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CLOUDS ROLLING IN:

The Forecast Calls for Increased Agility, Stability and Performance as Cloud Computing Comes to State and Local Government

CURRENT CONDITIONS: PARTLY CLOUDY

Clouds, stars and rainbows are not only objects of our fascination with the heavens, but have also come to symbolize our aspirations and our potential to be amazed. The appropriation of clouds to computer science had much more humble origins. The symbol of a cloud was used to represent the Internet on network drawings and schematics — it was shorthand for the complexity of the network and where it fit in the technological ecosystem.

The cloud metaphor stuck, even as what it represented came to be a computing platform. Like its namesake, cloud computing has taken on aspirational qualities. Not surprising for a platform that has come on so strong, cloud computing has attracted devotees and skeptics alike, both of whom are interested to see what this platform can deliver.

Rather than wishing on stars and rainbows, we can take a hard-nosed, business-driven and pragmatic approach to this new infrastructure with the funny name. Clouds deliver. In the physical world, clouds deliver rain with a side of thunder and lightning. In the technological sense, clouds deliver unprecedented levels of agility, flexibility and scalability to computational capacity. That was what Carolyn Lawson, chief information officer (CIO) for the California Public Utilities Commission (CPUC), needed. After successful deployments, discussed later, she says that being a promoter, dreamer or even detractor has nothing to do with making the right decision.

> *"Don't run out and do this just because it's 'cloud,' and don't run out and not do it because it's 'cloud.' If the goals and objectives of your organization lead you to a cloud solution, then go with it. Forget about the label. Where we ended up was with a cloud, but we didn't start there. We also didn't stop ourselves once we realized that was where we were going."*
>
> Carol Lawson, CIO, California
> Public Utilities Commission

My own experience as a state agency CIO taught me both the benefits and real challenges of cloud computing in a government context. As the former director of E-Government and Web Services for the State of Texas, I led the world's largest self-funded e-government project to breakthrough results of 829 new online services, 83 million financial transactions and $5 billion in online revenue. Our services were built in what came to be called the "cloud model" since inception — offered either direct to users over the Internet as Software-as-a-Service (SaaS) or to other agencies via a service-oriented architecture.

Texas E-Filing for Courts was one example of a system that worked particularly well in a cloud model.[1] Back in 2003, after I was appointed by Texas Gov. Rick Perry to serve as chairman of the Technology Committee of the Texas Online Authority, we were setting statewide direction for electronic government. In those days, moving to what we now call "cloud computing" was a tough decision that seemed fraught with risk. On August 26, 2003, after much deliberation, we pulled the trigger on a cloud-architected project to provide a service for the public to file legal documents with any local county court — direct from their desktops to the judge's bench. The XML-based Web service enabled new efficiencies while leveraging existing court investments in content and document management systems.

After hard work and innovative spirit from many concerned people — including the Judicial Committee on Information Technology (JCIT), Office of Court Administration, and the Texas Supreme Court — we made the new model work. Several years and many awards later, the system still powers the Texas civil court system. While each of our cloud projects was unique, they all broke through barriers to become powerful tools for the public. That experience taught me that even though cloud models are new to government, they can work in the public sector if done right.

WHAT CLOUD COMPUTING IS — AND WHAT IT ISN'T

As an architectural approach, cloud computing is really the inevitable result of three key changes in Information Technology (IT):

✓ faster networks that are quickly becoming *location-independent;*

✓ hardware standardization that makes computing resources much more interchangeable; and

✓ a labor force that is more tech-savvy, flexible and geographically distributed.

While the forces that have led to cloud computing are well understood, coming to a precise definition is not quite as easy. Most discussions about cloud computing, especially in government contexts, begin with the same tentative question: "Well, what do you mean when you say 'cloud computing'?" Thanks to the work of a research team lead by Louis Vaquero, we now have a solid answer to that question.

