Information Technology & Telecommunications

DEPARTMENT OF INFORMATION TECHNOLOGY AND TELECOMMUNICATIONS TESTIMONY BEFORE THE CITY COUNCIL COMMITTEE ON TECHNOLOGY

OVERSIGHT HEARING: BENEFITS AND DISADVANTAGES OF CLOUD-COMPUTING SYSTEMS

TUESDAY, DECEMBER 15, 2020

Good afternoon, Chair Holden and members of the Committee on Technology. My name is Jessica Tisch, and I am the Commissioner of the New York City Department of Information Technology and Telecommunications (DoITT) and the Citywide Chief Information Officer. I am joined today by Yosef Lehrman, DoITT's Deputy Commissioner for Information Security & Chief Information Security Officer and Steven Bezman, DoITT's Deputy Commissioner for Applications.

I am pleased to join you at today's oversight hearing on cloud-computing systems, and to discuss pre-considered legislation that would require DoITT to conduct an assessment and report on the feasibility of transferring city agencies' electronic data to the cloud.

The City has been leveraging cloud solutions for nearly a decade. The City also has a fairly robust Citywide Policy on Cloud that all agencies are subject to.

The agencies have hundreds if not thousands of applications running in the cloud. As part of the City's COVID-19 response efforts, for example, we built dozens of applications, and every single one ran in the cloud. In fact, I'd be hard pressed to come up with a new application that we are developing that isn't run in the cloud beyond the City's 911 system.

As security goes, there are different flavors of cloud solutions, and different levers on the tech and policy side that can be pulled. For example, FEDRAMP, GovCloud, encryption (in transit and at rest), encryption keys, etc. Point is, it's a mistake to paint the security implications of cloud use with a broad brush. Some solutions are quite secure; and others quite insecure. Same is true for data privacy.

Per the City's policy, each cloud solution and its associated security and data privacy controls must align with the type of data it is collecting. For example, is it collecting HIPAA data? Personally identifiable information (PII), or is it just a survey with no personally identifiable information?

I will now turn to the legislation we are considering today. This proposed pre-considered legislation would require DoITT to conduct an assessment of the feasibility of transferring city agencies' electronic data to the cloud computing systems. The Department would also be required to submit a report of the results of the assessment to the Council.

While we appreciate and share the Council's interest in cloud-based storage, because the City's use of the cloud is well under way, conducting a feasibility study would not be an efficient or productive use of City resources. I am looking forward to hearing more from the Council today on your goals for this bill and to continue discussing this piece of legislation.

Thank you for the opportunity to give testimony on the proposal. With that, I am happy to take any questions.

Written Testimony of Omid Ghaffari-Tabrizi
Director of Cloud Policy
Internet Association

Before the New York City Council
Committee on Technology
Hearing On A Local Law In Relation To An Assessment Of The Feasibility Of Storing City Agencies' Electronic Data On Cloud Computing Systems
December 15, 2020

Thank you to Chairman Holden, the Honorable members of the Committee on Technology, and the IT support staff of the New York City Council for allowing me to participate in this hearing via a cloud-based video conference tool.

My name is Omid Ghaffari-Tabrizi, and I am Internet Association's Director of Cloud Policy. IA represents over 40 of the world's leading internet companies and supports policies that promote and enable a free and open internet. Our companies are also global leaders in the drive to develop lower cost, more secure, scalable, elastic, efficient, resilient, and innovative cloud services for users and customers in the private and public sectors. In fact, all the major U.S.-based hyperscale cloud computing service providers are IA members.

Commercial cloud adoption is a necessary component of any modernization effort. It provides enhanced security, it helps reduce procurement costs, and it helps improve the effectiveness - and most importantly, morale - of the workforce.

IA members know this because, in their collective experience with governments of all sizes, they have been responsible for maintaining and securing data of all types and levels of sensitivity, from publicly available data sets to the most sensitive national security intelligence artifacts. All of our members invest a tremendous amount of energy, effort, and expense in security and compliance. Adopting commercial cloud-based computing would allow the City to take advantage of this investment for themselves.

Most relevant to the City is the way in which commercial cloud-based computing service providers have invested in physical and cyber security. In terms of physical security, the buildings where our members have the computing devices they use to store public sector data are, if you will allow the expression, more secure than Fort Knox.

IA members have data centers that use the most advanced biometric technology simply to grant entry into a facility, and this is only after passing some of the most rigorous of background checks. For those moments outside of the control of people, these data centers are also designed to withstand the most severe weather and most intense natural disasters.

If you were to be able to enter into one of these data centers and "see under the hood" at how the computers themselves operate, you would find tools using emerging technologies, such as artificial intelligence and machine learning, to provide both offensive and defensive cyber security resilience. Spotting abnormalities in network activity or providing the ability to immediately load backups should the worst occur will ensure that users of cloud computing services will experience uninterrupted delivery of essential services.

Confidentiality, integrity, and availability of data is what makes for a secure cloud and is one of the key benefits of commercial cloud service providers.

One of the other benefits of commercial cloud computing is that it enables on-demand access to shared computing resources. As I alluded to at the very beginning when I pointed out the fact that my participation in this hearing is made possible as a result of a cloud-based video conferencing tool, we are using an application that uses only the computing resources necessary to support the audience present.

If we were using a video conferencing tool that was hosted on city-owned computing devices, the number of computers that the City would have to own and maintain would have to be equal to the number necessary to support the maximum number of participants the City expects. This means every single Committee hearing where no one shows up would cost the City just as much as a hearing where 10,000 people show up, because that is the maximum number of participants the city-owned data center in our example was designed to support.

Expanding on that idea, everyone knows that certain City services will always experience ebbs and flows. Schools.NYC.gov, for example, will require a lot more computing power to support parents, students, and teachers looking for information when schools reopen rather than in the middle of the summer. If the Department of Education hosts applications on City-owned computing devices, the programs using those applications will have to find a budget to pay for their upkeep year round, whether there are thousands of visitors or just one.

Using commercial cloud-based solutions, on the other hand, would allow the City to adopt a "pay-as-you-go" form of IT budgeting, ensuring that the only computing services being paid for and maintained are those the City is actually using.

Another benefit of using consumption-based cloud computing services is that it allows City employees and the contractors who work with them to quickly develop a proof of concept or prototype for internal and public-facing applications, and when they are found to be successful, quickly scale them for use. By providing access to advanced capabilities that are constantly being updated or rolled out by commercial cloud service providers, paper-based forms and processes can be converted to digital ones - and the data collected can be used to make better decisions.

For example, an employee can quickly deploy a robotic process automation (RPA) bot using no code or low code tools - meaning they simply write out instructions, with no need for programming knowledge - to process applications for benefits. If an application for housing in a homeless shelter during the winter months or one for legal assistance in the event of an eviction is currently paper-based or dependent on applications running on antiquated hardware, there is a very real chance that additional services that would benefit this particular resident could be missed, simply because people throughout the chain

were unaware that person qualified. This is a situation that never has to happen again if cloud-based data-driven decision making is enabled.

Even further to that point, a team operating one of the more heavily trafficked call centers can take all the questions and answers they share on a regular basis, and load them into an AI-enabled chat bot that will allow for mobile-friendly delivery of personalized customer service at any hour of the day, any day of the week. There are some state and federal agencies which host their services on government-owned hardware, and as a result, they are unable to provide you with even basic information, such as your tax balance or appointment time, earlier than 6 a.m. on a weekday. This is because they need to ensure that support staff are available in the event of an outage or other technical issue.

Simply put, commercial cloud computing allows City officials and employees to focus less on upgrading and maintaining infrastructure and more on their efforts to deliver the critical services they provide.

We hope that the Committee will consider the examples shared today and recognize that the proposed amendments we have provided along with this testimony are designed to provide you, DoITT, the taxpayers, and all other stakeholders in this process with the objectively verifiable information they need to recognize the very real cost and performance benefits that the City, its employees, and most importantly, the users of the City's services, will see through the adoption of cloud computing services.

Thank you again for your time, and I look forward to following up with you as this bill progresses.

Int. No.

By Council Members Torres and Vallone

A Local Law in relation to an assessment of the feasibility of storing city agencies' electronic data on cloud computing systems

Be it enacted by the Council as follows:

Section 1. Assessment of the feasibility of storing city agencies' electronic data on cloud computing systems.

a. Definitions. For the purposes of this section, ~~the term~~ the following terms are defined as follows:

"cloud computing service" means a service that enables on-demand self-service network access to a shared pool of configurable computer resources to provide user-based productivity applications, including, but not limited to, data storage, analytics, electronic commerce, streaming services, mobile services, electronic mail, and document sharing and editing, which can be rapidly provided and released with minimal management effort or cloud computing service provider interaction.

