficial from an environmental perspective, as it has reduced the need for paper versions of files. NMAGO is now able to avoid costs such as the $50,000 spent a few years ago for replication software to store data to a disaster recovery site. The office has reduced costs and energy use through reduced hardware acquisitions and reduced workloads for IT staff. Additionally, the office has reduced time and money spent on licensing.

NMAGO's successful migration to the cloud is an example of what the office's CIO calls a "fundamental shift in the way information is transported to users." The CIO and his team believe that the sharing platform offered by cloud-based solutions is easily replicable and can be used to meet various government needs. They "believe cloud computing offers a new way for government to be more responsive and helpful to the public, and save more money than ever before."[30,31]

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[30] James Ferreira, message entitled "Microsoft Exchange or Google Apps? One government agency goes Google," the Google Enterprise Blog, message posted November 2009. http://googleenterprise.blogspot.com/2009/11/microsoft-exchange-or-google-apps-one.html.

[31] New Mexico Attorney General's Office of the Chief Information Officer, May 2010.

Commonwealth of Virginia

Project: Enterprise Application Development Platforms
(Virginia Information Technologies Agency)

The Virginia Information Technologies Agency (VITA) is the Commonwealth's consolidated information technology organization with responsibility for governance of IT investments and the security, technology procurement, and operations of IT infrastructure. The Agency Outreach group of the Enterprise Applications Division (EAD) at VITA provides software development and integration support and services to small agencies, the secretariat, and projects that require cross-agency collaboration.

In the spring of 2009 this group received a request from the Secretary of the Commonwealth to build and host an online solution for Notary and eNotary applications. At the same time it also received a request from Virginia's Workforce One Stop councils to create and host a low cost solution for a common intake form for the centers. Given the limited resources available, under the constraints of traditional technologies, these custom development projects would have been cost prohibitive.

Improving the application development process through use of virtual environments

To meet this challenge, EAD leveraged cloud computing to quickly provision a virtualized software development platform. Using Amazon EC2 services, the group was able to add and remove development or testing environments with ease. Even after full release to a production environment, EAD uses cloud computing to scale the production environment up as needed and for disaster recovery backups through RackSpace virtual storage services.

Virginia used cloud computing to develop new applications that would have otherwise been cost prohibitive. Instead of going through a process that typically lasts months, EAD was able to stand up a virtualized development platform from the cloud in less than two hours. VITA is still evaluating cloud computing at the agency level, reflecting on this group's recent success delivering service with the speed and flexibility its customers need.[32]

State of Wisconsin

Project: Collaboration
(Department of Natural Resources)

The Wisconsin Department of Natural Resources (DNR) has 200 locations scattered across the State, including some in remote areas. In the past, the department typically conducted business through conference calls and face-to-face meetings with staff from various locations. Outside of e-mail, there were no ad-hoc collaboration tools available to department staff to review documents which required multiple revisions by different staff members. The department's available video-conferencing system ran using outdated technology and cost the DNR $1,330 per month.

The DNR evaluated server-based collaboration software, but due to a recent migration of all of the department's servers to the State's new data center, there were no resources available to purchase an on-premises solution. The DNR began using Microsoft Live Meeting as a web conferencing solution and immediately realized cost savings and improved efficiencies. Staff

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[32] Virginia Information Technologies Agency, "Cloud computing: Commonwealth of Virginia" (government document, 2010).

members are now able to interact and can use dynamic solutions including a 360 degree panoramic video camera to conduct meetings together. The cost of running a web conference is only a fraction of the cost required to use a traditional conference call bridge and the DNR has the flexibility to purchase additional user licenses as needed for other departments.

Increasing collaboration through a hosted online meeting space that supports conference calls, interactive meetings, and information sharing

The DNR has used this cloud-based solution to completely replace on-site meetings, training, and telephone and conference calls among internal staff and with outside agencies. This solution allows remote users to participate in meetings even if they are not at one of the DNR's office locations. The staff is now more efficient because they spend significantly less time on the road travelling to meetings. Since this migration in 2009, the DNR estimates that staff members have participated in nearly 3,500 meetings, saving the department more than $320,000. In the coming years, the DNR expects the return on investment to grow from 270 percent for the first year to over 400 percent in future years.[33]

State of Utah

Project: Cloud Computing Services
(Department of Technology Services)

The State of Utah began an effort to standardize and unify its IT services in 2005 when it merged its technology assets into a single department, moving all IT staff under the state Chief Information Officer. To develop a suitable cloud strategy, the State needed to fulfill specific security requirements unique to the State. If these security challenges were met, Utah could take advantage of an array of cloud benefits including elastic expansion of services, rapidly provisioned computing capabilities, and shared services across multiple users and platforms based on customer demand.

