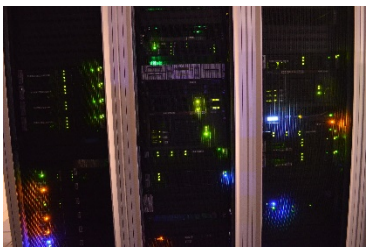
RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

Recommendations of the ITLC Enterprise Cloud Strategy Committee



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Forward from Committee Chair

The technology world bombards consumers, technologists, and organizational leadership alike with a never-ending stream of all things "cloud." A procession of vendors race to produce cloud-based solutions and offer enticing rates to migrate to the cloud. It is hard not to feel far behind in the ever-escalating and hype-driven world of technology related to the cloud; a world that offers scalability, agility, and is seemingly far more cost-effective than traditional technology.

Faced with large capital investments looming in the future, some institutions have even adopted large-scale all-in migrations to the cloud termed "lift and shift" in order to take advantage of these new technologies. While attending conferences, many of us have listened to speakers tout their embrace of the cloud and how it revolutionized their processes. Armed with this knowledge and feeling far behind, the committee set out to build a strategy to tackle the ostensibly lowest hanging fruit: Capital expenditures in the form of Infrastructure as a Service (IaaS). This is the work of moving physical computing to virtual environments and moving virtual environments to the cloud.

The committee surveyed the Rutgers IT community, researchers, and even reviewed vendor engagements only to find that very few groups had any cloud engagement beyond Software as a Service (SaaS) such as Office 365. After a number of vendor and consultant meetings, it also became apparent that IaaS was the most expensive option available. Most traditional vendors "cloud offerings" outside of the big three–Amazon Web Services, Microsoft Azure, and Google Cloud Platform–were merely repackaging of the three with add-on fees. Even more perplexing was that institutions that had performed "lift and shift" had seen their IT costs increase substantially, and universities touted as cloud champions had only a single staff member managing their entire cloud engagement which was relatively undeveloped. A frequent snarky comment echoed by cloud veterans is "welcome to the cloud".

The cloud is not the ultimate destination, it is an extremely powerful tool in a tool set. It is not all smoke and mirrors, and there are substantial, if not exponential gains to be made by embracing cloud technologies. The value proposition in cloud is in its agility, scalability, and yes- commoditized infrastructure. However, it is all based on purposeful engagement, a commitment to continuous learning and improvement, and flexibility in both approach and governance. There may be some savings moving to cloud technologies. However, much of the savings is realized in more esoteric concepts such as rapid, flexible deployment; compilation and analysis of big data; and improvements in productivity. Our committee realized that removing the confusing, daunting task of cloud engagement was the ultimate goal. Yes, truly, "welcome to the cloud".

Executive Summary

Cloud computing holds many promises; however, the journey to take advantage of this new technology can prove to be a challenging set of tasks. Navigating vendor cloud offerings is a forest of complexity. Developing new policies and procedures to accommodate the new technology is a daunting task, especially in our decentralized environment.

This Committee believes that Rutgers is better served by IT focusing on preparation and on agility in process to adapt to the rapid and incremental nature of the cloud. Laying proper groundwork, allowing for flexibility, and encouraging an environment of continuous education is the path to success in the cloud.

To that end, we feel the following goals are achievable through enacting the recommendations in this document:

- Reducing the complexity of cloud engagement
- Creating a strong, central backbone to foster and support initiatives
- Improving the security, understanding, and handling of data
- Educating, preparing, and retaining a next generation IT workforce

Recommendation Summary

Recommendation 1: Rutgers should adopt an "Opportunistic Cloud" Strategy for new services or solutions.

Recommendation 2: Rutgers should form both a "Cloud Center of Excellence" throughout all of Rutgers with specific dedicated subgroups focused on Research, Instructional, and Administrative computing as well as a central cloud infrastructure team.

Recommendation 3: Rutgers should establish centrally managed formal business relationships with Amazon Web Services, Microsoft Azure, and Google Cloud Platform integrating procurement, on-boarding, and billing into a seamless experience for the Rutgers community.

Recommendation 4: Governance should be made flexible enough to still realize benefits from cloud technologies while effectively mitigating risks to the university.

Recommendation 5: Rutgers organizations should look to modify current practices to fully leverage the advantages of cloud computing.

Recommendation 6: Rutgers should make cloud training broadly available to the IT community.

Recommendation 1: Rutgers should adopt an "Opportunistic Cloud" Strategy for new services or solutions.

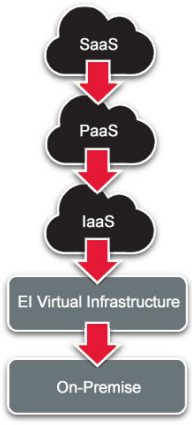
Given the existing investments in technology on campus, and highly distributed computing environment at the University, the committee recommends that Rutgers adopt an "Opportunistic Cloud" strategy. This means that IT leaders should consider the cloud where appropriate when deploying or refreshing technology. This will ensure that the projects Rutgers invests time and resources moving to the cloud are best positioned to take full advantage of what the cloud offers.

Definition of "Opportunistic Cloud:" The ECAR working group from EDUCAUSE published the following four cloud strategies as examples along a continuum. Given the current state of Rutgers, the committee recommends the third, "Opportunistic Cloud" as the best option.

- Cloud Aware: Awareness of broad cloud trends but not yet prepared to adopt cloud.
- Cloud Experimentation: May begin deploying some common SaaS solutions, which sometimes grows into testing IaaS deployments.
- Opportunistic Cloud: Actively seeks out cloud solutions to meet new business requirements.
- Cloud First: The default assumption is that cloud services will fulfill the majority of the institution's computing needs.