"department" means the department of information technology and telecommunications.

b. The department shall conduct an assessment to determine the feasibility of storing city agency electronic data at rest on cloud computing systems, rather than on physical data storage systems owned by the city.

c. No later than September 1, 2021, the department shall submit to the speaker of the council a report of the results of the assessment conducted pursuant to subdivision b of this section. Such report shall include, but not be limited to, the following:

1. an establishment of data classification categories for use with cloud computing services, including an inventory of the various data types;

2. an analysis of the feasibility and security of storing data from each data classification category on the cloud, including the legal implications, if any, as well as the potential benefits associated with applying the use of emerging technologies available through commercial cloud computing service providers to data integrity, data quality, and data security;

3. an analysis of the feasibility of transitioning legacy systems to utilize the cloud and the potential cost and performance benefits associated with developing cloud-native applications;

4. an analysis of any implications related to current software licenses and the potential cost and technical benefits that would be associated with adopting a consumption-based service model for cloud computing services;

5. an estimate of the costs, per unit of data, of storing, retrieving, and removing data from the average cloud computing system;

6. potential cost differentials, in both personal services and other than personal services costs, between physical data storage and cloud storage, as well as an analysis of the cost savings associated with the use of commercial cloud computing services to minimize, if not eliminate, duplicative services;

7. a brief analysis of the prospective cloud computing service providers, including a description of their physical principal places of business and other public sector customers they serve; and

8. recommendations on the requirements that a prospective cloud computing service provider should meet, such as on the physical data center location, the physical security of the data center, the deployment model of the cloud computing system, the disaster recovery strategy,

the mechanics of reporting a security breach, the data duplication process utilized, the level of encryption utilized, the financial stability of the provider, the auto-deletion options, suggested auditing protocols, and any terms that a contract with a cloud computing service provider should include, such as an indemnification clause, along with examples of other governments or industry bodies that use the requirements or clauses being recommended.

§ 2. This local law takes effect immediately.

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Testimony Before the NYC Council
Committee on Technology
December 15, 2020

Good Afternoon Chair Holden and Members of the Committee,

I am Ryan Naples, Deputy Director at Tech:NYC, an advocacy group for NYC's tech community representing more than 800 companies and organizations, including small tech start-ups, publicly traded companies like Etsy, Google, and Salesforce, and coding academies expanding access to computer science education in NYC.

COVID-19 has impacted New York in profound ways and it will take years for the city to fully recover. The city has a $4 billion budget deficit for next year; meanwhile, city services are now a matter of life and death for everyday New Yorkers.

Better technology infrastructure would save the city money, improve agency operations online, and secure data. This is ultimately why increasing usage of cloud computing is more important now than ever. Put simply, New York City government systems can be smarter, faster, more flexible, and cost less money by transferring data and technology needs to the cloud.

Cloud computing is a new name for an old concept: the delivery of computing services from a remote location, analogous to the way electricity, water, and other utilities are provided to most customers. In some ways, cloud computing is reminiscent of computing before the advent of the personal computer, where users shared the power of an off-site central mainframe computer through video terminals or other devices. Cloud computing, however, is much more powerful, flexible, and secure, and IT advances permit the approach to become ubiquitous.

The specific advantages of cloud computing are many. First, cloud technology is designed in such a way that the city would only pay when it consumes computing resources and thus no longer will have to guess the computing capacity it needs. Second, cloud services deliver scalability with agility. The city could access as much or as little capacity as needed, and scale up and down as required with only a few minutes' notice. Plus, in the cloud computing environment, additional IT resources are available within minutes, not weeks. Computing capacity also exists without needing physical space while on-site legacy servers need a climate-controlled city office all to themselves. The rent for this space could be better used.

New York City has actually already benefited from cloud technology and it has helped improve the safety of New Yorkers by enhancing transportation infrastructure. The Department of

Transportation built Vision Zero View and iRide NYC applications on the cloud, using crowdsourcing to collect safety data that can be used to redesign streets and traffic patterns with the goal of reducing traffic fatalities to zero.

Alternatively though, this spring the state experienced the consequences of not using the cloud when New York's Unemployment Insurance system failed to meet constituent demand. The UI system's antiquated, legacy infrastructure could not handle an unprecedented influx of claims until they leveraged cloud technology to rapidly scale and process claims at 6 times the rate and volume of after the 2008 financial crisis.

Most importantly, the cloud is also more secure than on-premise, legacy servers because cloud providers have made — and continue to make — significant investments to ensure data protection. Many cloud services have newer security features built in and better resiliency that make security architecture changes much easier. Also, leading tech companies are able to attract and retain top-tier talent to protect against real-time threats. Physical separation between servers and government offices would also lead to fewer cyber vulnerabilities. Because on-premises servers are usually located within or close to city agencies themselves, these IT network spaces are at high risk of physical access by unauthorized users.

Importantly, this superior technology would cost less than the legacy servers city government have built and continue to maintain. By using cloud computing, the city would incur a lower variable cost for cloud conversion than it would for simply repairing, upgrading, and maintaining its own legacy servers. Our members who provide cloud services report a 31% average infrastructure cost savings to their customers compared to physical on-premises servers as well as 62% more efficient IT infrastructure management. The numbers make sense for the city, especially right now.

As mentioned above, we recognize that cloud technology has been adopted in a few instances by New York, just not in a large and impactful way. In a city the size of NYC, any change is not an easy task. It is for these reasons that Tech:NYC strongly supports Councilmember Vallone's bill being discussed today, which would require an assessment of the feasibility of transferring city agencies' data to cloud computing systems.

Regardless of a feasibility study, the city's technological systems are years behind the everyday experiences of individual New Yorkers. Putting COVID aside, the world has changed a great deal in the last 5-10 years, but city government has missed the move to the cloud. On our smartphones, we use apps to accomplish a variety of tasks, from paying a bill to ordering takeout to hailing a taxi. This means we all use the cloud because these apps are only made possible by internet-based cloud computing. By using information technology services securely

delivered over the internet from the data centers of leading tech companies, cloud computing lets developers build dynamic systems that make life easier for millions of New Yorkers.

Thanks to the explosive growth and the advancement of new technologies for the storage, security and use of information in the cloud, we have an opportunity to make huge strides in how the city provides data storage and constituent services. If multiple agencies adopt the cloud to increase efficiency, the city can provide new and better services for all New Yorkers during this time of great need.

Without question, COVID has devastated our city but we will come back. When we do, city government needs to be just as smart as everyday New Yorkers and embrace what's new and what's working. It's time city government stops merely looking to the clouds and starts using them to help save money and manage city operations.

Testimony of Tom Speaker to the New York City Council Technology Committee on Proposed Cloud Computing Legislation (Vallone)

December 15, 2020

Thank you for the opportunity to submit written testimony on this proposed legislation.

This bill would require the Department of Information Technology and Telecommunications (DOITT) to assess the feasibility of storing city electronic data on cloud computing systems. After conducting its assessment, DOITT would have to submit a report to the Speaker of the City Council on the agency's findings, including but not limited to analyses of the transition's impact on software licenses, estimates of costs, recommendations on the standards that a cloud computing system provider must meet, and more.

Reinvent Albany welcomes City Council oversight on this topic and appreciates Councilmember Vallone's efforts to ensure that New York City's technology remains up to date. However, we do not believe the legislation is required at this time. In 2016, DOITT published New York City's official cloud services Policy, a document that already addresses many of the issues raised in the bill. Broadly, we believe the executive branch should have the discretion and flexibility to determine what kinds of digital storage to purchase. We note that the cost of cloud computing storage has been plummeting and that there are many types of cloud computing, including virtual clouds hosted on City or state servers and digital storage leased from commercial vendors like AWS, Microsoft or IBM – among others.

Therefore we request that the Council reconsider the need for this bill at this time.

Thank you for the opportunity to testify. If you have any questions, please reach out to Tom Speaker at tom [at] reinventalbany.org.

New York City Council Committee on Technology

Salesforce Cloud Computing Testimony

December 15, 2020

About Salesforce

Salesforce is a global leader in cloud enterprise software for customer relationship management (CRM), providing software-as-a-service ("SaaS") and platform-as-a-service ("PaaS") offerings to businesses. Founded in 1999, Salesforce provides business-focused software to businesses, governments and other organizations around the world. We operate in the business-to-business (B2B) environment, and our customers represent companies of all sizes and across all sectors. Our business model is subscription-based, allowing for faster deployment of technologies and greater agility. We help our customers connect with their customers — or employees or citizens — in a whole new way using cloud, social and mobile technologies.

Salesforce is committed to a set of core values — trust, customer success, innovation, and equality. Since we were founded, we have pioneered the 1-1-1 philanthropic model and each year we commit to giving 1% of our employee time, 1% of our product and 1% of our equity back to communities around the world.

Salesforce in NYC

New York has been core to Salesforce's growth, with a physical presence since 2006. Today, we have more than 1,500 employees in Salesforce Tower New York located at 1095 Avenue of the Americas right at the foot of Bryant Park. In 2019, we opened the most sought after space in the building, the top floor known as our Ohana Floor. Core to our values of giving back to the communities in which we live and work, we took an innovative approach to this one-of-a-kind floor with jaw dropping views of all of NYC. During the day, the space is open to employees and their guests to enjoy. On weeknights and weekends, we provide the Ohana Floor free of charge to nonprofits to host charitable fundraisers, receptions, and special events that have a focus on humanitarian, social, education, or environmental causes. While our offices, including the Ohana Floor, are currently closed, we are looking forward to returning to our offices and resuming Ohana Floor events when it is safe to do so.

We have also adopted four public schools in the New York City area: Brooklyn Collaborative, PS 277, PS 51, and Dual Language Middle School utilizing our Circle the Schools model, where we develop relationships with principals and faculty to level the playing field so that students from underrepresented areas can fulfill their greatest potential accessing the resources and expertise they deserve. Each school is matched with a Salesforce executive sponsor and a team of employees who participate in volunteer activities throughout the year. We give every employee 56 hours of Volunteer Time Off each year, and last year our New York City employees volunteered over 35,000 hours in their communities.

