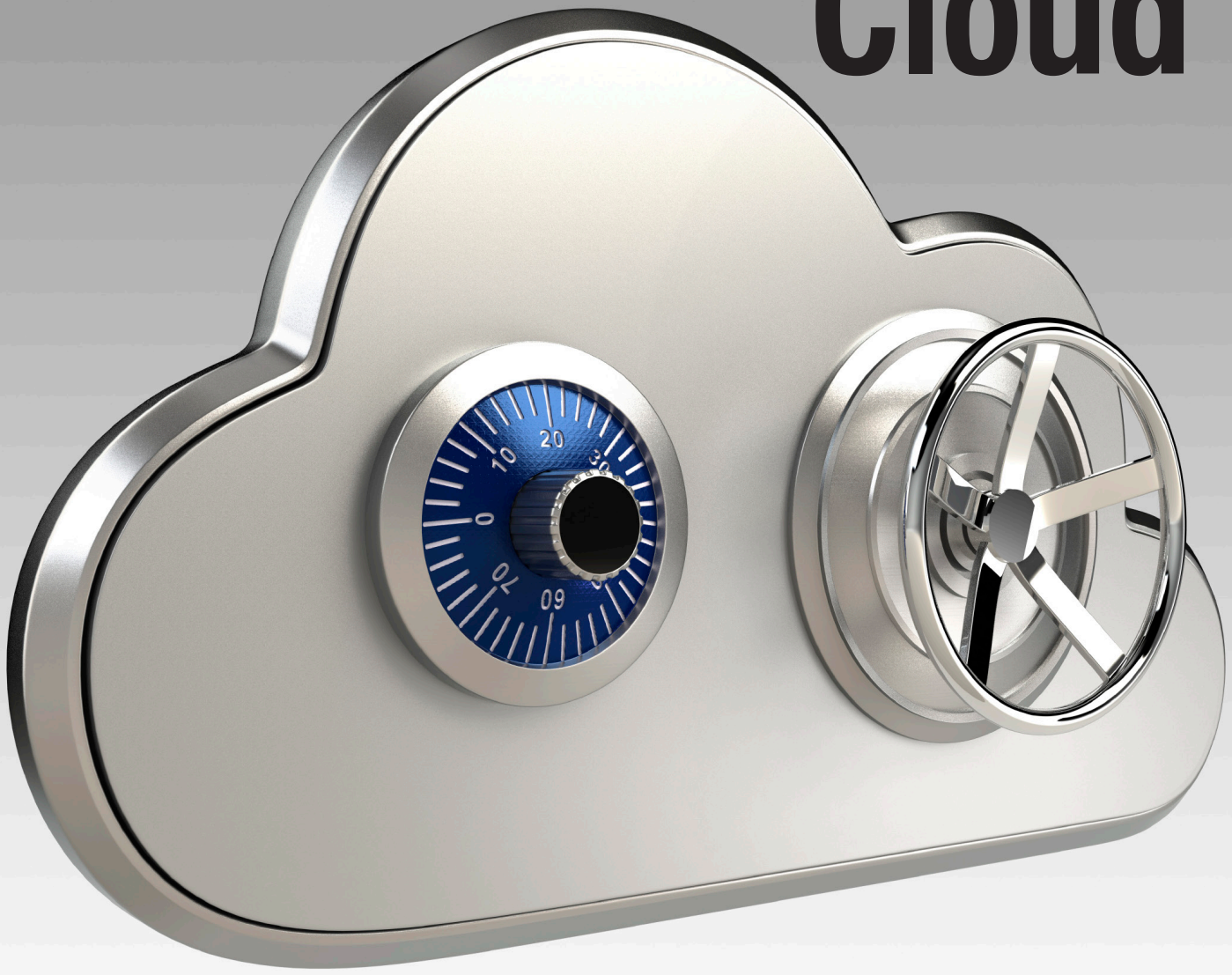
National Aeronautics and Space Administration

IT Talk

January - March 2018 Volume 8 • Issue 1

NASA in the Cloud



IT Talk

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Message from the NASA CIO

The adoption of cloud computing at NASA continues to grow in innovative and surprising ways. But it's not just our Agency where the cloud is making a dent. It is sure to have large growth in the Federal sector in 2018. The reason…cloud computing is simplifying how things get done through the use of endless new cloud microservices, serverless computing, and astonishing levels of automation.

NASA projects and programs are enthusiastically embracing cloud computing's new capabilities and the benefits they afford NASA missions. In this issue, we'll explore how the cloud is being used to accomplish NASA IT's 2018 business objectives. And we'll learn how we're moving Earth Science to the cloud and the benefits it brings to the Agency.

And finally, given all of the recent cybersecurity threats seen within the Federal sector, phase 2 of mobile device management at NASA will provide users with increased security and greater ease of use on their NASA-issued iOS and Android mobile devices.

I hope you enjoy this issue. Happy reading and Happy New Year!

