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Saving Money Through Cloud Computing

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EXECUTIVE SUMMARY

The U.S. federal government spends nearly $76 billion each year on information technology, and $20 billion of that is devoted to hardware, software, and file servers (Alford and Morton, 2009). Traditionally, computing services have been delivered through desktops or laptops operated by proprietary software. But new advances in cloud computing have made it possible for public and private sector agencies alike to access software, services, and data storage through remote file servers. With the number of federal data centers having skyrocketed from 493 to 1,200 over the past decade (Federal Communications Commission, 2010), it is time to more seriously consider whether money can be saved through greater reliance on cloud computing.

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Cloud computing refers to services, applications, and data storage delivered online through powerful file servers. As pointed out by Jeffrey Rayport and Andrew Heyward (2009), cloud computing has the potential to produce "an explosion in creativity, diversity, and democratization predicated on creating ubiquitous access to high-powered computing resources." By freeing users from being tied to desktop computers and specific geographic locations, clouds revolutionize the manner in which people, businesses, and governments may undertake basic computational and communication tasks (Benioff, 2009). In addition, clouds enable organizations to scale up or down to the level of needed service so that people can optimize their needed capacity. Fifty-eight percent of private sector information technology executives anticipate that "cloud computing will cause a radical shift in IT and 47 percent say they're already using it or actively researching it" (Forrest, 2009, p. 5).

To evaluate the possible cost savings a federal agency might expect from migrating to the cloud, in this study I review past studies, undertake case studies of government agencies that have made the move, and discuss the future of cloud computing. I found that the agencies generally saw between 25 and 50 percent savings in moving to the cloud. For the federal government as a whole, this translates into billions in cost savings, depending on the scope of the transition. Many factors go into such assessments, such as the nature of the migration, a reliance on public versus private clouds, the need for privacy and security, the number of file servers before and after migration, the extent of labor savings, and file server storage utilization rates.

Based on this analysis, I recommend five steps be undertaken in order to improve efficiency and operations in the public sector:

1) the government needs to redirect greater resources to cloud computing in order to reap efficiencies represented by that approach,
2) the General Services Administration should compile data on cloud computing applications, information storage, and cost savings in order to determine possible economies of scale generated by cloud computing,

3) officials should clarify procurement rules to facilitate purchasing through measured or subscription cloud services and cloud solutions appropriate for low, medium, and high-risk applications,
4) countries need to harmonize their laws on cloud computing to avoid a "Tower of Babel" and reduce current inconsistencies in regard to privacy, data storage, security processes, and personnel training, and
5) lawmakers need to examine rules relating to privacy and security to make sure agencies have safeguards appropriate to their mission.

There are five key features of cloud computing: on-demand self-service, ubiquitous network access, location-independent resource pooling, rapid elasticity, and measured service.

Definition of the Cloud

The National Institute of Standards and Technology has presented the most clear and comprehensive definition of cloud computing. It distinguishes cloud characteristics, delivery model, and deployment method (Mell and Grance, 2009). The Institute says there are five key features of cloud computing: on-demand self-service, ubiquitous network access, location-independent resource pooling, rapid elasticity, and measured service (Wyld, 2009, p. 12).

Computing can take the form of software-as-a-service (running specific applications through a cloud), platform-as-a-service (using a suite of applications, programming languages, and user tools), or infrastructure-as-a-service (relying on remote data storage networks). Deployment depends on whether the cloud is a private, community, public, or hybrid one. Private clouds are operated for a specific organization, for example, whereas community clouds are shared by a number of organizations. Public clouds are available to the general public or large groups of agencies, while hybrid clouds combine public and private elements in the same data center.

Estimating Cloud Savings

There are a wide range of cloud saving estimates from various sources, some of which are much more optimistic than others. Former Office of Budget and Management official Mark Forman says migration to the cloud will save 90 to 99 percent of IT operating costs (Center for Strategic and International Studies Forum, 2009). A report by Ted Alford and Gwen Morton (2009) of Booz Allen Hamilton concludes that government agencies moving to public or private clouds can save from 50 to 67 percent. An analysis by Merrill Lynch claimed that technology could make business applications "three to five times cheaper," meaning that organizations could save anywhere from 67 to 80 percent (Greenberg, 2009). Rajen Sheth (2009) of Google projects cost savings of 67 percent for moving e-mail to the cloud. Meritalk (2009) puts the overall cost savings at around 39 percent, based on projected economies from open source, virtualization, and cloud service delivery.