Cloud Computing and Government Services

Salesforce operates a subscription-based business model, serving customers through what is known as “multi-tenant” application architecture, designed for security, efficiency, availability, and rapid innovation. Our security team provides each Salesforce customer with the default security, out-of-the-box tools and educational resources necessary to protect their data. A multi-tenant application is one that can be accessed and used by many users simultaneously, with logical separation of data in hardware and software. The logical separation of data is designed to allow each Salesforce customer to view only their “instance” of Salesforce’s services and their associated data.

Salesforce’s multi-tenant architecture is analogous to that used to provide online banking and brokerage services (which can also be accessed and used by thousands of users simultaneously through the logical – not physical – separation of data). With purpose-built industry functionality and all the capabilities of the Salesforce platform, government agencies can increase employee productivity, accelerate time to value, and deepen citizen trust with data-based decisions with every interaction.

Cloud Computing: Privacy & Security

At Salesforce, trust is our number one value. The protection of our customers’ data is paramount, and we safeguard that data with a robust and comprehensive privacy and security program. To that end, we have undertaken significant efforts towards developing a privacy program that accounts for the ever-evolving landscape of global data protection laws. For example, Salesforce was among the first software companies to achieve approval for our Processor Binding Corporate Rules in November 2015. In addition, we are committed to numerous best in class security certifications, such as ISO 27001, 27017, and 27018, among many others.

Salesforce is committed to providing the most secure, compliant enterprise cloud on the market. Security is an integral part of our DNA, and we stake our reputation on ensuring the safety and accessibility of our customers’ and partners’ valuable data.

Salesforce has implemented technical and administrative security measures designed to protect our services and customer data. Salesforce’s technical security measures include protections against system vulnerabilities, logical separation of customer data, robust network security, encryption of data in transmission, and options for encryption of data at rest. Salesforce’s administrative security measures include limiting access to customer data to those personnel who require such access to perform their current job functions, comprehensive security policies regarding the handling of customer data, and robust security training and awareness programs. Salesforce offers its customers controllable features that permit them to configure the security settings of their respective instances of Salesforce as they deem appropriate for the sensitivity of their customer data.

We build security into everything we do, so that our customers know that their data is theirs — to be accessed when, where and how they intend.

Our government customers use our products to work with some of their most sensitive data and we have undertaken significant steps to develop a comprehensive data protection and security program built on five principles that highlight our commitment and focus on trust: customer control, security, transparency, compliance, and partnership.

Serving Citizens More Effectively

Digital transformation promotes innovation, better service quality, and operational resilience. We believe responsible cloud outsourcing presents a valuable opportunity to deliver better outcomes for citizens in an all-digital, work-from-anywhere environment. The necessity for this has been amplified by the requirements for work continuity throughout the COVID-19 pandemic.

With Salesforce, you can rapidly transform the way you deliver government services through capabilities, solutions, and products that flex and scale to meet every need.

- Implement immediately and see time to value and mission impact in days, not years
- Get a significant return on investment, with research showing 169%* of total economic impact for case management solutions
- Deliver an improved level of service to create satisfaction and build trust in government
- Innovate to give employees the power of the latest applications, tools, insights, and capabilities

With Salesforce, you can implement mission-ready technology with innovative cloud products created for government. Salesforce's industry-leading multi-tenant platform as a service (PaaS) and software as a service (SaaS) offerings were designed to solve every need in the public sector with full regulatory compliance and robust security.

For more information on our work with state and local governments, please visit our Salesforce for Government website.

** Source: A 2020 commissioned study conducted by Forrester Consulting on behalf of Salesforce.*

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Statement of

Matthew T. Cornelius

Executive Director of the Alliance for Digital Innovation

Before the New York City Council
Committee on Technology
Hearing On A Local Law In Relation To An Assessment Of The Feasibility Of Storing City Agencies' Electronic Data On Cloud Computing Systems

December 7, 2020

Introduction

Chairman Holden and Distinguished Members of the Committee, thank you for the opportunity to testify today on the benefits of cloud computing and how the New York City Council can leverage cloud and other emerging technologies to dramatically, and securely, modernize legacy systems and better deliver vital services and benefits to your constituents.

My name is Matthew Cornelius and I am the Executive Director of the Alliance for Digital Innovation (ADI). We are a non-profit organization, made up of over two dozen of America's most innovative commercial technology companies, which focuses on empowering public sector agencies at all levels of government to better deliver the effective digital experiences that citizens deserve and which taxpayers demand. We believe that the continuing reliance on outdated, insecure legacy technology fundamentally obstructs the creation of a modern, secure digital government. This hearing is a great opportunity to spotlight this important issue and discuss the opportunities that cloud computing and other new technologies can unleash for the city of New York. Below I will share our perspective on both the IT challenges and opportunities public sector agencies face, and will offer some recommendations to improve the speed, scale, and likelihood of success in modernizing the City's legacy technology.

Benefits of Cloud Computing

For starters, cloud-based technologies have a number of unique characteristics that can benefit the City of New York, including:

- The ability to buy and leverage IT resources immediately and virtually without limitation;

- A business model that enables "just in time" IT deployments, allowing government agencies to consume IT on an "as needed" basis without having to invest the enormous capital resources necessary to support surge-driven requirements;
- Enhanced security and privacy, especially regarding the confidentiality, integrity, and availability of public data sets, and
- Enabling a raft of new capabilities (such as artificial intelligence, DevOps, and agile development) that will streamline and modernize large IT development projects.

Up until February of this year, these points – incredibly valid in their own right – were too often just hypotheticals to even the most insightful, forward-leaning public sector leaders. However, the past 10 months of dealing with the COVID-19 pandemic has forced government agencies – at the Federal, state, and local levels – to accelerate their modernization efforts through the embrace of commercial cloud and other emerging technologies to keep schools functioning, to keep citizens informed, to deliver vital government services and benefits in a new digital-first format, and to ensure the continuity of agency operations during a time of maximum remote telework. Even today, our conversation is made possible by commercial video-conferencing equipment, without which this hearing – and so many other necessary functions of New York City – would be severely truncated or aborted.

Other less dramatic, but equally important, changes in government operations have led cities, states, and even entire Federal departments, to leverage cloud computing to meet their mission. For instance, tightening budgets and cost pressures have pushed numerous agencies to overhaul the antiquated mindset that an organization must own and secure its own data center infrastructure. The pace of innovation in the commercial market – where citizens can handle most of their day-to-day needs from their mobile phone – has led them to demand the same quality and ease of service from

government programs. And, the ever-evolving threats to public sector agency IT systems have encouraged government leaders to partner with commercial cloud companies and rely upon the enormous investments in security these firms must make to ensure their customers' data and information is appropriately protected from malicious actors.

For these reasons, and so many more, there is both a common sense – and a dollars and cents – mandate for government agencies to accelerate their adoption of cloud computing and the other emerging technologies, such as advanced data analytics, artificial intelligence, and machine learning, that the cloud makes possible.

The Committee's Legislation

ADI commends the Committee on Technology for introducing and considering the Local Law in relation to an assessment of the feasibility of storing city agencies' electronic data on cloud computing systems. To help improve the scope and impact of the assessment, we encourage the Committee to ensure the study to include some additional items to those already well articulated in the draft bill:

- The potential costs and benefits, including on the city's budget planning and execution, of adopting cloud's unique "consumption-based" pricing model;
- The potential benefits for interagency collaboration, including secure data sharing and program management, among city agencies;
- The potential benefits of accelerating speed-to-market and defined service levels, enabling the Department of Information Technology and Telecommunications to dynamically scale quality services up and down based on business demand;

- The potential benefits to workforce performance and morale through the adoption and use of modern commercial technologies;
- The potential cost savings of retiring antiquated IT systems and the ability of cloud computing and emerging technology to reduce, or eliminate, duplicative services or activities; and
- The potential benefits to New York City's cybersecurity posture and readiness.

In addition to these particular recommendations, we would also strongly encourage the Committee to consider further engagement opportunities and original research that can inform their views on cloud computing. For instance, ADI recently published a report on the hundreds of billions of dollars the government could have saved over the past two decades by embracing commercial innovation and modernizing legacy IT.[1] Each of our members, nearly all of whom collaborate with state and local governments, have incredible use cases they can share about how moving to cloud infrastructure has improved the security, reliability, performance, and mission outcomes for all types of public sector agencies. These are but a couple suggestions for further learning and collaboration opportunities that, in addition to the assessment outlined in your draft bill, can continue to inform the Committee on the numerous operational benefits, cost savings, and performance improvements New York City can realize by transitioning public sector workloads to the cloud.

Conclusion

To conclude, IT modernization and leveraging cloud computing are vital not only because it saves money and enhances the effectiveness of agency operations – it is the primary catalyst for increasing public confidence in the ability of government agencies to competently and capably deliver

[1] *See* https://alliance4digitalinnovation.org/wp-content/uploads/2019/11/cost-of-ignoring-innovation-report.pdf.

important services to constituents. This hearing, and the draft bill under consideration, are important, helpful steps towards enabling New York City and its millions of citizens better understand the value, efficacy, and effectiveness of cloud computing and how it can improve the operations and outcomes of city government agencies. Thank you very much for the time today and we look forward to continued engagement with the Committee on these important technology efforts as they move forward.

Hearing before the New York City Council
Committee on Technology

Cloud Computing and Storage

Steven M. Bellovin*
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December 15, 2020

*Affiliation listed for identification purposes only.

Introduction

Thank you for inviting me to speak here today on the proposed cloud storage bill.[1] As I noted the other time I was invited to speak before a Council committtee, I'm a native New Yorker. I grew up in Brooklyn and attended the city's public schools, my first paid summer job was in the Municipal Building, and I like to spend my free time bicycling or photographing birds in city parks. In other words, I really live here, and I'm delighted to have a chance to give back to the city.

