



SAS and Cloud Computing

Deployment and Service Model Options

WHITE PAPER

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Executive Summary

Today's economic climate – with rising customer expectations, an accelerated business pace and fierce competition – requires organizations to make better use of their ever-increasing volumes of data for fact-based decision making. More and more enterprises are taking their data use to new levels and applying business analytics to support rigorous, constant business experimentation that drives better decisions – whether it involves testing new products, developing better business models or transforming the customer experience. The challenge to provide more and better information faster is changing the traditional approach to information technology.

Cloud computing's ability to provide elastic scalability, faster service delivery, greater IT efficiencies and a subscription-based accounting model has broken down many of the physical and financial barriers to aligning IT with evolving business goals. With its promise to deliver better business models and services quickly and cheaply, cloud computing has become a major driver of business innovation across all industries, and the market adoption of cloud services is delivering increasing revenue to cloud services providers. According to Gartner Inc. in its *2012 Forecast Overview: Public Cloud Services, Worldwide 2011-2016*, the worldwide public cloud services market size in 2011 was \$93 billion, and it is projected to grow to \$211.9 billion in 2016.¹

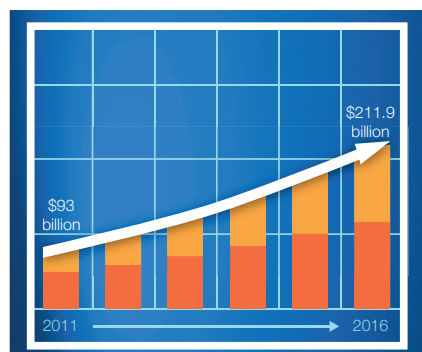


Figure 1: Growth and forecast of the worldwide public cloud services market.

While this paper discusses SAS® Cloud, and tools and technologies that deliver and support SAS in cloud environments, traditional on-premises SAS deployments will remain a key strategy for many of our customers. SAS Cloud is not a change in direction, but rather an effort to make SAS available to a broader audience through expanded deployment and delivery options.

This paper discusses the convergence of SAS software with the corporate movement to cloud computing. With clear goals to continue delivering business analytics software to enable fact-based decisions, SAS is committed to providing our customers with deployment options that target their evolving IT and business requirements. This includes enabling SAS Business Analytics for cloud deployment.

¹ Gartner Inc. *2012 Forecast Overview: Public Cloud Services, Worldwide, 2011-2016, 3Q12 Update*. November 2012.

In addition, this paper provides a summary of terms and concepts within the paradigm of cloud computing and “as-a-service” delivery models, focusing on different options and what SAS offers. Because virtualization enables the creation of flexible clouds with elastic computing resources, this paper presents a high-level overview of that technology. Other elements needed for successful cloud computing, such as security, data management, scalability and policy-based compliancy, are also addressed.

After reading this overview, we hope you will work with SAS to plan a cloud strategy that is best suited for your organization.

Cloud Computing Service and Deployment Models

It is helpful to frame the discussion of cloud computing within the market taxonomy. We start with the definitions of the cloud established by the National Institute of Standards and Technology (NIST),² which are adopted broadly by the technology analyst community and consumer marketplace.

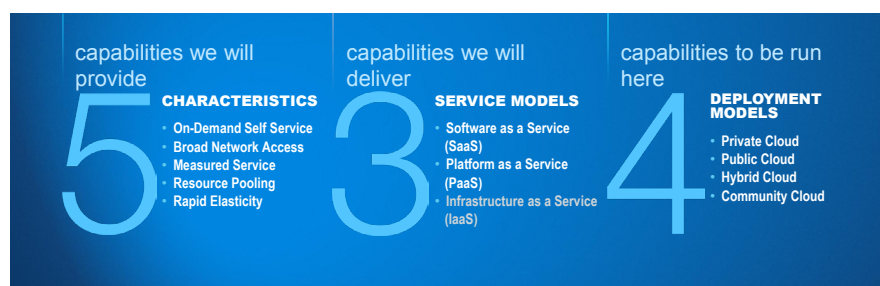


Figure 2: The key characteristics, service models and deployment models of cloud computing, according to the NIST.

Cloud Computing Characteristics

Cloud computing fundamentally changes the way IT services are delivered and consumed. Many perspectives define the benefits and characteristics of cloud computing, including business flexibility, operational efficiency and economies of IT and scale.