After a wave of data center consolidation, in 2009 Utah decided that a hybrid cloud approach would work best for the State's needs. A hybrid approach combines access to public cloud services that add to or replace existing state infrastructure with private cloud services meeting specialized access and security requirements. This cloud environment includes services hosted both by third-party providers and in-state data centers.

Launching cloud environment to provide enterprise services across the state and local governments at competitive prices

The move to cloud-based solutions has benefited local public sector actors across the state. Although many of the public cloud provisioned services are free, the State of Utah also supports a growing number of paid services where individual county and city governments pay only for their usage. These currently include Force.com for Customer Relationship Management, Google Earth Professional for shared Geographic Information System (GIS) planning, and Wikispaces where there are an increasing number of self-provisioned wikis. Contracts for these services are centrally managed through the Department of Technology Services (DTS) and make it easy for agencies to use.

Having provided its agencies and local governments with centralized access to the public cloud, the State of Utah is now focused on completing its private cloud. The State's

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[33] State of Wisconsin, May 2010.

applications previously resided on about 1,800 physical servers in over 35 locations. By December 2010, the State plans to move these applications to a virtual platform of 400 servers. This initiative is currently over 70 percent complete and is expected to save $4 million in annual costs for a state IT budget of only $150 million. Going forward, DTS plans to extend virtualization to desktops across the state.

By implementing a vast strategy for migrating services to the cloud, the State has created an enterprise where public or private services can be reused and provisioned on demand to meet agency needs as cost-effectively as possible. This effort has had an immediate impact on State agencies and is expected to result in significant future savings.[34,35]

City of Canton, Georgia

Project: E-mail

The City of Canton, GA, approximately 40 miles north of Atlanta, has a population of 21,000 and was recently recognized as the fastest growing city in Georgia and America's 5th fastest growing city. The City's 185 employees were looking to reduce the cost and effort of maintaining an IT infrastructure and increase the reliability of business e-mail and productivity solutions. The legacy e-mail system was difficult to maintain and keep up-to-date.

The City decided to migrate to Google Apps to provide staff members with a more reliable and feature-rich system. Staff members immediately benefited from gaining access to e-mail at home and on mobile devices, and from the increased collaboration available with tools such as group calendar, instant messaging, and shared documents and spreadsheets.

Migrating 185 city employees to cloud-based e-mail

With this cloud-based solution, the City's IT staff no longer has to handle spam filters, a task that took 20 hours a week to manage prior to migration. IT staff members are also able to use powerful e-mail discovery tools in the new cloud-based solution so that e-mails potentially related to legal investigations are securely archived but easily accessible to approved personnel. The City estimates an annual savings of $10,000 by migrating to cloud computing.[36]

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[34] State of Utah Department of Technology Services, "Implementing Utah's cloud computing strategy: A case study on bringing cloud-based IT services to government" (government document, 2010).
[35] State of Utah, May 2010.
[36] City of Canton, May 2010.

City of Carlsbad, California

Project: Communication & Collaboration Services

The City of Carlsbad, California has 1,100 employees across 22 departments who work in 30 different facilities across the city. Until recently, the City's employees used a 15 year-old, non-standard IT system. The City's IT department knew it had to simultaneously standardize its IT infrastructure and cut costs without sacrificing its high level of service. When the City began the process of standardizing its IT infrastructure, officials decided to review options for migrating from an on-premise e-mail and collaboration system to one hosted in the cloud.

Serving the city's needs for desktop and mobile e-mail, online collaboration tools, and web conferencing through hosted communication and collaboration services

The City ended up selecting a cloud-based version of the Microsoft productivity suite, hosted in Microsoft's data centers outside of Carlsbad. It was able to eliminate the costs of maintaining equipment, paying only monthly user fees for this new environment. While the City considered using an on-premises version of the productivity suite instead due to data security concerns, it realized that from a disaster recovery standpoint, their data was more secure being hosted outside of the City's data center.