However, a report by McKinsey analyst William Forrest (2009) disputed these cost savings. He argued that there would be few savings from cloud migrations and that moving to the cloud actually would cost 144 percent more than current expenditures. He based this analysis on a comparison of file server costs through a conventional data center versus Amazon's Elastic Compute Cloud. Whereas the regular storage mechanism would cost $150 per month for 3 GHz dual-core Xeon servers ($107 for labor and $43 for non-labor), Forrest said Amazon's cloud storage costs would total $366 per month ($270 for labor and $93 for non-labor) (Maitlin, 2009; Lohr, 2009).

The wide variation of numbers in "return on investment" studies demonstrates there is considerable uncertainty in projected cost savings and a need for more case studies to look at actual expenditures. Uncertainty is not surprising because many factors go into cost estimation. One factor is the scope and timing of the migration. It matters how extensive the migration is and whether the cloud deployment focuses on applications, service delivery, or platform storage. The bigger the migration, the higher the expected transition costs and the more labor costs involved. Simple migrations offer greater potential for cost savings than complex moves because of the labor costs, time, and expense of the migration.

The type of cloud being used also affects the cost savings that will be generated. Reliance on public versus private clouds makes a big difference. Alford and Morton (2009), for example, find that an agency needing 1,000 file servers would spend $22.5 million for storage on a public cloud, $28.8 million for a hybrid, and $31.1 million in a private cloud limited to their agency. Private clouds typically cost more due to greater security needs and lower storage utilization rates.

In comparing studies, it is clear that the efficiency of capacity utilization is another determinant cost savings. The higher the capacity utilization in an agency, the more likely there are to be cost savings because they can reduce the number of file servers after a migration. Alford and Morton found that many government data centers average 12 percent utilization, meaning that agencies use only 12 percent of their storage space. If migration to a cloud increases utilization to 60 percent, that translates directly into dollar savings.

The level of privacy and security protection is another big variable in cloud migrations for government agencies. Organizations that have sensitive or classified information obviously require greater safeguards, both in terms of monitoring and firewalls. This subsequently affects the cost of cloud storage and service delivery. Right now, the federal government has rolled out "low-risk" cloud solutions and soon will be doing the same thing for "moderate" and "high-risk" applications. One can reasonably expect cloud solutions at the high-risk level to cost more because of the need for secure facilities and personnel with security clearances.

One final significant factor determining the level of cost economies is the extent or labor savings, or whether migration to the cloud enables an agency to reduce personnel. If organizations are able to downsize their IT departments based on cloud migration, it increases their cost savings. For example, Forrest (2009, p. 25) argued that agencies could save 15 percent on labor costs by moving to a cloud. But these types of savings are possible only if agencies actually cut personnel through cloud computing. In general, staff reductions are politically and organizationally difficult for government agencies.

Data and Methodology

The data for this project comes from a series of case studies involving government agencies that have moved specific applications from local to remote file servers. Specific analysis involved the cities of Los Angeles, CA; Washington, D.C.; Carlsbad, CA; and Miami, FL as well as the U.S. State Department, National Aeronautics and Space Administration, and Air Force. I employed interviews, media coverage, case materials, and documentary research to determine why each agency wanted to move to the cloud, what their cost structure was before the move (if available), costs after the transition, cost savings in hardware, software, and personnel, and any difficulties experienced during the migration. Not every organization we looked at was able to provide complete information in each category, but we report all the available data that we were able to obtain.

E-mail Service in the City of Los Angeles

In 2009, the city of Los Angeles decided to move e-mail service for its 30,000 employees from Novell's Groupwise onto cloud file servers operated by Google. The $7.5 million contract provided five years of e-mail services for city employees at an average cost of $50 per employee per year. During City Council consideration of the bill, critics worried about security and reliability, especially for law enforcement agencies such as the Police Department (Sarno, 2009a). Google promised to store city data on its secure "Gov Cloud" platforms that are maintained within the continental United States and operated by individuals who have passed rigorous background checks. The company also agreed to provide financial credits to the city if the system was down in excess of service levels agreed to in the e-mail contract.