Vaquero and his team are researchers at Telefónica Investigación y Desarrollo (TID), which could be described as Europe's answer to the legendary Bell Laboratories. TID brings together technology researchers from 42 countries and 150 universities to produce one of the more productive sources of Information and Communications Technology (ICT) research on the continent.[2]

Vaquero's team started with 19 different cloud computing definitions, each one proposed by a different leading light of the ICT industry. These 19 different formulations represented
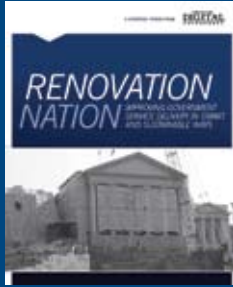
a variety of perspectives and approaches and they did vary to a degree. That said, Vaquero's team found that certain essential elements and common threads could be identified across all of their sources. Vaquero synthesized these core elements to create the following definition:

"Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically re-configured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized Service Level Agreements." [3]

While the definition is outstanding, it is also a bit technical. Let's break it down and get to the core of what cloud computing is all about. Consider this *Cloud Computing 101.*

CLOUD COMPUTING IS...	... WHICH MEANS ...
A Large Pool of Easy-to-Use Resources	Instead of everyone purchasing their own computer hardware and network gear, a virtualized pool of resources is offered.
Flexible Resource Allocation and Re-Configuration	Resource allocation isn't set in stone. The cloud offers flexibility so resources can be dynamically re-allocated as needed.
Pay-per-use	Instead of paying for all the capacity you might ever need, pay for just what you use on a flexible basis.
Contractually-Defined Service Levels	A service level agreement, or SLA for short, is a contract that outlines the quality and cost expectations under which the service is provided.

OPTIONS AND APPROACHES TO CLOUD COMPUTING

While it is possible to provide a clear and concise definition for cloud computing, there is no one-size-fits-all approach to making it a reality. Some early proponents of cloud computing, "cloud purists" for lack of a better term, have proposed an approach to cloud computing that is quite limited. In their "pure cloud" model, all clients would become thin clients, and all services — even including software for the desktop — would be implemented in a public cloud that would be accessed via the public Internet.

Not only does this "pure cloud" approach fail to capture the full scope of the initiative, it is also the fundamentally wrong choice for many organizations. More pragmatic practitioners have expanded the options and approaches to cloud computing to several hybrid models that leverage the best of both worlds: delivering some services via a cloud while still maintaining certain software inside of an existing environment. This model combines software running in a local environment with services hosted in a cloud, termed by some as a "software plus services" model. One size definitely doesn't fit all, and the "pure play" proponents would be wise to consider the value of existing investments in systems, applications and employee skills before driving the discussion to such a limited approach.

We have identified a spectrum of approaches that are intended to be adopted by different organizations to reflect their

FIGURE 1:

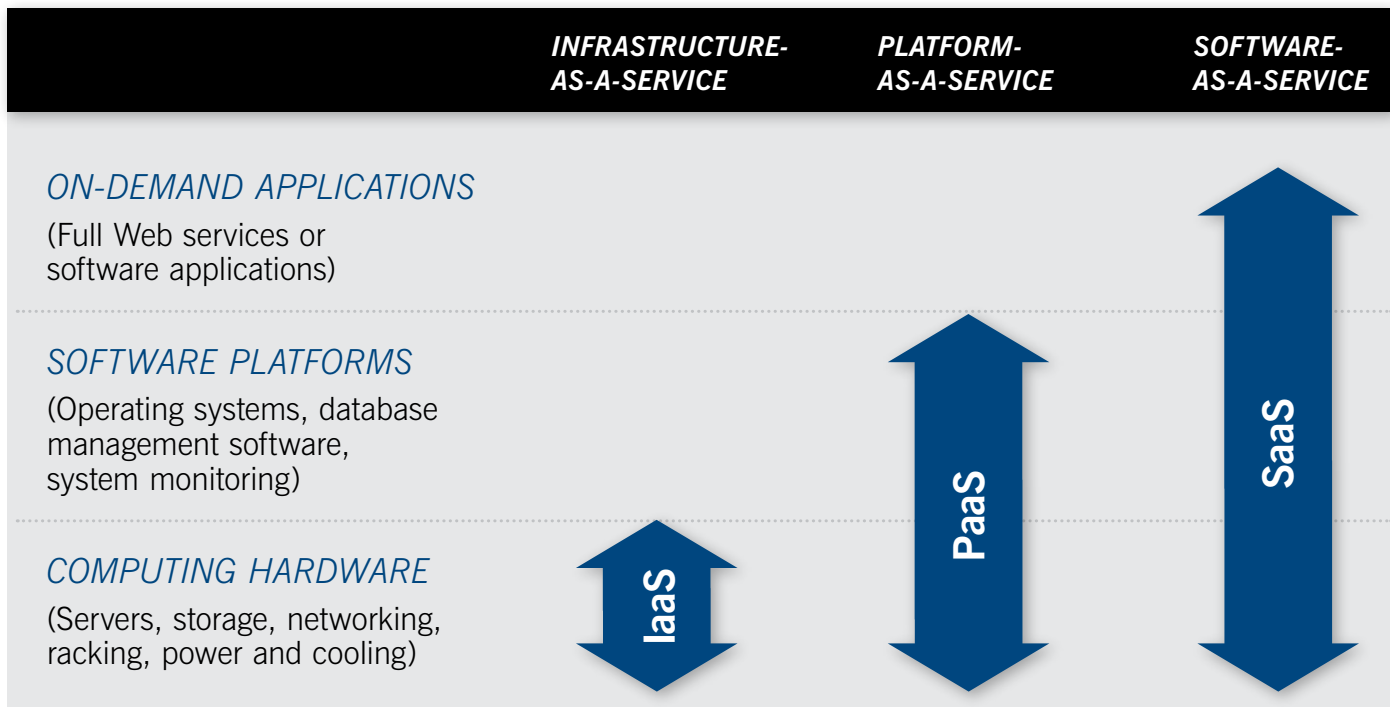### CLOUD COMPUTING OPTIONS

Service Delivery Models

- ✓ Infrastructure-as-a-Service (IaaS)
- ✓ Platform-as-a-Service (PaaS)
- ✓ Software-as-a-Service (SaaS)

Provider Models

- ✓ Private Cloud
- ✓ Community Cloud
- ✓ Public Cloud
- ✓ Hybrid Cloud

FIGURE 2:

	INFRASTRUCTURE-AS-A-SERVICE	PLATFORM-AS-A-SERVICE	SOFTWARE-AS-A-SERVICE

ON-DEMAND APPLICATIONS

(Full Web services or
software applications)

SOFTWARE PLATFORMS

(Operating systems, database
management software,
system monitoring)

COMPUTING HARDWARE

(Servers, storage, networking,
racking, power and cooling)

IaaS   PaaS   SaaS

unique needs and constraints. These different approaches for cloud computing vary on two dimensions: *Service Delivery Model* and *Provider Model* (See Figure 1).

As noted, several different approaches can all fit within the cloud computing environment. Some are exclusively *external*, relying entirely on SaaS and the public Internet, while others are quite *internal* in nature, making use of traditional software running on owned infrastructure. See Figure 2 for what the different *Service Delivery Models* mean.

The service delivery models basically show the variations of how much of the "IT Stack" is being provided by the cloud. The most basic level of cloud service delivery models is Infrastructure-as-a-Service (IaaS), in which cloud provisioning of virtualized hardware is the extent of what is provided. The highest level is SaaS, in which entire applications or services are provided in the cloud in a completely integrated offering.
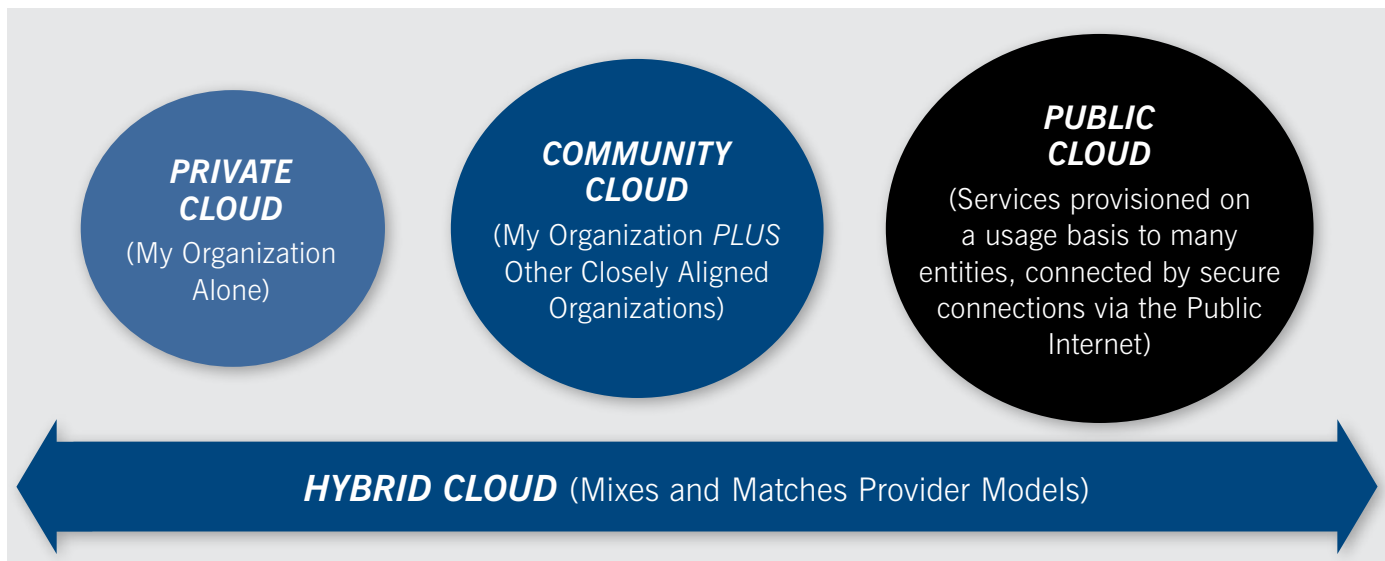
Likewise, there are choices for *Provider Models*, as shown in Figure 3. In this case, there are four choices — private, community, public and hybrid. These options allow flexibility to vary who owns which resources. Provider models depend greatly on the physical location or hardware, and are closely tied to the notion of audience (or users). Like their service delivery counterparts, not all provider models are created equal.