The NIST definition of cloud computing highlights the business value delivered through SAS Cloud Services offerings:

- Self-service access to get the software up and running quickly.
- Easy access from a diverse set of locations, devices and environments.
- Flexible options that build on capacity-based, user-based and value-based pricing.
- Resource sharing that is cost-efficient and sustainable for IT providers without compromising user capabilities.
- Options that scale as needed.

² nist.gov

Standard Service Models

In addition, NIST defines three standard service models:

- **Software as a service (SaaS).** SaaS enables consumers to use applications running on a cloud infrastructure. The applications can be accessed from various client devices through a thin-client interface such as a Web browser (for example, from Web-based email). The user does not manage or control the underlying cloud infrastructure or individual application capabilities, with the possible exception of limited user-specific application configuration settings.
- **Platform as a service (PaaS).** PaaS enables users to deploy their created or acquired applications using programming languages, frameworks and tools that are provided by the supplier. The consumer does not manage or control the underlying cloud infrastructure (networks, servers, operating systems and storage), but does have control over deployed applications and possibly the application-hosting configurations.
- **Infrastructure as a service (IaaS).** IaaS is considered the most basic “as-a-service” level where infrastructure equipment and resources are provided to clients. These can include storage, networks, processing and other general computing resources. The IaaS user is able to run software, has control over operating systems, applications and frameworks, and performs the general administrative functions, but does not manage or control the underlying infrastructure.

SAS Cloud tools and technologies include select offerings of SAS Business Analytics through software as a service (SaaS). SAS Cloud also includes a cloud development platform as a service (PaaS). As a software provider, SAS is not focused on providing the third model, infrastructure as a service (IaaS).

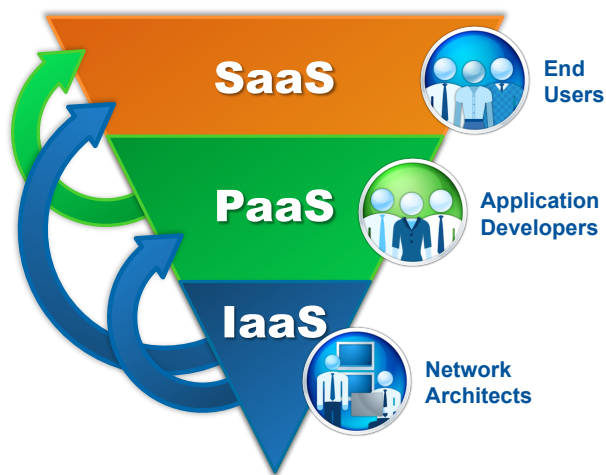


Figure 3: Infrastructure as a service (IaaS) provides cloud infrastructure that is typically accessed by IT and operations. IaaS delivers cloud infrastructure support for software as a service (SaaS) and platform as a service (PaaS). PaaS can provide development and run-time support for SaaS, but it is not required because SaaS can be delivered on top of IaaS.

Standard Deployment Models

Four standard deployment models are reflected in the industry: public cloud, private cloud, hybrid cloud and community cloud. To provide flexibility that meets the demands of our customers, SAS software can be deployed in on-premises private clouds, in a private cloud environment hosted by SAS and in commercially available public cloud environments such as Amazon EC2. SAS also supports the combination of public and private clouds in hybrid cloud deployment configurations.

- **Private cloud.** SAS customers seeking to benefit from cloud computing while maintaining control over their environment might choose a private cloud. Whether your goal is to more efficiently use existing underutilized hardware, simplify IT operations or provide users with scalable, on-demand access to applications, SAS provides multiple options for making SAS software available through private cloud deployment. Private clouds can be built and managed within an enterprise data center, or can be hosted by a third-party provider and managed either on- or off-premises. SAS cloud-enabled tools and solutions can be deployed and managed in private clouds. And, SAS Grid Manager can be used to build and manage your own private SAS cloud. SAS also provides enterprise-managed private cloud hosting through SAS Solutions OnDemand.
- **Public cloud.** Public clouds are open to the general public with cloud infrastructures that are owned and managed by the cloud service provider. Customers can benefit from cloud infrastructure cost efficiencies by deploying SAS on a public cloud infrastructure such as Amazon. SAS also provides professional services to assist customers who need advice setting up their SAS environment in a public cloud.
- **Hybrid cloud.** Customers can choose to create a bridge between public and private clouds to address increased demand for computing resources – such as end of month needs or peak shopping seasons. SAS Cloud Services supports scaling of deployments to meet fluctuating levels of demand.
- **Community cloud.** Sometimes several organizations with similar requirements may seek to share infrastructure to realize common goals. They will discover that a community cloud facilitates the necessary collaboration. While it is a widely accepted practice within the field of academia, commercial and governmental organizations are slowly augmenting their IT strategies with community cloud deployments. In the case of commercial organizations, the use and resources of a neutral third party best supports the common mission, security requirements, and policy and compliance considerations of multiple organizations.