An analysis undertaken by City Administrative Officer Miguel Santana (2009) for the City Council found that the five-year costs of running the Google system would be $17,556,484, which was 23.6 percent less than the $22,996,242 for operating GroupWise during that same period. The Google estimate included three pieces:

1) $10,664,445 for system applications, implementation, a required Internet update, two file servers, and four personnel positions necessary to run the system,
2) $907,913 for GroupWise e-mail licenses and software for 2009-10 during the transition to Google, and
3) $5,984,126 for Microsoft licenses for selected employees who would continue to use Office software during the five-year period.

If the city had chosen to stay with its current Groupwise e-mail system, the costs would include:

1) $15,459,438 for GroupWise licenses, upgrades, system applications, 90 file servers, and 13 staff positions, and
2) $7,536,804 for Microsoft Office licenses.

As far as personnel savings, the city would need nine fewer people in its information technology department as a result of the transition to the Google cloud. However, the Los Angeles Information Technology Agency (ITA) initially requested that the nine people whose jobs no longer were needed for e-mail operations be retained for use on other technology projects. But the City Administrator turned down that request and ITA agreed to eliminate the nine jobs over a period of time.

For the 88 file servers no longer needed to support e-mail, ITA decided to redirect 60 to replace obsolete servers in city government. Currently, the city of Los Angeles has 245 file servers that are five to 10 years old and therefore in need of replacement. Typically, the city spends $1 million a year to purchase 52 new and replacement file servers. ITA agreed to forego new file server purchases with the move to the cloud.

E-mail Service in the City of Washington, D.C.

In 2008, Washington, D.C. city government shifted many of its 38,000 employee e-mail services across 86 agencies to the cloud (Lynch, 2009). When he came into office, the city's Chief Technology Officer Vivek Kundra found that "85 percent of school computers had viruses" and that the city's fiber optic lines cost $6.3 million more than budgeted (Peterson, 2008). He decided drastic action was required to improve service delivery and save money. The new e-mail contract was not an exclusive arrangement as most workers were not required to shift to the Google system. A number continued to rely on Microsoft Outlook.

Government officials also employed a cloud approach that "plots the locations of construction projects and broken parking meters, among other things, on Google Maps, so residents can see how many potholes are scheduled to get filled on their street or how many computers a neighborhood school received this year"

(Hart, 2008). Google Docs and Spreadsheets were employed to store work flow data on city projects and employee performance information. Analysts found that the migration saved 48 percent on e-mail expenditures. Costs for Google Apps over the previous software were reduced from $96 to $50 per user per year (Lynch, 2008; Sarno, 2009b).

E-mail Service in the City of Carlsbad, California

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The city of Carlsbad decided in 2008 to move its 1,100 employees from Novell GroupWise onto a Microsoft@Online Services e-mail and web conferencing solution. The service was implemented on a "per-user, per-month" financing mechanism, and the city estimates that it saved 40 percent per year compared to its earlier, in-house system. This included the cost of file servers, software upgrades, and staff training. For 80 mobile workers who did not have offices, the city saved $4,800 on e-mail licensing costs, or an average of $60 per employee (Microsoft Case Studies, 2009).

311 Management in the City of Miami, Florida

The city of Miami chose a Microsoft Windows Azure platform in 2009 for its service hosting and mapping technology. Prior to this decision, Miami hosted its own file servers over a storage area network and anticipated it would need only 4 terabytes of storage over a five-year period. However, when it discovered after three years that it was using 27 terabytes of space, city officials moved to the cloud to track its 311 services to residents on potholes, illegal dumping, or missed garbage collection.

Azure offered a "pay as you go" mechanism that worked for the city given its tight budget and 18 percent drop in IT spending authority during the recession. The city combined Azure with a product from the ISC company known as MapDotNet UX, which made possible the visual display of information through geospatial mapping.

Because of the cloud storage, the city was able to drop much of the need to host and maintain its own physical file servers. City officials estimated that it saved 75 percent in the first year between hardware, software, and staff efficiencies (Microsoft Case Studies, 2010). Since this is a new system, cost figures for out years were not available from Miami administrators.

Budget Information for the U.S. State Department's Nonproliferation and Disarmament Fund (NDF)

The U.S. State Department needed an application that would make budget information on nonproliferation issues available to out-of-the-office program

managers around the world operating 24/7. Often times, these officials would not have regular access to desktop computers or management budgeting tools when they were traveling and out of their home office. They needed a ubiquitous, multi-platform application that would let them know how they have spent on particular nonproliferation issues and what money was left to pursue new program opportunities.