~Renee

CIO Executive Council (CEC)
Face-to-Face
November 2017

NASA Industry Day
December 2017

NASA's 508 Resource Group

Michele Farr, 508 Coordinator, Marshall Space Flight Center

When an application or system is under development for an Agency deployment, there are many things that must be taken into consideration and fully tested. Among these is 508 standards compliance; does the application or system meet or exceed the 508 standards identified by the General Services Administration (GSA) (*https://section508.gov/*)? These standards must be met regardless of whether NASA uses a commercial off-the-shelf (COTS) solution or develops a customized solution.

So often in our daily work lives, we do not stop to consider what a workday at NASA is like for those who face challenges, but at the Agency Applications Office (AAO), we have a better understanding thanks to Dr. Kathy Thompson. She has been an AAO team member for ten years and has less than 20 percent vision and is hard of hearing due to a genetic condition called Usher syndrome. These challenges make Dr. Thompson a key contributor to the NASA 508 Resource Group, which works to ensure that 508 standards are met.

In 2016, the NASA 508 Resource Group became an Office of the Chief Information Officer (OCIO)–chartered group composed of individuals from all NASA Centers and was established to "operate as an advocacy group in support of employees with disabilities, specifically with respect to Electronic Information Technology (EIT) accessibility" within NASA. All of the members of the 508 Resource Group work full-time at NASA in a variety of capacities, but, as necessary, they offer assistance on 508 issues and advocate for better understanding of 508 compliance in our IT-centric world.

Members of the 508 Resource Group have been tapped to support some interesting 508 evaluations and continue to provide input on how to make applications, software, and Web pages more accessible. Just recently, Dr. Thompson was contacted by the Space Launch System (SLS) Program to provide user feedback to the software developer of the "NASA SLS Oculus Rift Experience." This software, developed by Media Fusion for the SLS Program, will serve as a unique educational tool—a "personal roadshow" of the SLS, intended for members of the public who commonly use virtual reality hardware. It is an exciting experience that allows the user to "see" and "hear," via a realistic animation of the launch system, from a perspective unknown to most people. To add to the fun, this animation also lets the user sit next to a virtual astronaut in the capsule.

Other examples of 508 Compliance Group valuable feedback include NASA's civil-servant time-and-attendance software (WebTADS) and a test app for a mobile platform that would allow "citizen scientists" to provide crop and drought condition information from across the United States.

As we continue to move forward into becoming a more mobile workforce, the 508 Resource Group can provide valuable insight to help NASA remain on path and in orbit. For advice about testing or translating 508 standards, please reach out to the NASA 508 Program Manager, Lori Parker (*lori.parker-1@nasa.gov*); your Center 508 Coordinator; or the 508 Resource Group Coordinator, Dr. Craig Moore (*craig.e.moore@nasa.gov*).

MDM Phase 2: Coming Soon

Kellie White, Communications Specialist, Marshall Space Flight Center

The Center for Internal Mobile Applications (CIMA) has partnered with the Identity Credential and Access Management (ICAM) team and the End Users Services Office (EUSO) to provide users with increased security and greater ease of use on their NASA-issued iOS and Android mobile devices. Given all of the recent cybersecurity threats seen within the Federal sector, the new technology being introduced by these three teams could not have come at a better time.

The new technology, which is being implemented in three distinct phases, will reach full deployment in late 2018. The first phase, completed in 2016, introduced the use of mobile device management (MDM) to the NASA community. Phase 1 provided users with the ability to register their NASA mobile devices at *https://mdr.nasa.gov*, which helps to secure NASA resources in the event that the mobile device is lost or stolen.

The implementation of the derived credential certificate for mobile devices (Phase 2) began in March 2017 with a small group of testers from each Center; an Agency-wide waved rollout is scheduled to begin in January 2018, completing around March 2018. This release eliminates the use of passwords for authentication on mobile devices, provides users with the ability to send/receive encrypted e-mails for iOS and Android ACES-furnished mobile devices, and further improves NASA's IT Security. Please note that only those users with ACES-issued devices will be authorized to participate in MDM Phase 2.

The third and final phase will begin rollout later in the calendar year of 2018 and will introduce the secure container for NASA-provided mobile applications. The secure container will give the Agency the ability to fully manage the life cycles of NASA applications and services being accessed from a NASA-provided mobile device.

Beginning in January 2018, be sure to look for Center announcements and opportunities to learn more. Until then, if you have questions or suggestions, send us an e-mail at *msfc-cima@mail.nasa.gov*.

Store and Share Data in the Cloud

Chris Blakeley, Box Project Manager, Kennedy Space Center, and
Mary Phillips, WESTPrime Communications, Headquarters

Looking for an approved cloud service to securely store NASA sensitive data regardless of file size? Need a place to collaborate with team members and share documents? NASA's Box pilot program might be the answer.

NASA is currently piloting a secure file collaboration platform for employees and contractors through February 2018. Box enables NASA to manage versions of sensitive documents more efficiently by allowing teams to work together and have access to the most up-to-date content.

"Box is a major cloud service for NASA that was deployed in less than 6 months. It's the only secure tool available within the NASA community for the storage and sharing of ITAR [International Traffic in Arms Regulations] data," said Ian Sturken, NASA Web and Managed Cloud Program Manager, Web Services Office.