In a Private Cloud, which could be accomplished without any outsourcing, cloud technologies are leveraged inside the data center to deliver traditional software in a more on-demand mechanism. In this model, only one organization uses the cloud, although multiple departments inside that organization might share the cloud to some degree. In a Community Cloud, a small number of allied organizations — perhaps multiple cities or several related state agencies — can share the same cloud. In the Public Cloud model, services are provided in a secure manner to many organizations and typically provisioned via secure connection on the public Internet.

The Hybrid Cloud model deserves special mention, since it's a bit different than the other three. The Hybrid Cloud is less of a new model in itself, and more a statement that one size need not fit all. A given organization can mix and match cloud models, depending on the application. This flexibility is excellent, because it allows an organization to make the right platform decision for each of their systems.

FIGURE 3:

PRIVATE CLOUD
(My Organization Alone)

COMMUNITY CLOUD
(My Organization *PLUS* Other Closely Aligned Organizations)

PUBLIC CLOUD
(Services provisioned on a usage basis to many entities, connected by secure connections via the Public Internet)

HYBRID CLOUD (Mixes and Matches Provider Models)

KEY FACTORS TO CONSIDER WHEN SELECTING A PLATFORM

Choosing the right platform, even in the era of cloud computing, is always a difficult decision. Drawing on the advice of key practitioners, we recommend the following four key questions as you assess your own level of readiness:

Does my data belong in a cloud?	Is the quality of service high enough?
✓ How sensitive or personal is my data? ✓ Who uses my data? ✓ Where does my data come from? ✓ What type of cyber-security do I need?	✓ What service levels do I have now? ✓ What do I need? ✓ Are the cloud providers ready for prime time?
Do my legal rights change in a cloud?	**Is my technical staff "cloud ready"?**
✓ Can I perform all of my legal responsibilities for the Freedom of Information Act, open records and disclosure? ✓ Are legal ownership rights altered?	✓ Do we have the skills on our team to manage a cloud architecture? ✓ Can we acquire any missing skills?

MAPPING CLOUD APPLICABILITY TO SPECIFIC SERVICES

In surveying the literature and emerging best practices, we have identified several applications that are well suited for public-sector cloud applications: e-mail services via a hosted/cloud model; storage — especially of public data; payment processing; identity management; hosting of public-facing citizen services; e-government projects; and collaborative projects that involve multiple agencies. Indeed, collaboration is a key indicator for a cloud application. If many users or many agencies are using the same data and systems, it might just be a perfect candidate for a cloud approach.

CLOUD BENEFITS: SEPARATING HYPE FROM REALITY

Even the most ardent proponents of cloud computing acknowledge that there is a certain degree of hype surrounding it. At this moment, there is a real danger that widespread confusion will be reinforced as the definition of cloud computing is stretched to include everything and nothing.

Despite that reality, technologists would be well advised to remember that positive and negative hype *always* surrounds a new technology in its early days. Even the technologies that have ended up becoming heroically useful — inventions like the telephone, the telegraph, rockets and the personal

computer — had their early proponents and detractors. The presence of hype tells us to *proceed with caution*, but it doesn't tell us to stop proceeding altogether.