Virtualization: A Key Enabler for Cloud Computing

Virtualization is a core technology that enables the cloud computing model. In this paper, we focus on the virtualization of physical machines (i.e., the abstraction of logical resources away from their underlying physical resources). Using virtual machines (versus physical machines) as building blocks improves agility and flexibility.

For IT, virtualization technology reduces the costs of physical resources through the technologies' ability to host multiple virtual machines on a single physical machine. IT is able to provide a more highly available infrastructure by using server clustering through virtualization. This allows IT to more easily manage failover and redirect users to available servers when a server fails, and provide load balancing to redirect users to underutilized infrastructure for improved system response times.

Private cloud environments are built on virtualization so underutilized hardware can support multiple logical machines that are consolidated into a smaller number of better utilized devices.

SAS® Cloud Deployment Options and Offerings

SAS® Cloud

The SAS Cloud is a hosted private cloud environment where customers can subscribe to SAS Cloud tools and technologies to receive rapid, self-service access to SAS Cloud analytics tools and solutions. Through service packages offered by SAS, customers are able to have SAS assist them with preparing and moving their data to the SAS Cloud. Following initial data preparation and movement, additional data can be added in the future through bulk uploads or trickled uploads.

The SAS Cloud benefits customers by providing quick user access without customers having to acquire hardware. In addition, SAS performs all hardware and software management and maintenance and guarantees that the most current version of SAS software is running at all times.

SAS® Cloud Tools and Technologies

SAS 9.4 includes architecture updates that enable SAS Business Analytics to be rapidly and easily deployed and managed in cloud environments. SAS Cloud Services tools and technologies include:

- **SAS Virtual Applications (SAS vApps).** These prepackaged, multiple-system virtual appliances are designed for easy and rapid deployment in cloud environments. SAS vApps contain one or more virtual machines that make up the application environment. Also included in each vApp is a ledger that is read by the deployment service to instruct how to unpack the vApp and how each virtual machine in the vApp is to be unpacked and configured. SAS Visual Analytics is the first SAS solution to be offered through this new subscriber service.
- **SAS App Central.** Role-based, Web portal interface enables providers, administrators and users to manage and access SAS software in cloud environments.
 - » Administrators acquire and maintain SAS vApps and manage SAS user access.
 - » Subscribers log in and access the SAS tools and solutions they have been given access to. They can also request access to new SAS tools and solutions.

- **SAS App Engine.** These technologies are used to assemble and deploy SAS vApps and maintain deployed SAS vApp environments.
 - » A distributed environment facilitates the delivery and updates of SAS vApp images. SAS Administrators access the SAS App Engine through SAS App Central.
 - » The SAS App Engine can check SAS servers to validate that the environments have not been modified since the last update and to monitor for configuration creep.
- **SAS App Works.** This SAS cloud platform supports agile development and promotes sharing and collaboration between development teams. SAS programmers can work together with business analysts, data scientists and Web developers to build custom applications that integrate SAS into their business processes and create interactive custom reports and dashboards for users.

SAS Cloud tools and technologies can be deployed and used in private and public cloud environments. While all SAS tools and solutions are not available as SAS vApps, a rolling schedule of SAS vApp offerings is being made available.

Public Cloud Infrastructure with SAS® on Amazon

As an approach to reduce the total cost of IT operations and allow IT to focus on core business objectives, many companies are turning to public cloud infrastructures. Taking advantage of cloud usage-based pricing is often desirable, but public cloud providers also provide an infrastructure that is highly available, scalable and easy to manage. Starting with SAS 9.3 M2, SAS customers can deploy SAS on Amazon Web Services Elastic Compute Cloud (AWS EC2). While AWS EC2 is supported as a deployment environment for SAS, it is recommended that customers use AWS Virtual Private Cloud, which provides increased isolation, control, customization and security through a virtual private cloud environment within Amazon's public cloud infrastructure.