To further NASA's mission of pioneering the future in space exploration, scientific discovery, and aeronautics research, tools are needed that allow users to do their jobs as effectively as possible.

Box users can

- save files to the cloud (and access them from the NASA virtual private network [VPN]),
- always track file versions,
- invite team members to work on files,
- share links with team members, and
- use Box Notes to take interactive meeting notes.

Sensitive data categories include the following:

- ITAR
- Sensitive But Unclassified (SBU)
- Export Administration Regulations (EAR)
- Non-sensitive Personally Identifiable Information (PII)
- Federal Information Security Management Act (FISMA, moderate level)

Through secure file sharing and collaboration, work can be completed inside NASA among employees and contractors without the risk of compromising any ITAR or sensitive data.

The service is FedRamp-certified and was provisioned through the Web Services Office on the WESTPrime contract managed by IT services provider InfoZen, a subsidiary of ManTech.

Users interested in the pilot must have a NASA-issued Personal Identity Verification (PIV) smartcard, and sharing is limited to NASA Box users only. To request an account, users can go to NAMS at https://idmax.nasa.gov/nams/asset/234734.

SSC Young Engineer's Design Challenge

By Christopher Carmichael, Chief Technology Officer for IT, Stennis Space Center

The Young Engineer's Design Challenge, hosted and sponsored by the Rocket Propulsion Test Program Office (RPTPO) and the Office of the Chief Information Officer (OCIO) at the John C. Stennis Space Center (SSC) took off like a rocket and was a great success!

This challenge gathered the best and brightest young engineers from across NASA in a multi-Center collaborative effort to design a new mobile rocket test stand that can withstand a thrust of 15,000 pounds of force.

The OCIO goals for this challenge were to foster a collaborative environment and evaluate information technology (IT) equipment and resources to aid in achieving an innovative and creative environment.

The RPTPO and the OCIO transformed the Logtown Conference Room into a unique collaboration space with new technology, including experimenting with innovative cloud-based software, and inventive furniture solutions to support a conducive environment for fostering creativity. One of the greatest challenges for creating this environment occurred at the conclusion of the event, when the space immediately had to revert to its regular conference room environment, an event successfully planned for in the design.

Feedback from this challenge benefits the RPTPO and the OCIO. The RPTPO hopes to use the lessons learned from this challenge to establish collaborative spaces at each rocket propulsion facility across NASA. The OCIO will use lessons learned from this challenge to deploy its Innovations and Efficiencies Program (IEP), led by the SSC Chief Technology Officer for IT. This program will develop a Technology Infusion Lab and collaboration space, providing SSC with an environment to generate creative solutions to SSC's challenges.

The SSC IEP is a program of the SSC OCIO and looks to usher in the future by encouraging creative, out-of-the box thinking which will open doors to create innovative and imaginative cross functional solutions.

NASA in the Cloud

By Karen Petraska, Program Executive for Computing Services, Headquarters;
Mary Jo Alfano, Program Support for Computing Services Program, Goddard Space Flight Center; and
Ray O'Brien, Chief Technology Officer for Information Technology, Ames Research Center

Cloud computing has emerged as a major innovation in IT service delivery over the last decade. Web-age companies are leading the charge by harnessing the convergence of high-speed Internet, the Web, and virtualization. Cloud computing is truly a disruptive innovation that turns time-tested IT management, acquisition, and security approaches upside down; creates new market leaders; and provides enterprises like NASA with an ever-growing, rich universe of application and service capabilities. These capabilities are literally a mouse click or an applications programming interface (API) call away. NASA projects and programs are enthusiastically embracing cloud computing's new capabilities and the benefits they afford NASA missions.

At NASA, cloud computing is provided as an enterprise-managed service by the Office of the NASA Chief Information Officer through the Computing Services Program (CSP). All commercial cloud computing services must be obtained in coordination with the CSP. Enterprise management of cloud computing enables NASA's cloud consumption to be consistent, safe, and compliant with industry best practices and Federal laws and requirements. Features of enterprise-managed cloud include the following:

- use of Agency-provided cloud procurement vehicles that include all proper legal terms and conditions to protect NASA's rights and data;
- consistent integration with Identity, Credential, and Access Management (ICAM), NASA networks, the Federal Information Security Management Act (FISMA), and the Security Operations Center; and
- standard governance and processes for assessing and authorizing the use of cloud services.

The cloud framework implemented by the CSP reduces the amount of time it takes to get started in the cloud and streamlines the effort that each cloud user or project must invest in cloud startup.

NASA's cloud adoption is focused on commercially available cloud comput-

ing services. Cloud Infrastructure as a Service (IaaS) providers, such as Amazon AWS and Microsoft Azure, have built massive computing and storage capabilities. These services enable users to quickly rent the precise amount of computing and storage that are needed, for only as long as they are needed, and utilize them via the Internet. This enables much faster "time to user productivity" by eliminating long acquisition cycles and additional delays incurred by the installation and configuration of NASA-owned hardware. Being able to "rent" more computing than you can afford to own offers much faster and better ways to address big datasets and very large problems.