The City has already realized a 25 percent savings over the past year using the new off-site solution, as there is no longer a need to maintain servers, manage upgrades, implement hardware replacements, or hire a systems administrator. The City realized other immediate benefits after the migration, including better access to e-mail from mobile devices and new, integrated instant messaging and web collaboration for meetings and video conferences.[37]

City of Los Angeles, California

Project: E-mail & Office Productivity

The City of Los Angeles has 34,000 employees across 40+ departments. In 2009, the city faced a $400 million deficit. This budgetary crisis and the resulting IT staff layoffs exacerbated existing frustrations with the city's in-house IT systems. The city's Information Technology Agency sought to find a new e-mail and IT provider which would streamline productivity and create more efficiencies in day-to-day operations. The city received 15 proposals for possible replacements to its in-house system.

In October 2009, the City of Los Angeles announced plans to transition to Google Apps with the help of systems integrator, with a five year services contract. The city plans on having all employees on cloud-based e-mail by June 30, 2010 and has begun initial use of other products within the Google Apps Premier Edition suite and to the cloud as city employees have become more familiar with using the Cloud for workplace productivity.

Providing over 34,000 employees cloud-based e-mail and productivity tools

The City's Chief Technology Officer estimated a direct savings of $5.5 million over five years as a result of the implementation, with the potential ROI for increased productivity possibly reaching $20 to $30 million as city employees become fully trained on cloud-based applications. The city is now able to offer each city employee 25 times more storage

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[37] City of Carlsbad, May 2010.

space, and can provide much more capability and add new users without ever needing to worry about hardware availability on city servers. City employees will also benefit from cloud-based integrated instant messaging, video conferencing, simultaneous review and editing of documents by multiple people, and the ability to access their e-mail and work data from any computer or mobile device.

While at first some city council members and staff were skeptical about moving city data outside of direct city control, the vendors have ensured that from a security and disaster recovery standpoint, data being stored in the cloud environment exceeds both the City's contractual requirements and current environment. The city's new system and its data will be safe from earthquakes and other potential natural disasters that could and have affected the city. In addition, the City of Los Angeles retains full ownership of all data on the servers and the vendors must request access to see City data, stored in the clear. These were critical hurdles the system had to clear before being recommended by staff and accepted unanimously by the City Council. With these protections and the productivity benefits, moving to cloud computing was a natural step for Los Angeles and in keeping with our focus on innovation as well as fiscal responsibility.[38],[39],[40]

City of Miami, Florida

Project: 311 Service

The City of Miami, with a population of nearly 5.5 million, has 3,600 employees who work in 83 locations. When the City's centralized IT department needed to cut its budget by nearly 18 percent and was forced to drop nearly 20 percent of its already small staff, continuing to deliver quality and innovative services became a challenge. At the same time, the city sought to supplement its 311 phone line, used by citizens to report non-emergency situations, with an interactive online platform for tracking service requests and mapping them geographically.

The 311 website proposal posed several challenges to the city and its IT staff. The city needed to be sure it had adequate processing power to support its new, processing power-intensive mapping application. The city also needed to take into account disaster recovery measures, since the Miami area is frequently hit with hurricanes. Overall, the city was unsure it could provide the necessary resources to manage the 311 website in-house, so moving to the cloud was the logical next choice.

Improving the ability for citizens to report and track requests for city services through its "311" cloud-hosted web application

The City decided to leverage a scalable, cloud-based Windows Azure platform that provides developers with on-demand hosting in Microsoft data centers. From a technical standpoint, the City was able to seamlessly integrate existing technologies in use by development teams on other projects with the cloud-based platform. Also, the pay-as-you-go platform allowed the City to test out the application and only pay for actual usage, which was also beneficial when the application become more popular. Moreover, IT staff members were able to streamline development of the application and move from testing to production simply and quickly. The deployment of the 311 website application on the cloud-based platform was

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[38] City of Los Angeles Information Technology Agency, "Los Angeles Google Enterprise Email & Collaboration System" (presentation, 2010).
[39] City of Los Angeles, May 2010.
[40] City of Los Angeles, "City of L.A. CSC/Google Project Highlights – as of 12/18/09," the LA GEECS Google Site, document posted February 2010, https://sites.google.com/a/lageecs.lacity.org/la-geecs-blog/home.

successful and the City is planning additional service offerings to citizens based on the overall value and efficiency of cloud computing.[41,42]

City of Orlando, Florida

Project: E-mail

To address recent budget and human resource challenges, the City of Orlando moved its e-mail and productivity solution to the cloud. Preparing for the Fiscal Year 2010, the City faced a 12 percent budget cut and the retirement of two mail administrators and an information security officer. As the license renewal deadline approached, the City's CIO confronted these business challenges by leading Orlando into the cloud.