Different from SAS vApp deployment and management, with this approach SAS tools and solutions are installed on Amazon infrastructure using the same process as on-premises deployment of SAS. However, there are configuration and integration differences between traditional on-premises deployment of SAS and Amazon deployment of SAS. If needed, SAS Professional Services can assist customers with deploying SAS on Amazon.

The Private Cloud with SAS® Grid Manager

Working with the expectation that an IT organization desires tight controls over service levels and infrastructure or has concerns over data privacy and security, many enterprises will opt for a private cloud deployment where applications remain on-site. Compliance concerns surrounding shared technology become a moot point with a private cloud. With this option, IT builds the private cloud, which is used only by its enterprise.

To enable private cloud computing for its customers, SAS has partnered with Platform Computing to offer SAS Grid Manager. SAS Grid Manager allows users to submit SAS jobs to a shared and highly available pool of resources (rather than to an individual server) to balance workloads, decrease processing times and better manage their SAS environment. Computing-intensive programs can be allocated and managed to run in pieces across the grid, enabling IT organizations to optimize hardware capacity, improve performance and offer more flexibility.

SAS Grid Manager provides the ability to scale business processes and accelerate decisions, giving organizations a significant competitive advantage. Deploying SAS products and solutions with SAS Grid Manager to run in a private cloud centralizes management and reduces the complexity of your SAS environment, creates a highly available environment to allow business continuity, enhances performance of IT resources and increases flexibility to scale out and meet fluctuating demands.

The key capabilities offered by SAS Grid Manager include enterprise job scheduling, workload balancing and the ability to segment large jobs and run the segments in parallel using a virtual pool of resources in a distributed environment.

- Enterprise job scheduling allows you to create and schedule SAS workflows over multiple distributed machines. SAS Grid Manager will automatically find and select the best available resource to execute each job within that flow.
- Workload balancing is essential for optimizing the workloads of multiple users submitting multiple types of jobs to a shared pool of resources. SAS Grid Manager provides queuing of jobs, policies for different types of workloads to deliver the desired service levels, and prioritization of workloads to meet the needs of different business units as well as the entire organization.
- Large SAS applications or programs can be broken into segments that can be run in parallel using SAS Grid Manager. Huge performance gains can be realized when you have workloads that can be broken into independent subtasks and run across distributed resources in a grid environment.

When considering SAS Grid Manager for a private cloud deployment, organizations should also recognize the additional value and IT benefits the product provides:

- **A shared, centrally managed SAS platform.** A single location to manage policies ensures maximum throughput and efficient use of IT infrastructure across the organization.
- **Availability and resiliency.** Software must be available whenever customers want and need to use it. A fault-tolerant and resilient infrastructure, designed to be self-healing, ensures that users can continue to operate and applications will complete their processing regardless of what happens at the technology resource layer.
- **Growth.** The ability to easily provide additional resources and incrementally grow the grid as the number of users and size of data increases over time prepares the IT infrastructure for any future changes.
- **Flexibility.** SAS Grid Manager facilitates dynamic resource reallocation to meet peak demands. Ongoing maintenance is made easier by allowing machines to be taken offline with no disruption to the business.

- **Chargeback.** Implementation of equitable sharing and recovery of cloud computing costs can be achieved by charging departments or organizational entities for the IT resources they consume.
- **Service levels.** Visibility of performance metrics are provided for comparative analysis with service-level objectives to each line of business.
- **Management.** Web-based monitoring of all users, job activity and resource consumption across the grid as well as alerting and optimized grid configurations enable ongoing management of the grid operation.