Cloud Software as a Service (SaaS) is likely to have the broadest and most significant impact on the NASA workforce. Cloud SaaS is characterized by the use, via the Internet, of software that is deployed in the vendor's infrastructure. No longer will we purchase most software and install it on NASA-owned hardware. Instead, when we purchase the use of a SaaS product, we simply receive authentication credentials to use that software as installed on the vendor's infrastructure. Commercial software vendors are increasingly abandoning traditional "ship and support" and "download and install" delivery models in favor of SaaS. The SaaS model enables vendors to leverage a timelier and less costly software-updating methodology of "continuous feature deployment." This approach brings updates, patches, and new features to the user potentially on a daily basis. It also eliminates the high overhead associated with burdensome legacy software release cycles and associated support. As organizations evolve to owning less computing hardware, decreasing on-premises installations of software is the logical next step. Today, NASA's Application Portfolio is composed of approximately 80 percent traditional on-premises applications and 20 percent cloud SaaS applications. We expect to see those percentages reverse over the next five years.

Numerous SaaS services are either already authorized or in the process of being authorized for use at NASA. Google Apps for Work and Box are both currently available through the Web Services Office. Esri's ArcGIS, Jive, and Microsoft's Office 365 are all in various stages of being authorized for use at NASA. OCIO will be announcing quarterly the new major cloud offerings authorized for use in IT Talk.

Cloud adoption is not without risk. When you use the cloud, your data transits the Internet and is stored in a vendor's remote location that NASA does not control. These risks are manageable, and it is important to work with your Center's Cloud Point of Contact (POC) to ensure that your cloud usage is safe and compliant and that your data does not become compromised. Because cloud services are very easy to obtain and people often do not think about security or compliance when buying cloud services with a credit card or accessing those services for free, there is a tremendous amount of unauthorized cloud usage on NASA's network today. This usage threatens to compromise NASA's information security. NASA is embarking on a significant initiative to reduce the amount of unauthorized cloud use. This initiative will use appropriate processes to legitimately authorize some of these cloud services and eliminate the use of cloud services that cannot be made safe for use. (See sidebar for Cloud POCs.)

The cloud is revolutionizing how new IT capabilities are deployed by shortening the user's time to productivity and enabling users to benefit from new features immediately. Cloud computing is also simplifying how things get done through the use of endless new cloud microservices, serverless computing, and astonishing levels of automation. The adoption of cloud computing at NASA continues to grow in innovative and surprising ways. An increasingly cloud-savvy NASA workforce expects a high level of responsiveness in gaining access to the universe of powerful cloud offerings because it enables them to do their jobs better and helps them carry out NASA missions more effectively. We have only just begun to tap the vast potential of cloud computing.

Cloud Resources

Think there's a cloud solution for your project?

Want to join the Cloud Community?

Need to find cloud services and unsure of how to get started?

NASA's Enterprise Managed Cloud Computing (EMCC) Program has you covered! (All links are for internal NASA network use only.)

The EMCC is your guide to NASA's Cloud. Visit *https://emcc.nasa.gov* to find resources and news and learn how the commercial cloud is working for you.

Click here to join the Cloud Community of Interest, attend the monthly forums, and access past events:

https://intranet.share.nasa.gov/agency/cloudservices/Pages/CCOI.aspx.

To answer your questions about the NASA Cloud, find your Center's Cloud POC:

https://intranet.share.nasa.gov/agency/cloudservices/Pages/About-Us.aspx

Or check out the FAQ:

https://intranet.share.nasa.gov/agency/cloudservices/Pages/FAQs.aspx.

Serverless Computing in the GovCloud

By Sandeep D. Shetye, Data Management Program Manager and Chief Data Architect, Headquarters;
Cuong Nguyen, Extravehicular Activities Project Manager, Johnson Space Center; and
Chris Shenton, Chief Technology Officer for V! Studio, Johnson Space Center

Serverless computing is one of the hottest trends and is quickly gaining popularity, as well as widespread adoption. While misleading, the technology is called "serverless" because customers are not responsible for provisioning and managing servers; this burden falls to the cloud vendor. This is the next step in cloud computing, with vendors providing servers and assuming operational costs.

How Serverless Computing Works
Serverless computing is frequently referred to as "event-driven Function as a Service (FaaS)," where functions (code run on vendor servers) are typically invoked in response to events (actions triggering a computing process). This pattern is also referred to as "event-driven computing," in contrast to always-on servers that spend most of their lives idle. Since the functions are temporary, they are decommissioned after execution and users pay only for the computing time they consume. Additionally, the cloud provider manages data volume, allowing NASA to process large or small amounts of data based on demand.

What Can Serverless Computing Do?
Serverless computing is a great fit for the short-lived, event-driven applications where the code runs on the server for a brief period of time. Serverless architectures excel with complementary data, allowing many functions to operate simultaneously. Serverless computing is also a good match when the data load varies, as users are not billed for idle servers.