By way of introduction, I'm a professor of computer science at Columbia University Engineering and affiliate faculty at Columbia Law. Security and privacy have been my main focus for more than 30 years; I caught my first hackers in 1971 while working at the City College Computer Center. In 1994, I co-authored the first book on Internet security.[2]

The issue of cloud computing is a complex one, with many aspects; I discuss some of them below. Furthermore, it is difficult to discuss cloud storage without discussing cloud computing; the two are intimately linked. I do note that I know little of the operations of the Department of Information Technology and Telecommunications (DoITT); my experience as a computer programmer for the city's Comptroller's Office was more than 50 years ago! My conclusions, in brief, are:

- New York City may be large enough that, with one exception (the prices of real estate and electricity) it may not need to use cloud providers—but that is true if and only there is stable, predictable funding for information technology (IT) operations. Apart from that, there are likely cost, security, and stability advantages to using commercial cloud providers. Furthermore, there are some cloud services that are very hard for any single entity to replicate on its own.

- Cloud-based storage is maximally effective if coupled with cloud computing and cloud applications. Furthermore, there may be significant advantages in reliability and functionality from using such services, if done correctly.

- If the city does decide to use commercial cloud providers, it will necessitate some change in how DoITT is organized.

- Because of that, external as well as internal advice should be sought on the proposed conversion. It is desirable to do a trial deployment; this will be most effective on a service that would otherwise require a significant in-house upgrade.

All of this is explained in more detail below.

1. A Local Law in relation to an assessment of the feasibility of storing city agencies' electronic data on cloud computing systems, T2020-6906, New York City Council (2020), https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=4700300&GUID=EBB5B86F-C182-4A17-A4B2-FEE9E21043B4&Options=&Search=.

2. William R. Cheswick and Steven M. Bellovin, *Firewalls and Internet Security: Repelling the Wily Hacker*, 1st edition (Reading, MA: Addison-Wesley, 1994), ISBN: 0201633574, http://www.wilyhacker.com/1e/.

What is "The" Cloud?

People speak of "the cloud", "cloud computing", and "cloud storage", but those simple phrases hide a world of complexity. In reality, there is not one "cloud"; rather, there are many different services offered by the various providers. Even something as simple as "storage" can be provided in many different ways. It is not possible to do any single analysis; each cloud service has to be analyzed separately. Furthermore, there are interactions; the desirability of, say, a cloud-resident disk depends heavily on how that disk is used and whether the computation is local or remote.

The proposed bill speaks of "data classification categories"[3] without explaining what those are. It appears, though, that it refers to the contents of the data—payroll records, tenant complaints, taxi trip data, etc.—rather than how the data is organized and how it is used. While this is an appropriate way to reason about, say, security concerns, how the data is used in a technical sense can be more important for assessing the larger costs and benefits. A simple file with a list of names and salaries has different characteristics than a database; both can differ from data that is to be fed into a machine learning model.

There are three overriding issues that affect all analyses, though. Two are obvious: the cost in New York City of both real estate and electricity. Data centers can take a lot of space, and while they need not be located in Midtown, nowhere in the city is particularly cheap. Electricity is expensive everywhere in New York, and data centers use an amazing amount of power, both for the computers and for the air conditioning units they need.

The third issue, though, is little known outside of the computing field: latency, how long it takes for a message to reach its destination. Latency can have a significant effect on the performance and responsiveness of a system; the effective bandwidth of an Internet connection is intimately related to the latency between the two points. Furthermore, the ultimate limit is the speed of light, the absolute speed limit of the universe. The laws of physics dictate that a response to a message from New York City to an Amazon Web Services (AWS) data center in Northern Virginia *cannot* take less than 3.6 milliseconds; it will always take longer. While this seems fast to us, it is a long time to a computer. In many situations, then, it is wise to put computation near the storage. That is, cloud storage can often imply the need for cloud computing.[4]

In fact, there are more categories than those two. Roughly speaking, cloud services can be classified into three different categories: storage, computing, and applications. Each has its own variations and nuances.

3. T2020-6906 at §1(c)(1).

4. Latency can be so critical for applications like high-frequency Wall Street trading that some firms are using novel fiber optic cables to save just a few *billionths* of a second; see, e.g., Alexander Osipovich, "High-Frequency Traders Push Closer to Light Speed With Cutting-Edge Cables," *Wall Street Journal*, December 15, 2020, https://www.wsj.com/articles/high-frequency-traders-push-closer-to-light-speed-with-cutting-edge-cables-11608028200.

Cloud Storage

Basic cloud storage is the simplest possibility. In effect, one has an Internet connection to a set of remote disk drives. Used this way, it is almost certainly not worthwhile for general-purpose use—as noted above, it would be far slower than local disks for complex uses—unless cloud computing is used as well.

The analysis is somewhat different for more sophisticated uses, notably services optimized for sharing files. Dropbox is the best-known example, though there are others. The question here, and it is a question best answered by the DoITT, is to what extent such sharing is necessary or desirable. Some organizations block Dropbox et al. because they do not want their employees working from home on sensitive enterprise files. On the other hand, inter-organizational sharing within the city government is simplified if such services are used. The security of cloud storage solutions is likely to be better than trying to do it in-house with standard mechanisms. Not only are the remote access protocols better designed for hostile networks compared with local network-oriented protocols such as Oracle's NFS and Microsoft's CIFS, managing user authentication is easier: the services do that. Managing access control rules—who is allowed to do what with the data—is still a challenge but is likely easier for cloud storage services.

A third use for cloud storage is off-site backup of crucial files. This is almost certainly an excellent idea; it's faster, easier, and more automatic than manual solutions such as shipping backup media to specialist companies. Preference should be given to services that permit client-side encryption of the data, since that protects the information from any possible security failures by the cloud provider. Of course, tracking, managing, and protecting the encryption keys will require careful and reliable management by the DoITT.

Many of the cloud storage providers offer file versioning—having rapid, automatic access to older versions of files—and even their own long-term archival storage.

There is an important caveat: a sometimes-ignored part of the price structure of many cloud services is the cost of exporting data from them. That is, there can be a significant charge for the network traffic necessary to retrieve bulk data from the providers. Their goal, of course, is to encourage you to do more of your computing on their platforms.

Cloud Computing

Cloud computing has several interesting use cases. The first, of course, is to move computation near the cloud storage disks, to avoid latency-related problems. There is little more to say about that aspect: the cost-effectiveness of the two must be evaluated together.

A second common use case is for surge computing capacity: if an organization's need for CPU cycles varies dramatically over time, it can be considerably more cost-effective to rent it when needed, rather than purchased. The classic example is a movie studio that suddenly needs a vast amount of computing power for digital special effects, but may not need anything near that much until they produce another science fiction movie—but most organizations' needs computing needs are far less bursty. DoITT is

best equipped to ascertain if any city applications require surge capacity. (If there are such, cloud storage, either permanent or temporary, may be needed, too.)

There's an important special case of this: the ability to rapidly create new, high-quality, interactive services. They could start small on virtual machines; more capacity could be added as needed, using the built-in load-balancing features of cloud platforms.

The most interesting issue, though, is whether cloud computers are more or less secure than locally managed ones. The answer is very dependent on the precise scenarios being considered. In particular, since the quality of system administration is vital to security—an issue I raised in Congressional testimony some years ago,[5] my testimony here in February,[6] and which I discussed more fully in a recent book[7]—the relative security of a cloud-resident server compared with a locally-run one turns heavily on how well the systems are administered. That in turn depends on both the nature of the cloud computing service and on city policies.

System administration is easy to scrimp on. Many of its products—keeping things running smoothly and installing patches—are often invisible; indeed, many people wonder about system administration only when something breaks. If budgets are tight, it is all too easy to postpone hardware and software upgrades, and to hire too few system administrators or give them the budgets they need to do tool development.

This risks disaster—you find yourself in a trap where you *must* upgrade, for security reasons, but you're so far behind that the upgrade has become a major project. It's easier to stay current in the private sector, where computers can be depreciated; this aids in long-term planning. In government, at all levels, political necessities can result in budget cuts. If these cuts are to system administration, security can suffer. Obviously, there can be budget cuts in the private sector as well, but the tax benefits[8] make equipment upgrades less painful.

The tradeoffs are different for the large cloud providers. They have learned to do system administration at scale; the marginal human cost of adding another computer or another thousand computers is close to zero. They are thus much better equipped than almost any other organization to stay current on patches, which in turn improves security.

There is, however, a crucial caveat. "Cloud computing" can mean a virtual machine (VM) managed and administered entirely by the customer, in which case it is no better than a local machine administered by the same organization. Alternatively, cloud computing can be access to a system administered by the cloud provider, in which case there can be significant security benefits.

5. Cybersecurity Research Needs: Testimony before the House Select Committee on Homeland Security, Subcommittee on Cybersecurity, Science, Research, & Development, hearing on "Cybersecurity—Getting it Right", Transcript at https://archive.org/details/gov.gpo.fdsys.CHRG-108hhrg98150, 108th Cong. (July 22, 2003) (statement of Steven M. Bellovin), https://www.cs.columbia.edu/~smb/papers/Statement.pdf.

6. Steven M. Bellovin, "Cybersecurity for Small Businesses": Testimony for the New York City Council Committee on Technology and Committee on Small Business, New York City Council (Feb. 25, 2020) (statement of Steven M. Bellovin), https://www.cs.columbia.edu/~smb/papers/nyc-council-testimony.pdf.