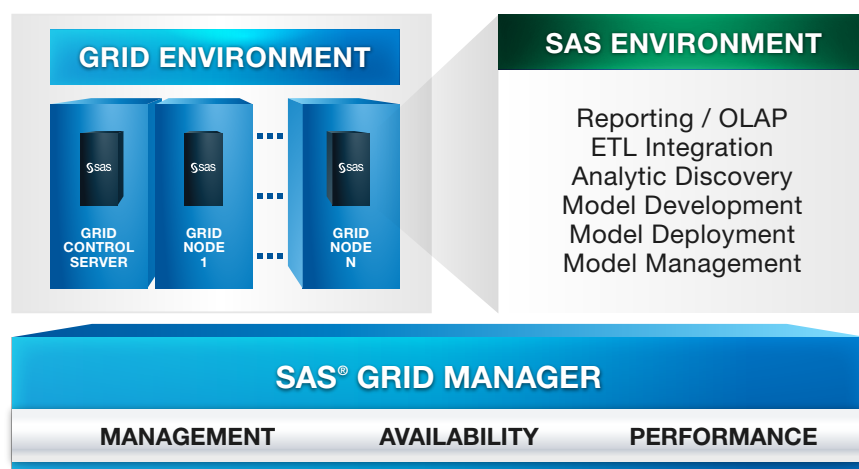


Figure 4: The SAS Grid Computing architecture.

Cloud Computing with SAS® Solutions OnDemand

A perennial problem for IT has been its ability to deliver new solutions at the speed demanded by the business. Working with the expectations of greater cost savings and speed-to-use as primary drivers, organizations can gain an advantage using public or community cloud deployments. To support the successful deployment of private and community cloud computing, SAS Solutions OnDemand was established with a state-of-the-art facility, managed by SAS experts, for the use of SAS applications and services.

While IT can be reluctant to relinquish control over infrastructure and service levels, benefits include improved engagement with constituents, an improved focus on core operational solutions and faster innovation for the organization overall. There are internal challenges for IT, including shifting service models, realigning personnel and adapting business processes, but the benefits of faster deployments make it worth consideration. Other drivers that support the use of public cloud deployments include:

- **Labor.** IT budgets are constrained by the rising cost of personnel required to install and maintain software. SAS Solutions OnDemand, staffed by SAS experts, reduces the need for IT to add to its headcount.

- **Energy.** Costs for power and cooling continue to rise, and increased focus on sustainability initiatives can make looking elsewhere for resources an attractive proposition for IT organizations.
- **Innovation.** Fast implementations and the ability to use new dynamic applications can improve time to market, market expansions and customer satisfaction.

SAS Solutions OnDemand provides select SAS solutions via the software-as-a-service model. It also provides SAS-hosted private cloud environments that are built, managed and maintained by SAS to deliver an isolated cloud environment with control over security and service levels.

Feeling Secure with SAS® Solutions OnDemand for Your Cloud Environment

SAS Solutions OnDemand was established in 2000 and serves users in more than 70 countries, representing academic, government and commercial sectors. State-of-the-art outsourced applications are provided to consumers along with subject-matter expertise to manage and implement them. SAS Solutions OnDemand operates data center facilities around the globe to deliver near proximity hosting for reduced network latency, and to comply with data sovereignty rules and regulations.

SAS Solutions OnDemand manages a wide variety of customer data in a highly secure manner and in compliance with data privacy requirements that vary with country and customer specifics across all continents. SAS Solutions OnDemand has a proven track record of managing highly sensitive data for both public- and private-sector organizations.

Security and compliance

Proving the commitment to safe and secure public cloud deployments, SAS has completed the following certifications and audits widely seen as standard for third-party delivery.

- SAS 70 Type II Audit – Recognized auditing standard developed by the American Institute of Certified Public Accountants (AICPA).
- SysTrust – Trust Services composed of the SysTrust and WebTrust programs. Trust Services are issued by the Assurance Services Executive Committee of the American Institute of Certified Public Accountants.
- TRUSTe – SAS has worked with TRUSTe to certify adherence by SAS Solutions OnDemand to its seven data and online privacy principles.
- Safe Harbor – Developed by the US Department of Commerce in consultation with the European Union (EU). US-EU Safe Harbor is a streamlined process for US companies to comply with the EU Directive 95/46/EC on the protection of personal data.
- Penetration testing – SAS Solutions OnDemand routinely performs vulnerability testing and application scans, and hires third parties to perform manual penetration testing.

- **Security** – SAS strongly believes security is not just about the technology. It's also about the processes in place to ensure the different levels of security.
- **EU data privacy and compliance** – SAS Solutions OnDemand manages and protects the privacy and security of global customer data that it processes on behalf of our customers.

Practices, policies and capabilities of SAS® Solutions OnDemand

SAS has implemented numerous systems to ease concerns of the most demanding domestic and international IT clientele. The following represent just a few of the policies and practices used to ensure availability and enforce logical, physical and personnel security.