Many companies are handling intense workloads, including sensor networks of Internet of Things (IoT) devices or mobile game streams, using serverless architecture. Large media companies are migrating their content serving and advertising functions to serverless computing for its speed and cost advantage.

Why Did We Select Serverless Computing?
Our team wanted to quickly develop and deploy a couple of services to handle unpredictable and fluctuating data loads without adding a lot to the operational cost. We looked at serverless architecture and its ability to easily scale while only paying for what we use. It was a no-brainer—we decided to use Amazon Web Service's (AWS's) Lambda, the first public serverless solution. Others include Google's Cloud Function, Microsoft Azure, and IBM's Cloud Functions.

Serverless computing with AWS Lambda has proven to be an effective way to scale up. Since functions are intentionally short-lived, this method allows us to develop each service independently of the others, speeding development and deployment. Cost estimates also showed that serverless computing would be much less expensive than other autoscaling servers.

Serverless Computing in Use
The NASA Extravehicular Activities (EVA) Office Insight/Enterprise Data Integration (EDI) group used AWS Lambda to build a serverless Optical Character Recognition (OCR) application. The solution enabled EVA to extract text from nearly 100,000 PDF pages, scanned each month, without overwhelming the data integration pipeline.

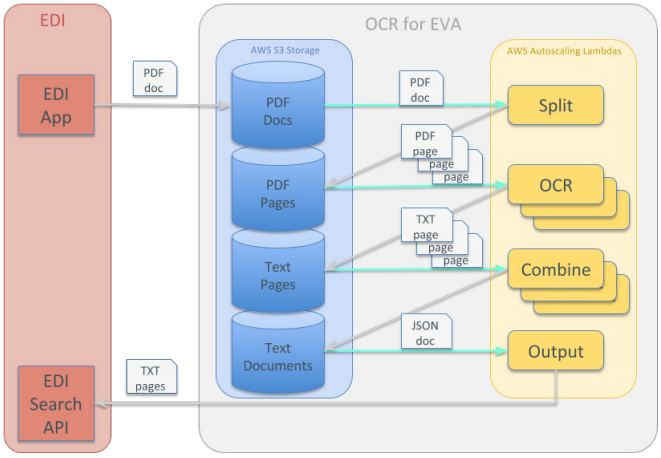
We realized that Lambda, with its instant and frictionless scaling, along with faster and cheaper service, provided us with the best serverless solution for this requirement. This was a perfect use case for serverless architectures, and it is the first deployment of serverless computing in the NASA GovCloud. The image below shows how the OCR technology uses serverless computing with AWS Lambda to meet EVA needs.

Benefits of Serverless Computing
The rise of serverless cloud computing offers key benefits:

1. Quick development and deployment.
2. Lower costs due to "pay for the runtime" model.
3. Elastic scalability taken care of by cloud providers.
4. Increased productivity from less administration and more development time.

Will It Lambda?
Serverless computing is a game changer, already benefiting NASA projects, and will be a part of the cloud strategy going forward. The Function as a Service approach allows us to evolve more rapidly than traditional systems, and costs are economical. We now approach new challenges with the question, "Will it Lambda?"

Reach out to sandeep.d.shetye@nasa.gov to find out how Lambda and serverless architectures can solve your challenges.



AWS Lambda uses serverless computing to split scanned EVA documents into individual pages, run an Optical Character Recognition application, convert the pages to text, and reassemble the pages into searchable documents.

Elevating Earth Science to the Cloud

Mark McInerney, EOSDIS Project Deputy Project Manager, and Keith Keller, Chief Technology Officer (CTO), Information Technology and Communications Directorate (ITCD), Goddard Space Flight Center

NASA's Earth Observing System Data and Information System (EOSDIS) (*https://earthdata.nasa.gov/about*) is in the middle of implementing a significant change in the way data users access and use NASA Earth Observation (EO) data (*https://earthdata.nasa.gov/earth-observation-data*): moving EOSDIS data and services to the cloud. Ironically, data users will likely not even notice when this change is implemented. What they will notice is more efficient access to mission data and the ability to do more with these data.

Between 2017 and 2022, the ingestion rate of data into the EOSDIS archive is projected to grow from the current 3.9 petabytes (PB) per year to as much as 47.7 PB per year, according to estimates from NASA's Earth Science Data Systems (ESDS) Program (*https://earthdata.nasa.gov/earth-science-data-systems-program*). As this ingestion rate increases, the volume of data in the EOSDIS archive also is expected to grow—from nearly 22 PB today to more than 37 PB by 2020. By 2025, the volume of data in the EOSDIS archive is expected to be more than 246 PB.

This anticipated growth in both the EOSDIS data ingestion rate and the overall archive volume poses new challenges for distributing and analyzing data currently stored and disseminated through physical servers on the premises at EOSDIS Distributed Active Archive Centers (DAACs) (*https://earthdata.nasa.gov/about/daacs*). To address these challenges, EOSDIS has partnered with NASA's Office of the Chief Information Officer (OCIO) and Amazon Web Services (AWS) to help build the Earthdata Cloud to ingest, archive, process, distribute, and manage the large volumes of EOS mission data. Implementing the Earthdata Cloud will, for the first time, place NASA EO data "close to compute," improve management and accessibility of the data, and help expedite science discovery.