Taking the vagaries of the hype cycle into account, it is our position that cloud computing is a concept that maintains its intellectual integrity and shows great promise for real benefits. We can summarize the biggest benefits this way: On the business side, there is the shift of high capital expenditures to lower operating costs, as well as enhanced agility in the marketplace. On the technical side, we see substantially increased stability and performance as key outcomes. The benefits of cloud computing arise from its unique approach to managing IT resources, and they are significantly different than the general benefits of non-cloud infrastructure consolidation.

APPLYING THE CLOUD TO GOVERNMENT AND EDUCATION

The public sector is a unique environment and it poses special challenges for the adoption of cloud computing. It also has certain attractive attributes that make it an ideal place for cloud adoption.

WHAT DATA FITS BEST IN A CLOUD?

One of the most favorable conditions for adoption of cloud computing in government is the sheer volume of public data. Much of our data is truly public in nature; that is, it is owned by the public, contains no sensitive personally identifiable information, and is subject to open records and Freedom of Information Act (FOIA) requests. Of course, some data held by government contains sensitive, personal information, which might be unsuitable for an external cloud environment. Experts across government, education and industry seem to agree on the suitability of a public cloud as a platform for government transparency and data sharing for the truly public, non-personal data sets.

WHAT DATA MAY NOT FIT WELL IN A CLOUD?

Some data may not end up being suitable for cloud computing, or at least for public clouds that are hosted over the public Internet. The following factors were uncovered in our

research as possible causes for concern when considering a public cloud model:
✓ response time for data connections over the Internet may be too slow for some tools;
✓ security and privacy protection may be too low to allow the data outside of the firewall;
✓ some private-sector providers may not be ready to handle the service levels;
✓ service level penalties may not be meaningful enough to drive proper behavior; and
✓ case law and legal frameworks for handling sensitive data have not yet been adjudicated.

All of these factors add up to a general, if not specific, cause for caution. While the cloud may be a fine destination for data from a variety of sources — including even public safety, emergency management and electronic government — it may not fit for all specific data sets.

CASE EXAMPLE: CITY OF CARLSBAD, CALIFORNIA

Gordon Peterson is IT director for the City of Carlsbad, and his shop has been reaping the benefits of cloud computing for more than five years. The city's first venture was a cloud deployment for the city's library catalog and circulation system.

At first, "We owned the application and it lived on our hardware," Peterson said, adding that the city explored a cloud model, and decided it would make sense. "We picked it up and gave it to the vendor. For the past five years, it has lived at their site and we have used it over the Internet."[4]

Peterson reports that the road to cloud computing was not without its challenges. "It had its ramp-up as you wonder, 'Is this easier than it was before?'" Peterson asked tough questions of himself and his team about the new model. "It was really new … but it has gone on to be very successful." Indeed, the library project was so successful that when it came time to migrate e-mail platforms, Peterson and his team looked again to cloud computing. Carlsbad was facing a platform change and they lacked the in-house staff, hardware, software and expertise to implement and support the new system. When they considered the situation, the cloud model made sense.

"We talked to analysts, our users, and sent out an RFP," Peterson said. "We learned that it could be a viable opportunity."

Cloud computing turned out to be more than viable; it was the winning choice. "We got proposals back in dedicated environments, but they didn't make any economic sense." Peterson said. "Only the multi-tenant environments made sense, and the economics were so compelling that we had to try it."

While the cost savings drove the initial decision, Peterson was quick to note that the city didn't sacrifice quality or security in the bargain. "The system runs seven-by-twenty-four, never gets sick, never goes on vacation, and we can't replicate that. Mail is an always-on thing." At 1,000 total users, the city could not feasibly match the service levels and uptime of the cloud solution.

Peterson noted that the project did take some getting used to and involved substantial culture change. "Technical folks are used to resolving problems by themselves and having direct control, so this is a bit of a culture change."

Bob Fries, who serves as IT manager for Enterprise Systems Group at the City of Carlsbad, agreed.

"In a shared environment, you lose some control and functionality, but you gain tremendously in terms of cost," Fries said. "Now we can spend more time on innovation and creating value than on the *keeping-the-lights-on* commodity stuff. Yes, we *could* host our own email server, but should we?" Fries concluded the thought with an insightful question: "Or should we be doing some other thing that really impacts the city?"