- **Facilities.** SAS Solutions OnDemand infrastructure is hosted in physically secure environments within SAS data centers. Data center operations personnel work together with the SAS security department to control physical access to the data centers by enforcing multiple layers of physical security.
- **Staff.** Detailed SAS security policies document the security guidelines for staff members who work in the SAS Solutions OnDemand facility. All personnel are subject to employment reference checks, a criminal background check and drug screening.
- **Data transfer.** SAS Solutions OnDemand maintains a secure file transfer infrastructure that requires data encryption for transmission using industry-standard encryption methods. All data transferred to SAS Solutions OnDemand hosting services must meet these encryption standards.
- **Advanced Analytics Lab.** The Advanced Analytics Lab at SAS works with clients to implement innovative analytical processes and techniques for cloud deployments using SAS software.

Case Studies

ISO: Private Cloud with SAS® Grid Manager

ISO Innovative Analytics (IIA), a unit of ISO, supplies data, analytics and decision-support services to property/casualty insurance, mortgage lending, health care and other markets. IIA exploits new technologies and new mathematical solutions to create advanced models for risk-based insurance pricing, claims fraud and other applications that ISO provides to its customers.

As the innovation engine for the entire organization, the IIA unit is keenly aware of the impact of inadequate technology on its ability to execute its mission. "Lack of scalability is an innovation killer," said Marty Ellingsworth, head of IIA. The organization found that its SMP servers running Base SAS and SAS/STAT® had several performance problems related to data provisioning, I/O and sequential job flows. These shortcomings led not only to analyst frustration, but also to slowdowns in the time to bring new products and services to market. In addition, because IIA was a new venture within ISO, there was a potential for damage to internal credibility, and strained relationships with internal groups and business development staff.

IIA analysts can now run up to 70 concurrent jobs on the grid-based solution. The grid is located in ISO's New Jersey headquarters facility, but the grid-based virtual machines are accessed from many US locations.

IIA was able to achieve substantial improvements after recently moving SAS® Enterprise Miner™ and SAS® Enterprise Guide® to a grid system with a cluster backbone using SAS Grid Manager. For example, IIA analysts can now run up to 70 concurrent jobs on the grid-based solution. This parallel processing capability, combined with sort speeds that are five to eight times greater and complex math runs that are completed three to four times faster, promises to dramatically boost analyst productivity.

A half-dozen models can now be tested within two hours to see which works best. And it is now feasible to create and run more granular, higher-resolution models that incorporate key statistical areas that had to be omitted before, such as ultraviolet-based paint fading and roof cracks in the property insurance domain. In addition to performance and scalability gains, IIA was also able to consolidate disparate modeling algorithms into one sharable, collaborative environment.

The new grid-based SAS Analytics solutions, which IIA calls “The Advanced Analytic Platform,” arrived none too soon. Due to increased demand, the unit plans to add more analysts soon. The grid-based solution has improved analyst productivity by changing the typical process from single job, serial-number-crunching cycles that took a long time to complete to a “fire and forget” method, whereby an analyst can start a computational job and immediately advance to the next project. The grid is located in ISO’s New Jersey headquarters facility, but the grid-based virtual machines are accessed from many US locations.³

McKesson: Winning Big with SAS® Solutions OnDemand

McKesson – a health care company that distributes pharmaceuticals and medical supplies and sells health care information technologies – is winning big with SAS. Stephen Buck, Vice President of Analytics Services, heads analytics in McKesson’s Pharmaceutical Division. Buck works with a team of 10 analytics professionals on marketing analysis, clinical analysis and industry analytics involving all types of reporting functions. By introducing SAS Solutions OnDemand, Analytics Services has increased productivity and creativity.

Analytics Services used to operate in silos, with team members doing individual analytics, data pulls and manipulations in a decentralized manner. The staff would spend months preparing data extracts and prepping for analytics instead of actually performing the analytics necessary to keep the business moving forward.

McKesson turned to SAS to help resolve that dilemma. By eliminating silos and putting data in a centralized place – housed securely at SAS – the necessary basics of getting started are taken care of and staff members are both more productive and focused on attacking issues and preventing problems rather than preparing for them. Analytics Services used to spend months working through cross-business units. With the SAS solution, the team spends minutes or hours doing the same type of work.