EOSDIS data in the Earthdata Cloud brings numerous benefits, including the following:

- **Easy access:** Data users will be able to access data directly in the cloud, removing the need to download volumes of data for use.
- **Rapid deployment:** With an established EOSDIS cloud platform, data users can bring their algorithms and processing software to the cloud and work directly with the data in the cloud, simplifying procurement and hardware support while expediting science discovery.
- **Scalability:** The size and use of the archive can expand easily and rapidly as needed.
- **Flexibility:** Mission needs can dictate options for selecting operating systems, programming languages, databases, and other criteria to enable the best use of mission data.
- **Cost effectiveness:** EOSDIS and NASA pay only for the storage and services actually used. Along with scalability benefits, this practice allows the amount of storage or services to be continually adjusted to ensure that data and services are effectively provided at the lowest possible cost to NASA and EOSDIS.

Langley Managed Cloud Environment

Corey Portalatin-Berrien, Project Manager, and Mike Hiser, Student Trainee (Information Technology), Langley Research Center

Cloud computing, cloud hosting, cloud storage. "Cloud" is the latest buzzword, and everyone is talking about it, but what is the cloud, and why is it such a big deal?

Many Federal mandates encourage the adoption of cloud computing, to include the Federal Data Center Consolidation Initiative (FDCCI), the Cloud First Initiative, and the 2017 Report to the President on Federal IT Modernization. Perhaps more persuasive than a mandate is the definitive migration to the cloud by all areas of the private sector—finance, health care, energy, entertainment, education, and manufacturing. *The Economist* suggests that 90 percent of global enterprises have invested in cloud use and that cloud computing is now the largest category of IT infrastructure budgets for most organizations.

NASA Langley Research Center (LaRC) provides Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) solutions under the Langley Managed Cloud Environment (LMCE).

How does LMCE fit within Agency cloud efforts?
The LMCE is one of a handful of Agency-designated managed cloud environments—and certainly one of the busiest. LMCE leverages the environment and support provided by the Agency and adds value for local customers by adding security, procurement, and management features.

The LMCE operates as a Managed Service Provider, offering a secure, managed, Agency-accredited virtual data center. Today, the core Cloud Service Provider (CSP) is Amazon Web Services. As the Agency brings new CSPs on board, the LMCE looks to quickly integrate them into the Langley OCIO portfolio for a more robust cloud catalog.

Who is using LMCE?
Several teams across NASA LaRC are leveraging LMCE to support their missions. Projects include large-scale air traffic simulations, media rendering and transcoding, data science and analytics, mobile application deployment, and storage of large scientific datasets. These cases include migrations from locally purchased and managed hardware, to include bare metal, Graphics Processing Unit (GPU) intensive machines, and Storage Area Networks (SANs).

Disaster Recovery: One team is leveraging AWS's cold storage and large-data transfer mechanism to implement a tapeless disaster recovery program. The data will be transferred using Snowball, a secure physical storage device designed for large data, into long-term storage, Glacier. Upon completion, the data can be recovered almost immediately if disaster recovery is required.

On-demand computing: Several teams are utilizing on-demand resources to run flight simulations. A recent test spun up over 200 machines, simulating several thousand in-flight aircraft. Upon completion of the test, the machines were turned off, ensuring that costs are incurred only when a resource is active.

How do I learn more?
If you are ready to set up a trial run, learn more, or talk to the someone about this, contact the Agency Cloud team at *https://intranet.share.nasa.gov/agency/cloudservices/Pages/GettingStarted.aspx*.

The Next Technology Waves

Tom Soderstrom, IT Chief Technology and Innovation Officer, Jet Propulsion Laboratory, California Institute of Technology

Trying to keep up with everything new is exhausting! It's also not very productive. Is there a better way to deal with the rapid pace of technology innovations and translate them into something useful for our stakeholders?

JPL's approach: tie the new to something familiar. Living in California, we relate forecasting new technologies to searching for the perfect wave. With new technologies coming in like ocean waves at different strengths and intervals, it's up to us to decide which ones are worth surfing (i.e. prototyping and piloting). While we pay attention to technology swells ten years in the future, we will actually "surf" the ones that can solve real user problems over the next two years. This approach ensures we publish a position on everything relevant to our stakeholders while focusing our efforts on the most promising waves delivering near-term benefits. Early participation can also help influence the influencers.

Fig 1 – We surf only the technology waves that solve actual user problems

We have uncovered six major technology waves which, when combined, form a tsunami-sized wave we call "Built-in intelligence everywhere." Information we need will be available on demand, from any device, at any location, and filtered for our needs.