In 2008, the NDF contracted with SalesForce.com for a new application that would provide detailed budget information from any Internet service around the world. The feature cost $1,426,691, including software, staff time, operations, and implementation. Executives estimated that this application cost one-quarter what it would have been had development been undertaken in-house. Cost savings included personnel that did not have to be hired, savings in development time, and file servers that did not have to be purchased (Nucleus Research, 2009).

An Infrastructure Platform for the National Aeronautics and Space Administration (NASA)

NASA has pioneered a new cloud system known as Nebula used for mission support, public education, and data communications and storage. It relies on Eucalyptus, which is an open source cloud platform developed at the University of California at Santa Barbara (Wyld, 2009, pp. 25-26).

Nebula is mostly used for internal projects at NASA's Ames Research Center in Mountain View, California, but NASA also leases some storage space to the U.S. Office of Management and Budget so that it is fully utilized. Initial funding for the project was $2 million, which was less expensive than if NASA had to develop its own software and data file servers. The organization decided to develop its own cloud instead of using commercial services because the latter did not have the bandwidth required for NASA missions or were not yet compliant with the security specifications of the Federal Information Security management Act.

According to an interview with Gretchen Curtis (2010), director of communications for the Nebula Cloud Computing Platform, Nebula has pioneered a new model of government cloud computing. When state and local organizations talk about moving to "the cloud," they are most often referring to software as a service functions (SaaS), such as e-mail and other end user services delivered over the Internet. "Here at NASA," she said, "the discussion revolves less about software as a service, and more about infrastructure as a service (IaaS) and platform as a service (PaaS)."

As a science organization, NASA processes and stores a large amount of data. Consequently, their need for storage and compute resources is very high. Currently, Nebula provides IaaS, is moving towards PaaS, and eventually plans to start adding SaaS. "Nebula will soon be available to a much wider audience," said Curtis. "We have a handful of select beta account users, and we're going to be adding to that list."

Cloud computing helps NASA scale up or down given levels of scientific needs and public interest. Curtis said that "NASA needed really powerful computing for short amounts of time, so Nebula was built to cater to the scientific community." For example, in the days leading up the LCROSS event (the search on the moon for water), they anticipated that there would be a huge spike in traffic - which would require a great deal of computing power - that would then die down, and so require less computing power. Organizations and agencies should think about what kind of needs they are trying to address, and then use the cloud accordingly to meet that need.

Specific cost savings are hard to compute because the project did not exist prior to Nebula. Computational savings vary on a per project basis, depending on how much computing power or storage is needed and for how long. One example is a Nebula project processing high resolution images of the moon and Mars, for use in a worldwide mapping. Data was sent back to Earth from satellites in space, processed, and sent to Microsoft for placement on a 3-D map of the world. Such a project requires very powerful computing.

If the group had not used Nebula, they would have had to procure a lot of new infrastructure in order to have the computing and storage resources powerful enough to handle that amount of information. The procurement process would have involved having to justify their needs for the hardware, shop around, wait for paperwork to go through, wait for approval, and then waiting for the new machines to arrive. Once the machines did arrive, they would have had to hire system administrators, who would then spend 1-2 months configuring the machines for use, and then the machines would not even be used all the time, because they would only be used when new data was coming in. Finally, once the project concluded, the group would have a bunch of hardware just sitting there.

By employing Nebula to take care of the computing and storage, they were able to provision virtual machines and get up and running right away. As Curtis put it, "it was a matter of minutes, versus months." In addition, once the project was complete, the resources in the Nebula cloud can be used by others. Curtis estimates that the group saved four to five months of time having to go through the procurement process, the many man hours involved in that, a month and a half of full-time work for a couple of systems administrators, and the ability for the resources to be used after the project. That, she felt, represented a major cost savings.

Data Storage for the U.S. Air Force 45th Space Wing

The 45th Space Wing is responsible for launching and tracking unmanned space vehicles from Cape Canaveral Air Force Station and employs more than 10,000 workers. The Wing had 60 distinct file servers, but found that it utilized only 10 percent of central processing unit capacity and 60 percent of random access memory space. IT supervisors found that low utilization levels cost hundreds of

thousands of dollars each year so they decided to replace their old file servers with four servers running WMware ESX. The base stores data at two sites (Cape Canaveral and Patrick Air Force Base) and uses an Internet cloud to link the data centers.