³ IDC White Paper. *Raising the Bar on Business Analytics: Innovation Powered by Grid*. No. 310709

McKesson's Analytics Services team develops analyses to quantify a variety of insights. One example is the impact multiple enrollments in marketing and sales programs have on overall loyalty to McKesson. Without a master database to show particular pharmaceutical customers in all areas where McKesson does business, the analysis could not be done. With SAS, McKesson has taken sales data and combined it with all of its program enrollment information to give management a clear picture of which programs, products and services are keys in driving customer loyalty. As McKesson seeks even more insight about customer loyalty, SAS provides the means to make the data ready and waiting.

"There is no doubt that the solution provided by SAS Solutions OnDemand was the missing element in accelerating analytics at McKesson," Buck says. "SAS had us up and running in less than two months, compared to a 12- to 18-month time frame if we did this on our own."

The team is also analyzing drug and medical conditions to determine the right type of pharmacy-based interventions pharmacists can perform. Without the SAS platform's ability to hold and analyze this data, McKesson would not be able to develop cutting-edge medical practices and clinical protocols. Mohammed Mahboub, MD, Director of Analytics Services at McKesson, puts it this way: "Our SAS centralized analytic platform empowered efficient, accurate and consistent analytics. It did so by providing everyone on the team access to the same clean, de-normalized, reliable, consistent and up-to-date data sources."

When the team starts projects with new manufacturers or new payers, SAS provides a ready, accessible platform to store the data. "SAS has eliminated and streamlined so much for us that it makes us confident in talking with a payer or manufacturer to say, 'No problem. If you want to send us data or we need to get data, we have a place where we can store it, protect it and organize it,'" Buck says.⁴

Enterprise Hosting with SAS: North Carolina Office of the State Controller Is Getting Tougher with Crime

Increased data volume, archaic information systems, shrinking budgets and constrained resources can hinder law enforcement and criminal justice agencies from effectively coordinating information and proactively maintaining public safety. Public safety agencies need reliable, timely and accurate data to strategically and tactically reduce crime and victimization, enhance public safety and optimize the allocation of finite resources. Challenged with obtaining a comprehensive view of individuals with prior criminal records, including potentially dangerous offenders, law enforcement and criminal justice officials in the state of North Carolina needed an efficient, integrated application to provide quick access to accurate offender information.

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McKesson

⁴ sas.com/success/mckesson.html

To replace the manual process of integrating historical criminal data from multiple systems, reduce the risk of overlooking critical data and improve the information needs of law enforcement agencies, the North Carolina Office of the State Controller worked with SAS to develop the Criminal Justice Law Enforcement Automated Services (CJLEADS) application. CJLEADS is an on-demand, Web-based application hosted by SAS. It integrates criminal offender data to provide courts, law enforcement, and probation and parole agencies with a complete view of a criminal offender. The system also includes a watch list that allows officials to monitor the change of any offender's status, such as arrests, future court appearances or a release from custody.

"CJLEADS is a tool to support criminal justice officials with making quicker and more effective decisions," says Kay Meyer, Project Director, NC Office of the State Controller. "CJLEADS brings together disparate criminal justice data to help create a more rounded profile of offenders – including court, warrant, probation, parole and local jail information – which agencies can access securely via the Web."

With the new system, authorized criminal justice professionals can log in to the application through a secure, Web-based interface to perform searches. Search results on individuals are displayed as summaries, which can be clicked on to view more detailed data. In addition, automated messages can be requested to monitor an individual's legal status changes.

"Because SAS hosts CJLEADS, the state was able to focus on design and business requirements, rather than procurement and installation of a technical infrastructure," explains Meyer. "With shrinking state budgets, leveraging existing computing capabilities and technical support resources was an economical and efficient way to establish the new application environment. CJLEADS is highly scalable. Initially supporting 3,000 users, it will grow to support some 33,000 criminal justice professionals. Based on improved access to information, the state estimates a savings of \$7 million annually. SAS' expertise in data integration and analytics, as well as strong security controls of the technical environment, application access and authentication, was critical due to the complexity and sensitivity of the data."⁵

"Initially supporting 3,000 users, it will grow to support some 33,000 criminal justice professionals. Based on improved access to information, the state estimates a savings of \$7 million annually."

Kay Meyer

Project Director, NC Office of the State Controller

SAS: Internal Private Cloud with PaaS Deployment

SAS has been delivering dynamic, on-demand computing resources to its sales force, customer instructors and internal trainers since 2004 through the remote access computing environment, known internally as the RACE cloud. Using resources in the RACE cloud enables the global R&D development, testing and delivery teams to build, test and deliver software and solutions to market – with the quality that customers expect – in a shorter time frame because these teams can quickly set up the computing resources needed for each phase of the process.