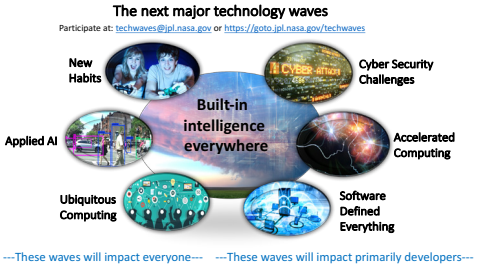


Fig 2 – The Next Technology Waves

Cyber Security Challenges

We must protect ourselves from sophisticated at-scale hackers from successfully taking down NASA websites using Netbots or organized phishing, vishing, and denial of service attacks. Protections will come from role-based training, default encryption, and possibly via Blockchain-based solutions.

Accelerated Computing

Computing capabilities will skyrocket through High Performance Computing in the cloud, Graphical Processing Units, edge computing to handle massive scale and latency, and problem solving with Serverless Computing. Blockchain, neuromorphic, and quantum computing will see productive implementations.

Software Defined Everything

In the future, everything becomes a programming problem and everyone is a programmer. Application Programming Interfaces are new currencies to be managed, maintained, and treasured. New programming languages will appear but the old masters (Python, JavaScript-based languages, and C) will still rule. Software defined, self-healing networks will become the infrastructure used by shape-shifting enterprises while software containers will facilitate improved scalability, testing, operations, and security. DevOps becomes a fact, not a discussion, and Open Source becomes the default choice.

Ubiquitous Computing

Internet of Things (IoT) will pay huge dividends to early adopters and evolve rapidly through natural user interfaces (i.e., speech/gesture/touch) and by using low-cost sensors. All computing is soon available on the go with mobile and wearable devices. You can have a full-fidelity Augmented Reality (AR) experience, or bring it with you on mobile devices. All your computing needs are with you at all times, and they are highly responsive.

Applied AI

Artificial Intelligence (AI), will be democratized and perpetually available on all devices. AI algorithms will be trained on huge data sets in the cloud and low-cost computing devices (e.g., Raspberry Pis and microcontrollers). We will have Digital Assistants and Chatbots at the ready or working in the background. Everything possible will be automated, and predictive, prescriptive analytics will be totally indistinguishable from AI.

New Habits

We will have interconnectivity to each other and all devices, enabling work from anywhere with relevant data always at our fingertips. In the workforce, we will share offices and equipment, paying only for what we use, à la Uber or Airbnb. Workspaces are environmentally aware and "green," helping recruiting. Gaming will enter the workforce in unexpected ways, just as it has in industry (e.g., video gamers earning millions of dollars playing online while others watch).

By catching and surfing these technology waves early, we will influence the influencers and ensure that NASA and humanity benefits. We want to see the swells early, watch the waves build, surf them to fruition, and then build the necessary ecosystem on the beach to be able to surf the even more impactful technology waves yet to come. Do you want to become a technology wave surfer? Join us by sending an email to techwaves@jpl.nasa.gov.

BSA Corner

By Meredith Isaacs, Communications Specialist, Headquarters

Over a year and a half ago, the Office of the Chief Information Officer (OCIO) began implementation of the Information Technology (IT) Business Services Assessment (BSA). The Business Services Steering Committee recommended, and the Mission Support Council approved, seven Decision Areas (Roles and Responsibilities, Governance, Computing Services, Communications, Workstations, Collaboration, and IT Security) designed to optimize IT services, enhancing collaboration, efficiency, and service delivery.

As teams from IT organizations across the Centers got to work, they encountered challenges, achieved victories, and began to change IT services at NASA. Some of these shifts were behind the scenes and others were visible to customers. Recently, OCIO leadership took a deep dive into IT BSA progress and concluded that we are nearing the finish line!

Taking a Victory Lap!

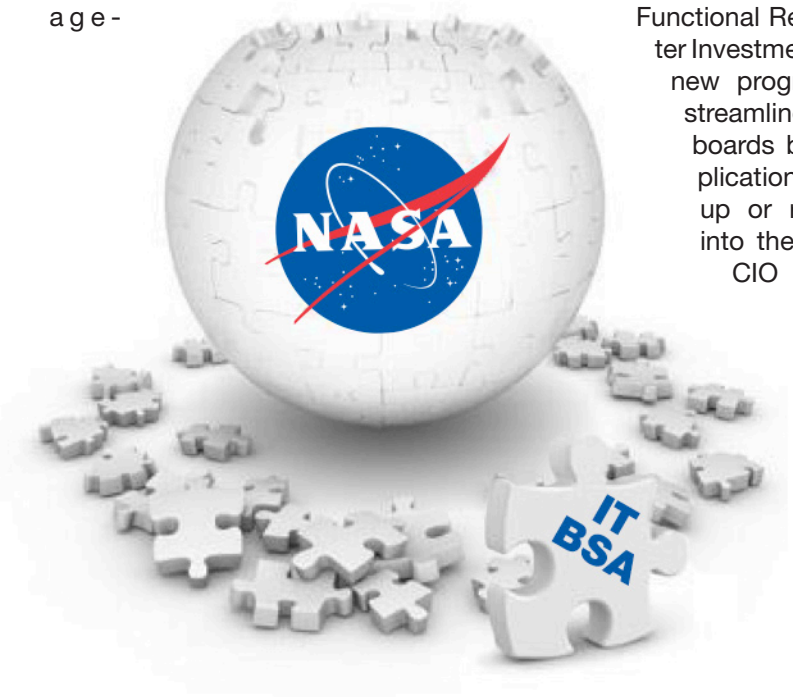
The Agency's IT Security teams were charged with establishing a risk management framework and reviewing IT security spending. Implementation of this decision resulted in the adoption of the National Institute of Standards and Technology (NIST) Risk Management Framework: Identify, Protect, Detect, Respond, and Recover. The OCIO also completed a zero-base review of cybersecurity spending.