Commanders estimate that they save $180,000 per year in computing costs. This includes $104,000 in hardware costs, $30,000 in power to cool what used to be 60 file servers, $28,000 in maintenance costs, and $18,000 in other expenses (ArcServe.com, 2009). In addition, the unit no longer has to devote financial resources each year buying new hardware or deploying new software. There were no estimated personnel savings.

There is a strong argument for the federal government to place a greater emphasis on cloud solutions. Clouds bring convenience, efficiency, and connectability that are vital to government agencies.

The Future of Cloud Computing

To summarize, based on these case studies, there are significant cost savings associated with various cloud computing migrations. Depending on the scope and timing of the migration, reliance on public versus private clouds, the need for privacy and security, the number of file servers before and after migration, the extent of labor savings, and file server storage utilization rates, savings generally average between 25 and 50 percent. Combined with cross-platform accessibility, scalability, and reliability, there is a strong argument for the federal government to place a greater emphasis on cloud solutions. Clouds bring convenience, efficiency, and connectability that are vital to government agencies.

Right now, cloud computing represents a relatively small amount of federal IT spending. In 2008, for example, only $277 million of the federal government's IT budget was devoted to cloud computing (Wyld, 2009, p. 20). This is a tiny fraction of its IT expenditures. However, with the savings associated with the cloud, these numbers should grow rapidly.

Currently, the federal government provides cloud solutions through www.Apps.gov. This site allows agency officials to purchase cloud computing services in the areas of business, productivity, and social media applications. Among the business apps are ones for asset management, business processes, dashboard, data management, geographic information, surveys, and travel. Productivity apps include video conferencing, office tools, project management scheduling, and workflow. Social media possibilities include search tools, blogs, videos, and contests. Most of these fall within the Federal Information Security Management Act certification for "low-risk" solutions.

Since there are few options for "moderate-risk" applications requiring greater security standards, the U.S. General Services Administration has withdrawn its blanket purchase agreement and is drawing up new procurement documents for infrastructure as a service. This will allow the government to take on more sensitive cloud needs from agencies and departments having more advanced security requirements (Hoover, 2010).

A General Services Administration Information Technology initiative is completing a benchmarking study of possible cloud computing savings across the federal government. It is seeking to determine possible economies of scale result from cloud computing. It has devised an ambitious timetable for implementing cloud solutions in the federal government and collecting data on impact and performance. Eventually, the federal government aims to meet "high-risk" security needs for agencies such as the Department of Defense. It plans to roll out these applications for software, platform, and infrastructure needs this year (Lewin, 2009).

The agency has created a federal cloud computing executive group composed of federal executives and chief information officers. It has developed a technical framework for federal cloud computing and issued a data call to federal agencies on cloud-related issues. These types of evaluations should be undertaken regularly so leaders and citizens can understand progress being made. The assessments should include the amount spent on technology, security and privacy protections, and agency adoption and innovation activities.

Privacy and security remain important areas of emphasis in cloud computing (Knode, 2009). Government agencies need to develop safeguards appropriate to the mission of each organization. And Congress should update the Electronic Communications Privacy Act that was written 24 years ago, before the dawn of the Internet and cloud computing. A Digital Due Process coalition backed by Google, Microsoft, AT&T, Salesforce.com, and many non-profit organizations is pushing for legislation on how to strengthen online privacy (Helft, 2010; McCullagh, 2010). With concern over cyber-security threats, there also are pressures to increase security safeguards and maintain secure facilities (Amoroso, 2006). But officials need to be cognizant of the costs and benefits of enhanced security safeguards. Based on this case study analysis, the greater the need for highly secure storage and applications, the higher the cost of the cloud and the less the possible cost savings that may come from cloud migration. Agencies with high security needs generally require that information be stored in secure facilities within the continental United States and operated by individuals with high-level security clearances who have passed background checks.

Another factor that is important to long-term cloud cost savings is the lack of uniformity of national laws across borders (Thibodeau, 2010). Many countries have different rules or norms on cloud computing, privacy, data storage, security processes, and personnel training. It is hard to get the full efficiency of cloud computing when laws are inconsistent or contradictory. Rules on cross-border transactions via the cloud should be clarified and harmonized when possible in order to facilitate innovation, avoid creating a cloud "Tower of Babel", and get the greatest economies of scale from this new technology.

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