Another key note from the Carlsbad experience was security. Many people think that security must be relaxed to move into the cloud environment. Peterson isn't one of them.

"We asked, 'Will they take care of it like we do?'" Peterson said. "It took lots of conversation and digging into the service provider to get comfortable that they could do as well, or better than we could."

Ultimately, the cloud computing solution met or exceeded Peterson's criteria for security. "It's a comfort zone issue, but in the security game, sometimes these bigger shops can actually do it better in ways that a small shop couldn't do."

CASE EXAMPLE: CALIFORNIA PUBLIC UTILITIES COMMISSION

The CPUC's Lawson recently completed two cloud-based technology projects in her own shop. Having real experience with the issue, Lawson is hard to peg as either a proponent or a detractor of cloud computing. Instead, she presents herself as a practically-minded CIO using the right tool for the job.

"I would tell CIOs, don't run out and do this just because it's 'cloud,' and don't run out and *not do it* because it's 'cloud,'" she said. "If the goals and objectives of your organization lead you to a cloud solution, then go with it. Forget about the label, and that is what we did in our project. Where we ended up was with a cloud, but we didn't start there. We also didn't stop ourselves once we realized that was where we were going."[5]

The first of Lawson's cloud computing projects is called Open Campus, which provides a robust, portable mobile desktop computing environment to agency staff regard-

Looking Skyward: Examples of Cloud Computing in Government

Renovation Nation, the recently-released thought leadership white paper authored by Dr. Paul Taylor, includes a great list of examples of governments that are moving to the cloud:[6]

Arizona: centrally managed SaaS utility lets agencies 'XML enable' their legacy applications	**California :** SaaS model for claim processing in the state's Medi-Cal program
Utah: SaaS-provided search, collaboration, data sharing, and rich-media tools	**Michigan:** SaaS-costing alternatives in every major request for proposal (RFP)
Kentucky: large-scale production-level use of SaaS in a new online employment system	**New Jersey:** SaaS solution for customer relationship management and reporting

less of their location or specific device. In Lawson's words, "Open Campus is a new way of working at the Commission. Built on an internal cloud, Open Campus provides users with a single way of accessing computing resources regardless of their location — work, home, cafeteria, Starbucks or the train."

A cloud platform wasn't the only possible option available, but she was ultimately certain it was the right one. "The user experience is provided through SaaS — Software as a Service — and data storage is in the internal cloud using what we call 'extreme wireless' as the foundation."

It seems that four main factors led Lawson to the identification of a cloud solution:

✓ It was a stable platform for geographic failover;
✓ cost pressure driving innovation;
✓ advice from her technical staff; and
✓ a strong desire to provide leadership for innovation.

"In my view," Lawson said, "you are either leading innovation or leading entrenchment. You are doing one or the other, just by virtue of the position you are in as the CIO."

## ASSESSING THE READINESS OF PRIVATE-SECTOR PARTNERS

Unfortunately, not all cloud-based services are created equal. Not all are even ready for prime time, if examples and testimony from the private sector are any indication. Some services have been plagued by outages, service level agreement deficiencies and other unforeseen problems. Cheaper may not always be better. As Lawson notes, "No amount of money will save you when the Governor's e-mail doesn't work."

Before you choose a private partner, ask yourself the tough questions.

✓ Have they done this before?
✓ How long and strong is their track record?
✓ Can you measure actual performance against service levels beforehand — even before a contract is awarded?
✓ What is the customer service process?
✓ Will your organization be given a dedicated team to respond to critical outages, or will you call a generic help desk?

✓ Does the organization understand the unique challenges of government?
✓ Are the contractual penalties for failing to attain service levels sufficiently serious?

These questions and more are critical to making sure that your cloud project goes smoothly and achieves the benefits advertised.
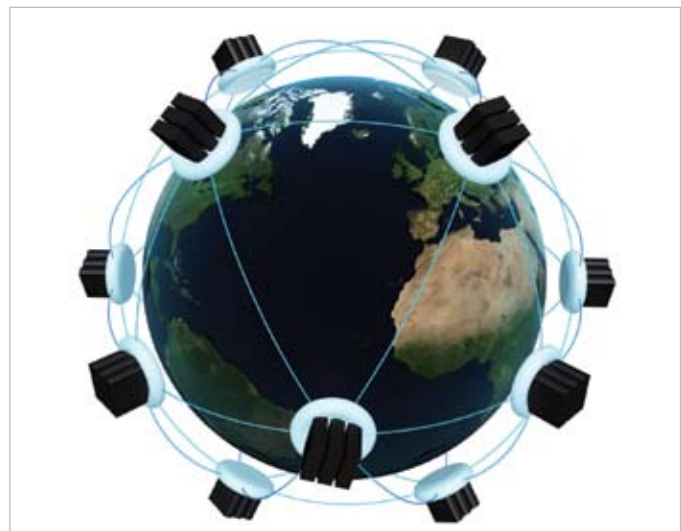
Emerging Private-Sector Cloud Providers