7. Steven M. Bellovin, *Thinking Security: Stopping Next Year's Hackers* (Boston: Addison-Wesley, 2016), Chapter 15, ISBN: 978-0-13-427754-7, http://www.informit.com/store/thinking-security-stopping-next-years-hackers-9780134277547.

8. See IRS, *Frequently Asked Questions: Depreciation & Recapture*, October 14, 2020, https://www.irs.gov/faqs/sale-or-trade-of-business-depreciation-rentals/depreciation-recapture for details.

Even here, though, cloud providers have an edge: they have sufficient capacity that customers can avoid the need to patch a running computer. Instead, one can simply bring up new, already-patched virtual machines and switch the application to them, knowing that it's easy to revert to the older version if necessary. To be sure, this takes customer effort: it requires planning, automated build and configuration management tools, and more. But it is easier to implement on a cloud platform.

The major cloud providers also provide good support for better forms of authentication than passwords. It is hard to overstate how important this is; many devastating attacks, such as Russia's 2016 hack of John Podesta's emails, were due to reliance on passwords.[9] Ubiquitous support for, e.g., FIDO2 tokens, an issue I discussed here in February,[10] is crucial, and it is much more easily done via cloud providers—they've already implemented it.

There is a more subtle benefit to using someone else's authentication service. If it is ever necessary to audit use or abuse of credentials, a service operated by an outside party can maintain logs not accessible to a rogue system administrator—and rogue system administrators can happen.[11] (I should note that cloud authentication services are generally designed so that not even the provider can steal someone's credentials.)

In other words, there is no one answer to the question, "Is cloud computing more secure?" Apart from the risk of mischief by the provider's employees or of security problems in their own infrastructure—and those risks, though low, certainly exist—there are enough different models for cloud computing and for that matter local administration that an accurate assessment depends entirely on what service is being proposed and what it would replace.

Cloud Applications

What I call "cloud applications" are the least understood, most important, and most fraught aspect of cloud computing. Cloud applications are just that: ordinary applications, but run by the cloud provider. The application could be something as commonplace as email—we're all familiar with Google's `gmail.com` and Microsoft's `outlook.com`—or quite complex. AWS offers things like databases, machine learning systems, facial recognition, video analysis, and more.[12]

Cloud services offer the greatest potential for both cost savings and for security improvements. They are administered by the cloud providers; as noted, they have learned to do this well, and at scale. Furthermore, the applications are often far more sophisticated than what an individual organization is capable of developing or managing on its own. Spam filtering accuracy is entirely dependent on scale; a company that sees

9. Nicole Perlroth and Michael D. Shear, "Private Security Group Says Russia Was Behind John Podesta's Email Hack," October 20, 2016, https://www.nytimes.com/2016/10/21/us/private-security-group-says-russia-was-behind-john-podestas-email-hack.html.

10. Bellovin, "Cybersecurity for Small Businesses".

11. Richard Esposito, Matthew Cole, and Robert Windrem, "Snowden Impersonated NSA Officials, Sources Say," *NBC News*, August 29, 2013, http://investigations.nbcnews.com/_news/2013/08/29/20234171-snowden-impersonated-nsa-officials-sources-say.

12. See, e.g., *Find the hands-on tutorials for your AWS needs*, November 22, 2020, https://aws.amazon.com/getting-started/hands-on/?awsm.page-getting-started-all=1. Every cloud provider will of course have its own service offereings.

billions of messages a day—Gmail has about 1.8 billion users[13]—has a far better grasp of what spam is than any single organization's email can show.

Cloud-based web hosting is almost the norm. The web site from which I read this bill, https://legistar.council.nyc.gov/, appears to be run by a private company, Granicus, which specializes in digital government applications; it in turn is owned by a venture capital firm.[14] There is not only nothing wrong with using this service, it is an excellent practice. It saved the city the money that would have been needed to develop and run a custom application.

Cloud applications can, of course, pose security risks. Foremost among them is the necessity to administer them correctly. A Google search for "open s3 bucket"—sites that have not properly protected their AWS cloud storage—will return many hits.[15] Overall, though, with a modicum of care they are likely to be far more secure than in-house alternatives.

There is, however, a subtle danger: lock-in. Program access to, say, an AWS facial recognition service is likely to be different than the equivalent Microsoft Azure service. In other words, migrating from AWS to Azure or to an in-house offering is likely to require significant reprogramming and hence significant expense. This does not mean that it is a bad idea to use these cloud services—as noted, they can be more secure and more functional than locally developed versions—but the cost of migrating away from them should be taken into account when making a decision.

Cloud Availability

One major benefit of cloud services is high availability: applications run on whichever virtual machines are available. If some hardware fails, the application is migrated to another VM. That can be done locally, too, of course, but only if there is sufficient extra hardware. With a cloud provider, the cost of the extra hardware can be amortized over many more physical machines.

The large cloud providers also have multiple data centers, both in the US and around the world. There can thus be redundancy even against the failure of a single data center. Add-on services include applications that automatically synchronize databases between different disks and different sites.

To be sure, even the large cloud providers can experience outages. Google had two significant outages this week,[16] AWS experienced a major hiccup within the last

13. Christo Petrov, "50 Gmail Statistics To Show How Big It Is In 2020," *TechJury*, June 30, 2020, https://techjury.net/blog/gmail-statistics/.

14. Tamara Chuang, "Vista Equity buys another Denver tech firm, Granicus," *Denver Post*, August 18, 2016, https://www.denverpost.com/2016/08/18/vista-equity-buys-denver-tech-firm-granicus/.

15. Yifat Perry, "Amazon S3 Bucket Security: How to Find Open Buckets and Keep Them Safe," *NetApp.com Blog*, September 14, 2020, https://cloud.netapp.com/blog/aws-cvo-blg-amazon-s3-buckets-finding-open-buckets-with-grayhat-warfare.

16. Adam Satariano, "Google's apps crash in a worldwide outage.," *New York Times*, December 14, 2020, https://www.nytimes.com/2020/12/11/business/google-down-worldwide.html; Ron Amadeo, "Google sees major services outages two days in a row," *Ars Technica*, December 16, 2020, https://arstechnica.com/gadgets/2020/12/google-sees-major-services-outages-two-days-in-a-row/.

month,[17] and Microsoft has also had problems.[18] Such outages are very visible because their scale: many customers are affected. It is likely, though, that if their customers all ran their own servers, their aggregate outage time would be far greater than they have experienced via their cloud providers. Critical services can fail, even if—or because–they are locally run. New York City has experienced at least two significant failures of its 911 system,[19] though of course more centralized systems can experience similar issues.[20]

Recommendations

As I noted at the start, New York City is large enough that it could have its own first-class computing infrastructure. It is not clear, though, that this would be the most cost-effective path. Making the right decision will take considerable effort.

New York City might be able to do it itself: It might be feasible for the city to run its own information technology infrastructure at standards of reliability approaching that of cloud providers. Doing this will require a long-term commitment of stable funding and an ongoing program of equipment and software modernization.

I cannot speak to New York City's experiences; in the Federal government, IT modernization efforts have sometimes been delayed by budget sequestrations due to political deadlocks. For example, the GAO reported that the US Patent and Trademark Office "reduced spending on IT modernization contracts by $80 million,"[21] the Alcohol and Tobacco Tax and Trade Bureau dealt with its cuts by delaying IT updates,[22] the Nuclear Regulatory Commission delayed or rescoped contracts for its modernization efforts,[23] and so on.

For reliability, the city would need to create a backup data center To guard against problems that affect the entire city—think of Hurricane Sandy—and to reduce costs for electricity and perhaps real estate, it may be wise to locate this center

17. Jay Greene, "Amazon Web Services outage hobbles businesses," *Washington Post*, November 25, 2020, https://www.washingtonpost.com/business/economy/amazon-web-services-outage-stymies-businesses/2020/11/25/b54a6106-2f4f-11eb-860d-f7999599cbc2_story.html; Jay Greene, "Amazon's cloud-computing outage on Wednesday was triggered by effort to boost system's capacity," *Washington Post*, November 28, 2020, https://www.washingtonpost.com/technology/2020/11/28/amazon-outage-explained/.

18. Ed Targett, "Microsoft Azure Throttles Cloud Access, Blames Capacity Crunch," *Computer Business Review*, April 2, 2020, https://www.cbronline.com/news/microsoft-azure-capacity-crunch.

19. Michael Cooper, "Reviews of 911 System Are Promised After Hourlong Failure," *New York Times*, February 2, 1999, https://www.nytimes.com/1999/02/02/nyregion/reviews-of-911-system-are-promised-after-hourlong-failure.html; Michael Schwirtz, "Tracking the Storm: New York's 911 System Overloaded," *New York Times*, October 28, 2012, https://cityroom.blogs.nytimes.com/2012/10/28/hurricane-sandy-live-updates/#new-yorks-911-system-overloaded.

20. Brian Krebs, "Who's Behind Monday's 14-State 911 Outage?," *Krebs on Security*, September 29, 2020, https://krebsonsecurity.com/2020/09/whos-behind-mondays-14-state-911-outage/.

21. GAO, *Report to the Chairman, Committee on the Budget, House of Representatives: 2013 Sequestration*, GAO- 14-244 (Government Accountability Office, March 2014), p. 73, https://www.gao.gov/assets/670/661444.pdf.