After evaluating several providers, Orlando chose to contract with Google to provide an e-mail solution for all 3,000 City workers. City leadership supported the transition based on several decision factors including projected cost savings of $262,500 per year, centralized document storage and collaboration, increased mail storage from 100MB to 25GB per user, and enhanced support for mobile devices.

Providing 3,000 city employees cloud-based e-mail services

Although the City's contract includes Google Docs, the City also retained the Microsoft Office productivity suite in order to avoid the cost to retrain employees.

After piloting with a small number of users, the full roll-out of the solution occurred on January 7, 2010. The City has realized a 65 percent reduction in e-mail costs and provided additional features to increase the productivity of workers. Google is now responsible for the City's e-mail server maintenance and IT support. Security functions and features such as virus checking and spam control are also performed by Google through their Postini services.[43,44]

Klamath County, Oregon

Project: Office Productivity

Klamath County, Oregon is one of Oregon's geographically largest counties spanning 6,000 square miles. The county has about 70,000 residents and a staff of 600 employees spread across the expansive county. County employees typically leverage video conferencing on a regular basis. When the county's director of IT realized that the need to upgrade IT capacity was imminent, coupled with the fact that the county faced a budget crunch, he began evaluating cloud-based solutions.

Providing county of 6,000 square miles with cloud-based collaboration tools

After considering the options, the county decided to migrate to a hosted solution, and selected Microsoft Online Business Productivity Suite. This would not only free up valuable human resources from managing the server environment, but also cut costs. The county also noted the potential for dependability of the system to improve since performance was

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[41] Rutrell Yasin, "City of Miami takes citizen services to cloud," *Government Computer News,* March 2010. http://gcn.com/articles/2010/03/10/city-of-miami-microsoft-azure.aspx.
[42] City of Miami, May 2010.
[43] Mark Schlueb, "Orlando goes Google for cheaper e-mail," *Orlando Sentinel*, January 2010. http://articles.orlandosentinel.com/2010-01-09/news/1001080262_1_google-e-mail-google-enterprise-google-docs.
[44] City of Orlando, "Orlando Goes Google" (government document, 2010).

not tied to county IT staff's ability to keep the servers optimized.

With this migration, the county was able to keep costs low and ensure that IT personnel and other resources were used appropriately amidst the flat county revenues. The personnel required to manage the e-mail solution decreased by 1.5 full time equivalents, an 86 percent reduction.   The county also managed to implement new features including integrated messaging, collaborative tools to increase productivity for the entire county, and the ability to archive emails for a longer period of time.[45]

Prince George's County, Maryland

Project: School District E-mail

The Prince George's County, MD school district is the 18th largest school district in the country, with over 200 schools, 129,000 students and nearly 28,000 faculty/staff. For the 2008-2009 school year, the school district was facing budget cuts of $185 million and projected that a needed upgrade to their on-premises e-mail system would cost $1 million. The existing system required the support of multiple dedicated members of the district's IT staff, and due to the lack of an e-mail archiving system, IT personnel spent an excessive amount of time tracking down electronic records for legal purposes.

Migrating staff e-mails to a cloud-based solution that is offered to public schools free-of-charge

The district decided to migrate staff e-mail accounts to the Google Apps platform, which is offered to public schools at no cost. The school district's faculty and staff are now leveraging Google's cloud computing platform for messaging and collaboration. More than 13,000 of the staff members also use Google Message Discovery, powered by Postini, for archiving and discovery. Due to the cost effectiveness of the cloud computing solution, the district was able to also add the Message Discovery add-on, which costs only a few dollars per user per year, allowing authorized users to locate e-mail messages within minutes. With the success of this cloud computing experience the school district is also considering phasing in a cloud-based solution for use by students throughout the school district.[46,47]

State of Colorado

Announced Project: Launching an Enterprise Cloud
(Office of Information Technology)

In 2008, Colorado's Governor's Office of Information Technology (OIT) began to consolidate the IT systems from 17 Executive Branch agencies. Prior to consolidation, the State was responsible for 40 data centers consisting of 1,800 servers, of which 122 alone powered different versions of Lotus Notes, Microsoft Exchange, and Novell GroupWise for e-mail. The goal of consolidation was to achieve cost savings through standardization while reducing the complexity of administering multiple platforms, and improving service delivery. OIT also envisioned gaining the ability to share resources with local jurisdictions and schools across the State.