Through an inventory of tools, the Collaboration team identified requirements and established the Collaborations Tool Portal: *https://inside.nasa.gov/ecs/approved-collaboration-tools*. Users can also look forward to NASA's Core Suite of Collaboration Tools, soon to be populated with Office 365 and Cisco capabilities. While both teams have completed their IT BSA objectives, they continue to evolve their services.

Nearing the Finish Line!

Agency Data Center and Cloud investments are now coordinated with the Computing Services Program, and Cloud Community of Interest forums are available to interested participants. (Want to join? Visit *https://intranet.share.nasa.gov/agency/cloudservices/Pages/CCOI.aspx*.) The Communications Program (CP) continued network transformation, aligning some communications services to the enterprise. Additionally, enterprise communication service funding was transferred from individual Centers to the Agency.

Governance teams implemented program reviews, the Center Functional Review, the IT Center Investment Review (ITCIR), new program boards, and streamlined IT governance boards by eliminating duplication and standing up or revamping others into the IT Council (ITC), CIO Leadership Team (CLT), and IT Program Management Board (ITPMB). The comprehensive program and portfolio reviews allow leadership the insight for stronger investment decisions.



Teams in these Decision Areas are working to finalize the data center architecture, strategic sourcing guidance, and network transformation, among others, to optimize IT services. This work is at least 90 percent complete.

In the Home Stretch!

Also nearing completion are Workstations and Roles and Responsibilities Decisions. The End User Service Program is coordinating with Centers to consolidate non-ACES workstations as contracts expire and to bring at least 80 percent of user workstations under the ACES contract. Most Centers have reached this second goal!

Under Roles and Responsibilities, the Applications, Computing Services, Communications, and End User Services Program Offices have been established and assigned Program Executives. Leadership is implementing common roles and responsibilities for consistent use across programs and Centers while Information Management and Security Service Programs continue maturation.

The Finish Line

IT BSA efforts have spanned the Agency, with countless hours dedicated to examining how IT works at NASA, determining how to optimize IT, and executing projects that benefit providers, customers, and the entire Agency. Thanks to these teams for their hard work, and we look forward to crossing the finish line!

The Right Solution—Hitachi Content Platform

By Jaumarro A. Cuffee, Communications Strategist, Johnson Space Center

In a Hitachi Content Platform (HCP) ribbon-cutting ceremony held on Monday, November 6, 2017, the Information Resources Directorate (IRD) and International Space Station (ISS) Program demonstrated their dedication to the continued implementation of the true spirit of JSC 2.0.

Focus on the priorities: In 2013, IRD recognized the need to investigate issues on the existing StorNext Archival System, which demanded a more comprehensive and forward-leaning solution that would address problems with the process, design, and accessibility of data for IRD customers.

"Do things differently"—improve our ways of doing business: After identifying the problems, IRD began researching new solutions with three key focus areas in mind: meeting customer needs, adhering to Agency priorities for meeting mission goals, and enhancing and exploring new technologies such as cloud computing. IRD worked with several individuals at Hitachi; Sony; the Communications, Outreach, Multimedia, and Information Technology Contract (COMIT); and NASA to devise a strategy to create a solid design that would meet all of IRD customers' needs while providing a hybrid approach to storing data that could leverage cloud technology.

"Accelerate the mission"—challenge inefficient and outdated processes: IRD invested more than 1 year researching new technology and working with multiple vendors to learn about and explore new, innovative ways to archive, secure, and separate data while engaging with IRD customers to better understand and capture their requirements. After diligent consideration and a decision analysis review of the many proposals identifying new technologies, IRD recognized that HCP had the capability to meet the mission

needs. True to JSC 2.0 and the goal of accelerating the mission, the HCP was not only the solution for right now, but also the right solution with future potential.

"**Advance commercialization"**—collaboration across organizations, Centers, and the broader space community: While the International Space Station is the largest customer of this new technology, IRD is committed to bringing other customers on board with this solution in the near future. Phase III of this project is scheduled for implementation in April 2018; it will execute disaster recovery at the White Sands Tests Facility and investigate the use of other features for accessing, collaborating, and storing data. The future of this platform has broad potential in the commercialization of space.

JSC 2.0

The technology and approach to archiving data through the Hitachi Content Management System allows IRD to meet evolving stakeholder needs and support mission success while reducing costs for both the Government and the customer.

The Director of IRD, Annette Moore, commented, "This strategy solution represents the spirit of JSC 2.0, and we are proud of this partnership with the International Space Station Program!"

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