22. Ibid., p. 151.

23. Ibid., p. 179.

elsewhere. (Relatively speaking, the impact on jobs will not be large; data centers do not have very many employees per square foot of floor area except during construction.) Using a commercial cloud service, with live storage but standby computing, is likely the most economical way to do create backup capacity. Doing this could lead to significant savings in real estate costs.

But it isn't clear that this would save money compared with commercial cloud services. They scale-dependent advantages to cloud services cannot be replicated by any single entity, not even New York City.

Using cloud computing and services As described earlier, cloud storage can be hard to use effectively unless cloud computing or cloud applications are used. If the decision is made to move some storage to a cloud provider, serious consideration should be given to moving the associated processing as well.

The need for very high availability is another possible driver for cloud computing. Although the principles underlying the mechanisms are well known, implementation is not trivial, and data replication may have to be added to many programs. However, the software underlying many cloud storage and cloud application services was designed with replication in mind. This pre-existing infrastructure can make it much easier to implement extremely reliable services.

The most intriguing advantages come from the ability to use high-level cloud services. On the one hand, there is the chance to build creative new applications, and to do so at a far lower cost than starting from scratch. On the other hand, this needs to be weighed against the lock-in problem. There is no "one size fits all" answer to these questions; they must be answered separately for each IT subsystem.

I stress that simply moving the existing service architectures to the cloud, without modification—a strategy known in the business as "lift and shift"—is unlikely to produce savings. The real benefit from the cloud is the ability to work in a completely different way.

Changes to DoITT The more functionality that DoITT moves to cloud applications, the less need there will be for in-house system administration—cloud providers do that for their own application platforms. Furthermore, such a move will almost certainly improve the security of the city's applications.

This does not, however, mean that the city does not need IT expertise. Indeed, in many ways it needs more expertise just to manage outside contractors. A National Academies report (disclaimer: I was on the study committee) noted that about a Federal Aviation Administration effort:[24]

> Even if the FAA were not acting as systems integrator, it would still need to be a "smart customer,"—meaning that it needs expertise

24. David E. Liddle and Lynette I. Millett, eds., *A Review of the Next Generation Air Transportation System: Implications and Importance of System Architecture* (Washington, DC: National Academies Press, 2015), p. 77, https://www.nap.edu/catalog/21721/a-review-of-the-next-generation-air-transportation-system-implications.

that will enable it to effectively structure and manage its supplier relationships.

Developing and retaining this expertise will be a challenge. However, proceeding with inexperienced or less than the best personnel in key leadership positions is a significant risk.

The need for in-house expertise does not stop at the project management level. Administering cloud-resident resources is still necessary, to avoid errors such as the open bucket problem. Programmers will still be needed to effectively utilize the cloud applications.

Finally, great care in system design is needed to minimize the lock-in problem: while there is likely no way to avoid having platform-specific modules, good software engineering can provide the software abstractions to isolate such dependencies, making them much easier to replace if necessary.

Making the Decision As I've outlined here, there are many complex, interacting factors that affect the city's possible decision to use assorted cloud services. Given the complexity of the city's existing IT operations, it is clear that DoITT involvement in the process is utterly vital—no one outside would have nearly enough knowledge of what is done today.

However, given that some scenarios would imply significant changes to DoITT, it is important to that the decision process include outsiders as well. These people should have significant operational experience with cloud services and data center operations, and they should work closely with the experts in the DoITT.

Overall, I recommend an initial trial deployment of some services on a cloud platform. Moving an existing service, in any form other than lift-and-shift, is a considerable effort; as noted, though, lift-and-shift will not result in nearly as many benefits. I recommend, then, that the next few systems that need a significant hardware or software upgrade be rebuilt as "cloud-native", and (if necessary) that the city procure or provide proper training to developers on how to do this well. This will provide better baseline data on the costs and benefits of such moves.

To sum up: the issues in use of cloud platforms are complex and there is no simple answer. Furthermore, it is not an all-or-nothing decision; some services may be best kept in-house while others are moved to the cloud. But the advantages can be compelling; the city should at least try.

Biography

Steven M. Bellovin is the Percy K. and Vida L. W. Hudson Professor of Computer Science at Columbia University, a member of the Cybersecurity and Privacy Center of the university's Data Science Institute, and an affiliate faculty member at Columbia Law School. Bellovin does research on security and privacy and on related public policy issues. In his copious spare professional time, he does some work on the history of cryptography. He joined the faculty in 2005 after many years at Bell Labs and AT&T Labs Research, where he was an AT&T Fellow. He received a BA degree from Columbia University, and an MS and PhD in Computer Science from the University of North Carolina at Chapel Hill. While a graduate student, he helped create Netnews; for this, he and the other perpetrators were given the 1995 Usenix Lifetime Achievement Award (The Flame). He has also received the 2007 NIST/NSA National Computer Systems Security Award and has been elected to the Cybersecurity Hall of Fame. Bellovin has served as Chief Technologist of the Federal Trade Commission and as the Technology Scholar at the Privacy and Civil Liberties Oversight Board. He is a member of the National Academy of Engineering and has served on the Computer Science and Telecommunications Board of the National Academies of Sciences, Engineering, and Medicine. In the past, he has been a member of the Department of Homeland Security's Science and Technology Advisory Committee, and the Technical Guidelines Development Committee of the Election Assistance Commission.

Bellovin is the author of *Thinking Security* and the co-author of *Firewalls and Internet Security: Repelling the Wily Hacker*, and holds a number of patents on cryptographic and network protocols. He has served on many National Academies study committees, including those on information systems trustworthiness, the privacy implications of authentication technologies, and cybersecurity research needs; he was also on science versus terrorism. He was a member of the Internet Architecture Board from 1996-2002; he was co-director of the Security Area of the Internet Engineering Task Force from 2002 through 2004.

More details may be found at http://www.cs.columbia.edu/~smb/.

December 15, 2020

The Honorable Robert F. Holden
Chair, Committee on Technology
New York City Council
City Hall
New York, NY 10007

Dear Chairman Holden:

On behalf of BSA | The Software Alliance[1] I am writing today regarding the oversight hearing held on December 15 before the New York City Council Committee on Technology concerning the benefits and potential disadvantages of cloud-computing systems.

As I am certain you will hear from others testifying before the committee, cloud-computing has emerged as one of the most transformative technologies of this generation. It has fundamentally revolutionized how computing resources are delivered and consumed. Consumers no longer need to be tied to using software or data found only on their computing devices. They can access innovative cloud-enabled services and data anytime, anywhere, and on any device with Internet connectivity. This has allowed for better, more reliable, affordable, and flexible usage of applications and data during these unprecedented times.

For the benefit of you and other members of the Committee on Technology, I am including a white paper published by BSA highlighting many of the valuable aspects of cloud computing while dispelling several common myths. Thank you for the opportunity to share our views and we look forward to working with you and your colleagues to further examine this important issue in 2021.

Sincerely,

Tom Foulkes
Senior Director, State Advocacy

[1] BSA | The Software Alliance (www.bsa.org) is the leading advocate for the global software industry before governments and in the international marketplace. Its members are among the world's most innovative companies, creating software solutions that spark the economy and improve modern life. With headquarters in Washington, DC, and operations in more than 30 countries, BSA pioneers compliance programs that promote legal software use and advocates for public policies that foster technology innovation and drive growth in the digital economy.

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The Software Alliance

BSA

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Moving to the Cloud

A Primer on Cloud Computing

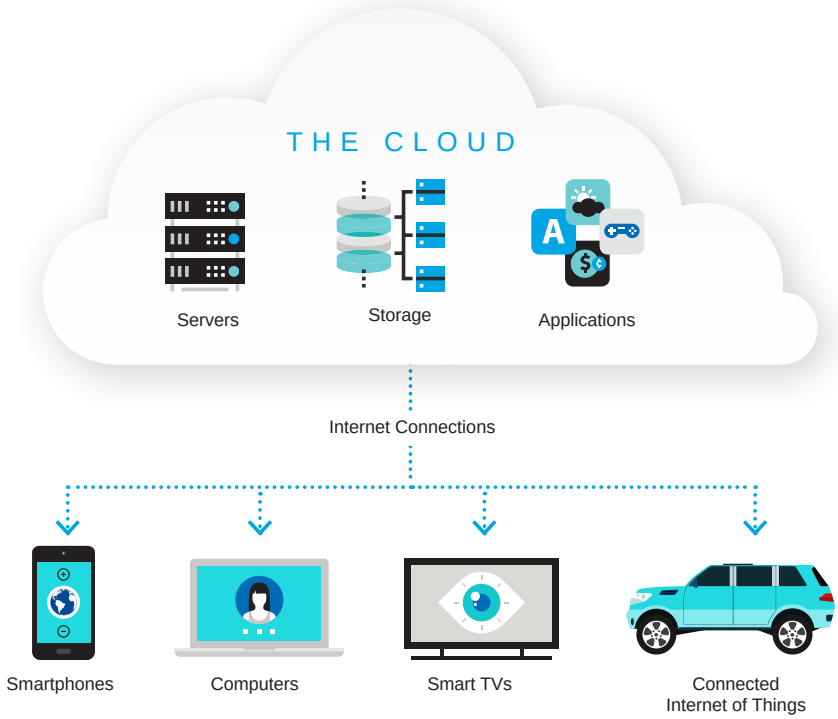
Research Insights by

IDC ANALYZE THE FUTURE

What Is Cloud Computing?

At its most basic, cloud computing refers to online computing resources made available to a customer on demand by a third-party service provider (the cloud services provider, or CSP). These resources are typically delivered over the Internet, and users are charged for only the resources they actually consume, similar to the manner in which consumers pay for electricity or water.