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[45] Klamath County Oregon, May 2010.

[46] Prince George's County Public Schools. "Googlizing the Masses" (presentation, School Board of Prince George's County Public Schools, MD, 2010). http://docs.google.com/present/view?id=dxjw4sx_14gvr3r7fz.

[47] Prince George's County Public Schools, May 2010.

Colorado decided to implement a hybrid cloud solution to meet the diverse needs of its 17 state agencies. Each agency has its own applications which required different levels of security, so the State's plan includes three elements: a private cloud for line-of-business/highly secure data and systems, a virtual private cloud for archival storage/disaster recovery, and a public cloud for e-mail office productivity applications and websites.

Implementing a hybrid cloud strategy to increase offerings and reduce costs while meeting the diverse security needs of 17 agencies

For Colorado's private cloud, the State will use an existing data center and begin to leverage server virtualization. All production data will remain on-site while virtualized instances of the production server can be stored off-site, increasing disaster recovery capabilities at reduced cost. Colorado's virtual private cloud allows for additional scalability on a pay-as-you-go model for large systems. Colorado has recently started transitioning systems to the virtual private cloud.

Colorado's usage of the public cloud will initially be a pilot of Google Apps for e-mail and office productivity. Using cloud-based e-mail provides Colorado with increased mobility, disaster recovery, storage, better document sharing, and collaboration. The pilot will test the migration of e-mail from three different agencies, focusing on security and workflow processing. If the pilot is successful and the cost-benefit analysis proves positive, the State plans to transition all 27,600 Executive Branch employees to the new system.

By shifting e-mail to the cloud, Colorado will be able to take all 122 existing e-mail servers out of production and experience significant operational cost savings. An initial cost-benefit analysis of the migration to cloud-based e-mail estimates annual savings of $8 million. In addition, Colorado will avoid additional expenses of up to $20 million over the next three years.[48]

State of Michigan

Announced Project: MiCloud
(Department of Technology Management and Budget)

In March 2010, Michigan's Department of Information Technology consolidated with the State's Department of Management and Budget. The new Department of Technology, Management & Budget (DTMB) is now building a full array of services to provide across governments and the private sector. Michigan is moving toward leveraging cloud-based solutions to provide clients with rapid, secure, and lower cost services though a program dubbed "MiCloud."

Making strategic investments in virtualization technologies and developing a cloud platform to support state-wide services

One key area of current action is the State's strategic investment in storage virtualization technologies, expected to go live in October 2010. Michigan is actively piloting MiCloud "Storage for Users" and "Storage for Servers" as internal government cloud functions delivered by DTMB. The consumption expectation is more than 250 terabytes in the first year of operation at a projected storage cost that is 90 percent lower than today's lowest-cost storage tier. MiCloud provides self-service and automated delivery within 10 minutes of submitting an online request. The following table expresses projected savings based on migration rates. It is

[48] State of Colorado Government Office of Information Technology, "Moving Colorado to the cloud: A business case" (government document, 2010).

important to note that this low-cost option represents a service alternative that is only appropriate for data that do not require 24x7 availability or real-time, block-level replication.

The State of Michigan's 2010-2014 strategic plan also outlines critical future investments in virtual server hosting and process automation. The State is in the proof-of-concept phase for the MiCloud "Hosting for Development" and "Process Orchestrator" functions in the internal government cloud. The hosting for development function automates the delivery of virtual servers within 30 minutes of submitting an online request. Michigan will also explore a hybrid cloud to deliver a more complex Application Platform as a Service (APaaS).   The process orchestrator function enables agency business users, regardless of IT skill level, to create and test simple process definitions. Business users will be able to publish processes and related forms to the

Migration Rate	Potential Annual Savings or Cost Avoidance
10%	$228,000
20%	$456,000
30%	$684,000
40%	$912,000
50%	$1,140,000
60%	$1,368,000

service catalog and over time analyze related metrics. Ultimately, the shift to cloud computing will allow Michigan to improve services to citizens and business while freeing up scarce capital, staff resources, and IT assets for critical investments.[49]

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[49] State of Michigan Department of Technology, Management & Budget, "Governing in the cloud – a government case study from Michigan" (government document, 2010).

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