⁵ sas.com/success/ncofficeofstatecontroller.html

The RACE cloud is a development and test cloud environment that provides an IaaS and PaaS service model for more than 11,500 employees globally. The Scheduling and Image Management System (SIMS) is the provisioning platform that orchestrates the construction and deployment of servers within the cloud. The cloud architecture uses network appliance storage accessible via SAN as the foundation of the cloud for near-instantaneous cloning of disk images. The combination of thin provisioning and the centralized storage and management of data in the cloud facilitates reuse of data and eliminates redundancy. Therefore, SAS has been able to reduce the data footprint of its code image library by 50 percent.

For computing resources, the RACE cloud uses VMware ESX for Intel x86-based systems such as Windows and Linux. Solaris zones and containers are used to support SPARC-based systems, and workload partitioning is used for AIX systems. Through the use of these virtualization technologies, the ability to scale the RACE cloud becomes a simple matter of introducing new resources and updating the SIMS application to recognize those resources. Management of the cloud is made easier by the level of abstraction between the bare metal equipment and the servers configured in the cloud. As an example, older IBM hosts within the RACE cloud were swapped out for newer Dell hosts supporting more CPU and RAM without a major outage, disruption of service or cloud reconfiguration. After the upgrade, the SIMS application was updated to allow servers with larger memory and CPU requirements to be constructed and deployed on the new hardware. The RACE cloud supports three main technologies to enable accessibility to a server once it is deployed: console access through Windows Remote Desktop Client (RDC), CVPN connectivity through a Juniper-supported Web portal and application-level access through Citrix.

SAS requires such a dynamic environment because supporting many platform hosts for its finished products is a core requirement. SAS supports provisioning of Windows, Solaris, AIX and several variants of Linux operating systems on finished images, which is abstracted from the person choosing the image to run.

In addition, making code images available in multiple languages is a requirement for SAS with developers in countries around the world. Images are rated, much like titles at an online movie rental site, to help developers quickly find what they need. Images in the RACE cloud are indexed, which is another significant benefit that drives efficiency. Prior to the RACE cloud, finding a server with the software needed for testing or development was very time-consuming. Developers and testers often had to sit down to discuss how a machine was configured and what software products it contained. That process now is simplified with the interface used to select the images. A quick check of the index tells when the image was created, who created it and what software the image contains.

Conclusion: SAS as Your Cloud Partner

Cloud computing not only represents a wave of change in the way organizations expect software to be delivered, but also how the IT departments deliver diverse value to support their organizations. With cloud computing, IT departments can reap a number of benefits:

- **Infrastructure.** Reduce spending by sharing infrastructure and other resources, saving procurement cycles and money.
- **Scalability.** Improve processing or store more data than with private computer systems and expand/contract needs within the cycle of business.
- **Automation.** Forego the need for additional IT personnel to manage software updates or version compatibility with different operational systems, databases and middleware.
- **Mobility.** Access information wherever and whenever via Web browser. This improves productivity for the growing mobile workforce.
- **Collaboration.** Organizations under different ownership structures find it pragmatic and expedient to share documents and solutions in the cloud, thereby solving legal or governance issues related to access of each other's network.
- **Subscription.** Traditionally software vendors have offered only an outright product purchase, thereby imposing higher financial strains and risks on the purchasing organization. Alternatively, ongoing subscription licensing reduces the upfront expense and provides organizations with an opportunity to use operational budgets rather than capital expenditures.

The capabilities and benefits shown above prove SAS is a trusted partner that can be counted on to help transform IT organizations with cloud computing, whether:

- Within an enterprise as a private cloud model.
- Outside your enterprise as a public cloud model.
- Outside your enterprise with a software-as-a-service model.
- Integrated from an enterprise business process to SAS Solutions OnDemand as a hybrid cloud model.

About SAS

SAS is the leader in business analytics software and services, and the largest independent vendor in the business intelligence market. Through innovative solutions, SAS helps customers at more than 65,000 sites improve performance and deliver value by making better decisions faster. Since 1976 SAS has been giving customers around the world THE POWER TO KNOW®. For more information on SAS® Business Analytics software and services, visit sas.com.



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