The cloud is emerging as one of the most transformative technologies of this generation. It is fundamentally revolutionizing how computing resources are delivered and consumed. Consumers no longer need to be tied to using software or data found only on their computing devices. They can access innovative cloud-enabled services and data anytime, anywhere, and on any device with Internet connectivity. This allows for better, more reliable, affordable, and flexible usage of applications and data.



Because of the cloud's power and versatility, there has been an explosion in the quantity, quality, and variety of cloud-based services available to consumers. Worldwide, the public cloud services market is projected to reach a value of a US$128.4 billion in 2017 and grow to US$266.0 billion by 2021[1].

Indeed, the cloud is already at the heart of many indispensable Internet-based services and apps used in our daily lives. Today, the cloud enables us to check our e-mail from multiple devices, share our personal photos with others around the world, access our bank accounts while on the go, and use social networking to collaborate with friends and colleagues.

The cloud has revolutionized not only the way that consumers interact with applications and data, but also how companies do business. The cloud provides enterprises—both large and small—access to affordable and scalable storage, processing power and information-sharing capabilities. Colleagues and clients can collaborate across the globe in ways never before possible. Products and services can now be delivered in entirely different ways, opening up new forms of business and business models. Because remote servers handle much of the computing and storage, companies can avoid expensive in-house IT infrastructure maintenance and upgrade costs, and instead leverage nearly infinite computing and storage capacity over the Internet.

By harnessing the cloud, organizations are accelerating opportunities, enhancing productivity, achieving cost savings, strengthening data security, and even helping the environment. Governments are similarly turning to the cloud to reduce their technology costs, improve the way they deliver citizen services, reduce energy needs, and better protect sensitive data.

1 IDC Worldwide Public Cloud Services Market 2016

Three Common Cloud Service Models

	TYPES	EXAMPLES	USERS
SaaS	**Software-as-a-Service (SaaS)** SaaS is a software distribution model in which the software application is hosted remotely on the CSP's IT infrastructure, instead of being run locally on the user's device. SaaS allows users to access software applications on demand, using a simple web browser or application.	Web-based e-mail, online documents, customer relationship management and online collaboration tools	End users
PaaS	**Platform-as-a-Service (PaaS)** PaaS provides on-demand access to a platform and associated tools to develop and run software applications, all managed by the CSP and housed on the CSP's IT infrastructure.	Operating system, programming languages, software development tools	Developers
IaaS	**Infrastructure-as-a-Service (IaaS)** IaaS enables the use of basic computing resources, traditionally associated with the purchase of hardware, like data processing, storage and networking components. With IaaS, however, hardware is provided externally and managed by the CSP, avoiding the need for expensive on-premises investments in IT infrastructure and enabling users to easily scale operations according to changing needs.	Remote hardware	System administrators

What Can You Do with the Cloud?

Consumers, businesses and governments alike are flocking to the cloud because they are now able to do things that were previously impossible or unimaginable.

For example, they can:

Access files anytime, anywhere, from any device

Storing data in the cloud allows users to access and retrieve the data regardless of whether they are on the go, or using a desktop, laptop, or smartphone.

Collaborate in new and innovative ways

Users can share and synchronize data stored in the cloud across different devices while maintaining data integrity. It enables workers to collaborate on documents and projects, and communicate in more seamless ways. Cloud-based systems that enable data to flow easily and usefully throughout the entire organization and ecosystem of partners—including suppliers and customers—improves decision-making and time to market.

Work more efficiently and effectively

Users can access software functionality across the Internet without needing to take the time to load the entire software application on a particular device.

Improve data integrity and resiliency

Users can easily backup data to the cloud in geographically separated locations, protecting against data loss due to technical problems or natural disasters.

Develop, test and deploy new applications

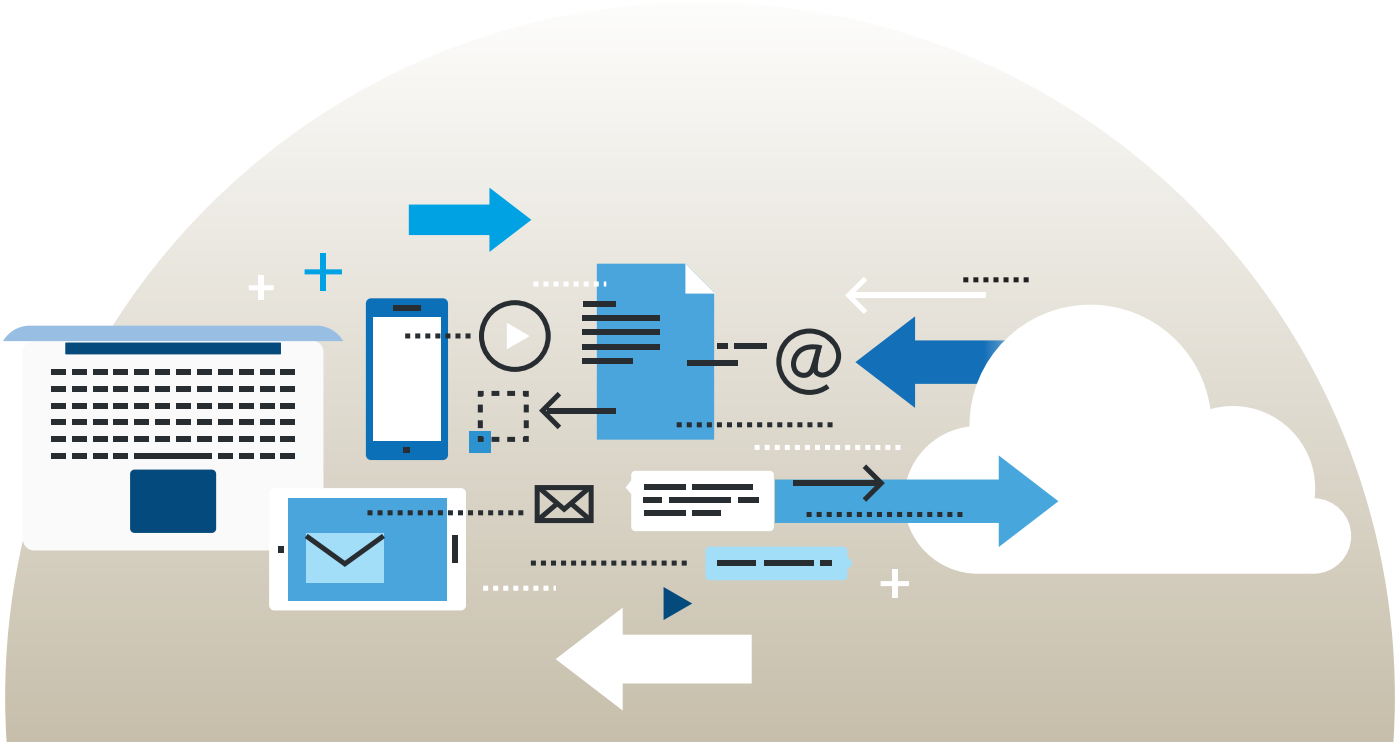
IT professionals and businesses can use the cloud to develop and test new software applications, such as mobile phone apps, without the need to procure costly IT equipment or additional software licenses. This allows them to roll out new applications and updates to their customers quickly and respond more dynamically to the demands of their customers.

Gain new insights from data

Cloud-enabled data analytics is making data from both inside and outside organizations more accessible, actionable, and increasingly more valuable by transforming insights into action, and action into tangible results.

Lead better lives with the Internet of Things

Sensors built into the physical objects around us and powered by cloud technology allow the “things” around us to help us with daily chores, monitor our health, sense the environment, adjust temperature control systems, and endless other activities.



Why You Should Get in the Cloud

Decision-makers point to several key characteristics that make the cloud critical to their success.

Transforms Speed to Market into a Key Competitive Advantage

- Using cloud computing services avoids the need to invest in large upfront capital outlays to set up and acquire IT assets. It is a democratizing force as small- and medium-sized enterprises can now access the same powerful IT resources once only affordable to the largest enterprises.
- The cloud also enables organizations to develop and deploy technology faster, enabling enterprises to be more agile as they adapt more quickly to changing needs and demands.
- Because the cloud is accessible over the Internet, it enables businesses to scale up nearly instantly to meet the demands that arise from entering into new markets, new geographies, new demographics, and new channels. Cloud resources can be tapped on rapidly, elastically, and cost-effectively to provide services based on users' changing needs.

Boosts the Way You Communicate and Collaborate

- The cloud enables entirely new forms of collaboration and communication. In a global economy, it opens new business opportunities and dramatically transforms the supply chain by enabling businesses to reach partners, suppliers and customers, and deliver services across vast geographical regions in real-time.
- Colleagues can now use cloud-based services like file storage, social networking, emails, instant messaging, and other productivity tools to significantly improve collaboration and work efficiencies. Cloud-based apps also break down the four walls of an office, enabling today's workforce to work—and companies to source talent—from anywhere in the world.

Improves the Security and Resiliency of Your Data

- With the cloud, computing and storage are distributed across multiple physical hardware systems so that if one system fails, another will automatically take over. Cloud customers can also choose to have their data stored and processed in multiple geographical locations, providing for even better data resiliency. In cases of natural or man-made disasters, the ability to have continued access to citizen data allows public and emergency services to be quickly deployed and scaled up, which often could mean the difference between life and death.
- Well-managed cloud services are often more secure than their on-premises counterparts. Because the cloud is their business, CSPs make significant investments to ensure their systems are secure, both physically and digitally. CSPs typically go through stringent auditing processes to meet international security certifications, and are able to provide advanced threat protection technologies and secure data at rest and in transit. CSPs operating globally also have visibility into cyber threats around the world, and ensure their cyber defenses are quickly updated against newly discovered threats.