Doing cloud computing doesn't mean that you have to build your own cloud. An emerging cadre of private firms is developing enterprise-class cloud platforms that are powering applications in many commercial settings. They are beginning to gain a foothold in government as well. Ones to watch:

Amazon Elastic Compute Cloud (EC2), Amazon S3 (storage), and their Web payment services

Google Application Engine (GAE) platform for building and hosting Web services

Microsoft Azure Services Platform to blend cloud services with on-premise software

ROADMAP AND NEXT STEPS FOR ADOPTION

Government can certainly take steps now, and indeed is already taking steps in this direction. The great benefits of lower costs, increased operational agility, better stability and higher performance are too important to be ignored. We recommend that organizations chart their own cloud computing roadmap around these key steps:

ASSESS SUITABILITY FOR YOUR GOALS

ASSESS INTERNAL CAPABILITIES

CHOOSE A CLOUD APPROACH

ASSESS PARTNER CAPABILITIES

IMPLEMENT SOLUTIONS

CONCLUSION: GOVERNMENT TAKES FLIGHT

Innovation is hard work, and we will likely not know the final answer to the questions above for several years. But what we do know is this: Cloud computing promises extraordinary benefits in terms of cost, agility, stability and performance. We also know that leading government practitioners have embraced this technology shift in their projects and they are already beginning to realize the benefits. In fact, some government organizations may be using cloud computing in the form of SaaS without even knowing it. Government may host public data on a public cloud, deliver services via an internally hosted PaaS model or employ any number of variations on the cloud model. In any case, the future of cloud computing in government looks especially bright.

END NOTES

[1] http://www.dir.state.tx.us/txoa/Meetings/2003/082603 _ minutes.htm

[2] http://www.tid.es

[3] A Break in the Clouds: Toward a Cloud Definition by Luis M. Vaquero, Luis Rodero-Merino, Juan Caceres, Maik Lindner, ACM SIGCOMM Computer Communication Review, Volume 39, Issue 1, January 2009.

[4] Interview with Gordon Peterson and Bob Fries, City of Carlsbad, California, June 17, 2009.

[5] Interview with Carolyn Lawson, CIO for the California Public Utilities Commission, May 23, 2009.

[6] Courtesy of Dr. Paul Taylor, Chief Strategy Officer for the Center for Digital Government, and author of *Renovation Nation. This thought-leadership white paper can be downloaded at http://www.govtech.com/renovationnation*

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Microsoft is also contributing tangible benefits to the cause of open government data with the recently released Microsoft Open Government Data Initiative (OGDI). OGDI is an **open source** starter kit developed by Microsoft to help government agencies publish data that can be queried by using open web programming interfaces (API's). Data housed in OGDI services can be accessed from a variety of client technologies such as Silverlight, Flash, JavaScript, PHP, Python, Ruby, mapping web sites, and more. OGDI enables government, business and "citizen developers" to develop real applications using government data regardless of skill set. Information about the initiative can be found here: **http://www.opengovdi.com**

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ACKNOWLEDGEMENTS:

John Miri is a Senior Fellow at the Center for Digital Government.

After a successful career as a private-sector software executive, John Miri was appointed by the Texas Governor to the top regulatory board overseeing statewide electronic government. He went on to lead transformational projects for two successive Texas State chief technology officers and has become an advisor and confidant to leading state, local and education CIOs around the nation. As the past director of E-Government and Web Services for the State of Texas, Miri led the TexasOnline.com program to breakthrough results of 829 online services, 83 million citizen financial transactions and $5 billion in online revenue. Prior, he helped found three Web-based technology companies that leveraged a cloud model to achieve dramatic results for clients in the commercial markets. Miri has been a passionate advocate of Internet-based service computing and the cloud model for more than a decade.

With the assistance of **Dr. Paul Taylor**, Chief Strategy Officer, Center for Digital Government.