Who Is Already in the Cloud?

Almost every sector of the economy now widely uses cloud computing technologies, including financial services, healthcare, life sciences, manufacturing, retail, and utilities sectors. The public sector is no exception. Governments around the world are adopting public-cloud-first procurement policies[2]. The following examples illustrate some of the organizations that have already made the move to the cloud.

Cloud Services for Public Sector

- Estonia is leading the world in e-government, leveraging the power of the cloud to deliver many government services online. It established online voting and paperless government meetings in 2007, and its legislation is only valid if published online. In 2014, Estonia pioneered an e-Residency program, allowing entrepreneurs around the world to remotely establish their digital businesses in Estonia.

Cloud Services for Banking

- DBS Bank, a regional bank headquartered in Singapore, is on the forefront of a major digital transformation as they fundamentally re-architect their business, using the cloud to be more responsive to customer needs. Cloud implementation allows DBS to rapidly deliver new technological applications, and scale up and down computing capacity to meet the fluctuating demands of financial market analyses, while meeting the risk management requirements of the regulator—the Monetary Authority of Singapore.

Cloud Services for Healthcare

- New South Wales Health (NSW Health) provides statewide public health services and operates the largest public health system in Australia, operating more than 225 public hospitals across metropolitan, regional, and rural communities. Using the cloud, NSW Health unified its processes for managing its cost centers across 21 health agencies, and gained greater visibility into and control over health services spending. The migration to the cloud helped NSW Health improve its decision-making on fund allocations and more easily meet auditor-general requirements.

Cloud Services for Education

- The De La Salle-College of Saint Benilde in Manila, Philippines, recently moved its specialist program for the deaf to the cloud. The move enabled De La Salle-College to modernize its educational program and provide students with the opportunity to learn on the latest industry tools, keeping them at the cutting edge of design and graphics, while making it simple for the institution to cater to the special needs of students in the course. Graduates from the program are regarded highly and well-sought after by employers, with many becoming important members of their creative teams.

Cloud Services for Hospitality and Travel

- Based in Tokyo, Japan, Navitime Japan offers several mobile apps that help users navigate Japan's transit systems. Recognizing the particular benefits English speakers could derive from the app, Navitime harnessed the power of the cloud to integrate a chatbot with language intelligence capable of answering travel-related questions. Navitime now provides tourists with real-time answers to their travel questions as they explore Japan's major tourist cities. Since its launch in February 2017, an increasing number of travelers are using the chatbot not just for sightseeing but also for experience-related searches, such as sampling Japanese food.

2 For example, in New Zealand, Australia and the Philippines.

Dispelling Common Myths

Myth 1

The Cloud Is NOT Secure

Just as a bank can better protect the assets of its patrons than individuals can at home, CSPs can provide a level of protection for their customers' digital assets that exceeds what most individual companies can provide on their own. In fact, cloud services provide some key security advantages over most on-premises environments:

- **Physical Security**: Certified personnel can carefully monitor servers 24/7 to prevent physical breaches. CSPs can protect physical access to servers by requiring multifactor authentication (e.g., biometric) and monitoring using motion sensors and video surveillance.
- **Data Security**: CSPs can ensure data integrity through use of state-of-the-art encryption protocols for data at-rest and in-transit. CSPs can establish redundant backups of data in geographically dispersed data centers, mitigating risk of loss in the event of power outages or natural or man-made disasters.
- **Advanced Threat Detection**: CSPs leverage state-of-the-art enhanced security intelligence to track, prevent, and mitigate the risks of cyber threats. They use regular penetration testing to simulate real-world attacks and evaluate security protocols against emerging threats.
- **Automated Patch Deployment**: Automated and centralized patch deployment and real-time updates to network security protocols work to protect systems from newly identified vulnerabilities.
- **Incident Management and Response**: CSPs maintain global teams of incident response professionals to respond and mitigate the effects of attacks and malicious activity.
- **Certification**: CSPs are typically certified to international security standards[3], and go through regular audits to maintain their certifications. This provides independent third-party verification that the security controls and practices of these CSPs comply with international best practices.

Myth 2

The Cloud Should NOT Be Used for "Critical" Applications

Many features of cloud computing make it the preferred IT solution for "critical applications." Few enterprises, no matter how large, can achieve the degree of reliability that CSPs provide. Leading enterprise CSPs, with their globally distributed networks and massive infrastructure, can withstand even the largest distributed denial of service attacks. Enterprise cloud services provide redundant data storage either globally or regionally based on customer preference and regulatory requirements. This level of redundancy improves availability even in the face of large-scale natural disasters or online disruptions and ensures that customer data is protected from local disturbances.

Myth 3

The Cloud Is Expensive

Cloud computing is an affordable way to allow organizations of all sizes to leverage the economies of scale that emerge when computing resources are pooled and the overhead costs associated with the management and maintenance of those resource are shared between multiple users. These economies of scale make cloud computing cheaper and more efficient than the traditional on-premises model. For instance, whereas companies once bore the costs of running and maintaining their own servers and data centers, such costs can now be spread among a CSPs many customers.

The cloud also enables organizations to reduce their IT costs by giving them the flexibility to scale up or down to accommodate fluctuating computing demands. The need for costly capital investments in hardware is eliminated and replaced by a more flexible pay-as-you-go subscription model. Whereas companies once had to make hardware investments based on unpredictable forecasts of their future computing needs, the cloud now allows them to pay only for the resources they need. By freeing up capital once tied up in hardware that exceeded a company's computing needs, cloud is a far more efficient model for IT spending.

Myth 4

Cloud Users Do NOT Have Control of Their Data

Cloud customers remain firmly in control of their own data and can establish access and use policies tailored to their organization's needs, risk profile, and regulatory obligations. With many CSPs, customers retain control over user credentialing, encryption key management, and data retention/destruction policies. At the same time, CSPs also ensure that the storage of customer data complies with applicable international, regional, and industry-specific compliance standards.

3 Such as those comprising the ISO/IEC 27000 family of standards for information security management systems.

Access Cloud Anywhere Anytime

The cloud is fundamentally revolutionizing how computing resources are delivered and consumed. Users and consumers can access innovative cloud-enabled services and data anytime, anywhere, and on any device. It has revolutionized how companies do business by providing access to affordable and scalable storage, processing power, and information-sharing capabilities.

Its many uses are serving businesses and individuals in accelerating opportunities, enhancing productivity, achieving cost savings, strengthening data security, and even helping the environment. Governments are also turning to the cloud to reduce their technology costs, improve the way they deliver citizen services, reduce energy needs, and better protect sensitive data.

The value of cloud computing is estimated to run well over the $120 billion mark by 2017. As far as cloud computing goes, the future's already here.

The Software Alliance
BSA

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ABOUT BSA

BSA | The Software Alliance (www.bsa.org) is the leading advocate for the global software industry before governments and in the international marketplace. Its members are among the world's most innovative companies, creating software solutions that spark the economy and improve modern life. With headquarters in Washington, DC, and operations in more than 60 countries around the world, BSA pioneers compliance programs that promote legal software use and advocates for public policies that foster technology innovation and drive growth in the digital economy.

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Chair Holden and Members of the Committee,

I am Tristan Morel L'Horset, Senior Managing Director with Accenture, and I work within our firm's Cloud Practice. Accenture is a global professional services company with leading capabilities in digital, cloud, and security. We employ more than 5,000 New Yorkers, operate in more than 120 countries and 40 industries – including the government sector – and are opening a flagship office at 1 Manhattan West this spring.

I echo the points made by today's earlier presenters and will highlight additional benefits that cloud can yield.

First, simply put, cloud can be a source of tremendous technical innovation. Cloud enables systems to grow with the changing demands of the city while also minimizing cost. It also allows for on-demand availability of services, as well as more agility and faster deployment of these services. Cloud saves entities a large amount of time that would otherwise be spent on procurement, capacity planning, and solicitation of traditional infrastructure resources which ultimately allows faster delivery of value to all NYC constituents. As an example, NYC has taken some important initial steps to harness the power of the cloud for its residents. We have been honored to partner with the city on some of these initiatives, including creating a mobile app to help residents apply for SNAP and TANF benefits, and the Fair Fares program.

In short, cloud can enable interactive services for all constituents to align with their needs and which can be deployed with higher speed to respond to market events and changes, such as COVID-19. For example, when the pandemic first began, our teams in Europe worked with a Spanish healthcare provider to urgently set up and operationalize new emergency medical locations (such as fairgrounds, hotels, etc.) into the health network to be able to operate as the rest of the provider's locations. Additionally, a chatbot was deployed to aid with the triage of cases as the healthcare system was initially overwhelmed in its response to the high number of COVID cases it was faced with. These are the types of capabilities that cloud can bring to large cities and enable them to deliver better services to their constituents.

Finally, cloud has been touted as the center of future innovation. And with this innovation will come the attraction of more high-end talent to the city. Cloud is not only attractive to top talent because of its pioneering virtues, but because it is also able to remove the barriers that inhibit growth to make it simpler to handle IT resources and allow companies to develop faster as a result. This will be critical to the success of the city in the post-pandemic era as NYC looks to propel itself into modern-day technology and for new ways to manage its operations and growth.

Regards,

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Senior Managing Director
Accenture, Cloud First