Typical Types of Cloud Offerings: The following terms are part of a continuum and some offerings will have traits of multiple types. IT leaders are encouraged to look at this continuum from the top down when considering solutions:

- Software as a Service (SaaS): These offerings deliver a fully managed business service to the University typically via a subscription model. Development, patching, monitoring, and hosting are all performed by the vendor. Typically offerings will have rapid feature development, but more limited opportunities for the University to dictate the priorities of new features. Vendor support may be streamlined since the hosting and software is a unified offering reducing the number of vendors involved. Examples of SaaS in use at the university include Office365, Qualtrics, Slack, and the SciQuest Marketplace.



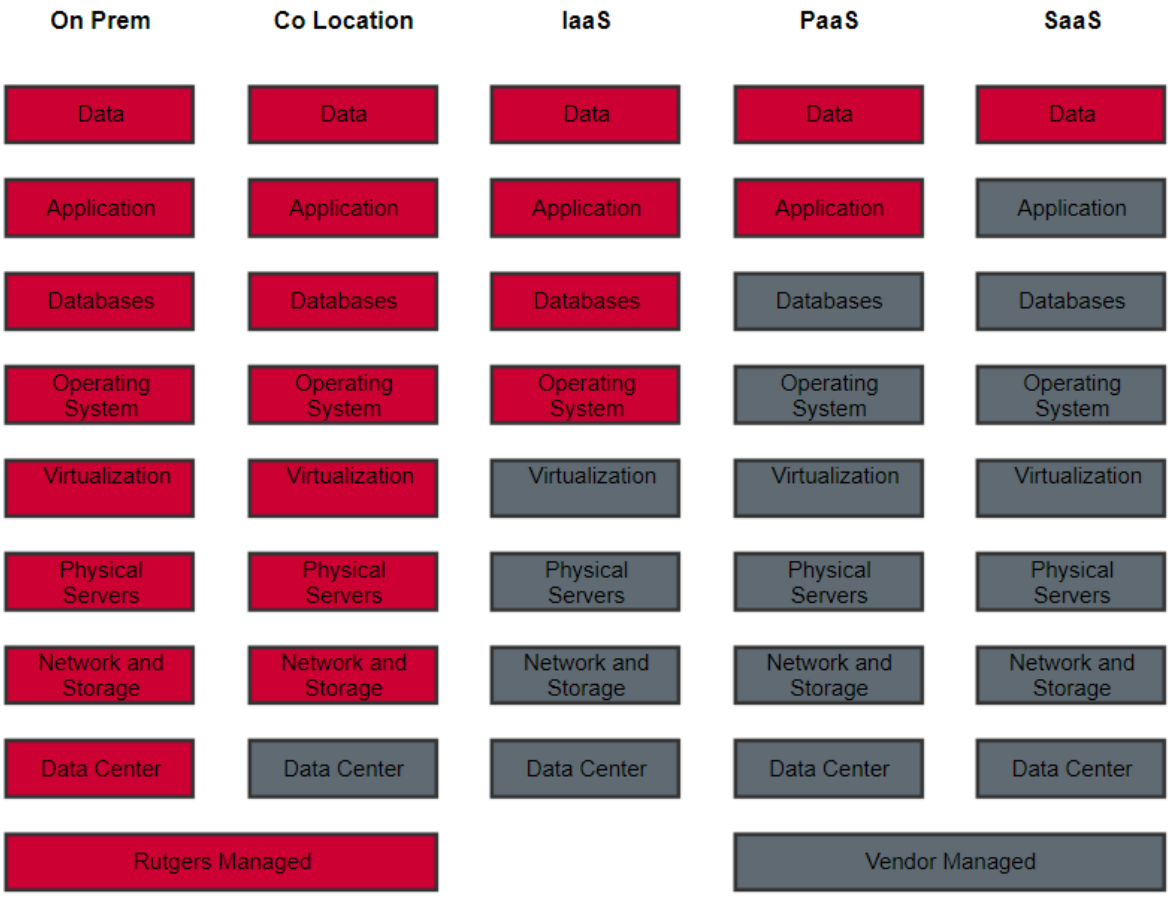
- Platform as a Service (PaaS): Sits towards the middle of the continuum. PaaS offers the ability to run custom applications on a managed platform without direct access to the underlying infrastructure. Patching and updates of the platform are managed for the university. These offerings allow Rutgers to leverage best-in-breed pre-built solutions in the design and delivery of custom IT services. The AWS Relational Database Service, Pantheon Web Hosting, Docker Container Services, and the Machine Learning APIs available from Google Cloud Platform are all examples of PaaS offerings.

- Infrastructure as a Service (IaaS): Typically the lowest level offering, IaaS offers typical IT resources in the cloud. Virtual Machines, networks, load balancers, and storage all exist as IaaS offerings. These solutions offer the most customization and control of the continuum while still allowing for the rapid provisioning of all cloud offerings. AWS, Google Cloud Platform, and Azure all offer a full suite of these services.

Current Types of On-Premise Solutions: (These options currently exist on the Rutgers campus)

- Central Virtual Infrastructure (VI): Starting in 2015, the Enterprise Infrastructure group deployed a large scale virtual hosting infrastructure for the use of OIT and departments. Both centrally managed and department managed machines run in this shared environment. In this shared environment, a high level of customization is available, but deployment times are significantly slower than what is available on the cloud as solutions are provisioned by hand.
- Colocation: Enterprise Infrastructure runs a number of on-campus data centers which offer physical hosting of IT assets. Several off-campus contracts are also maintained.
- Local deployment: Historically, Rutgers has had a highly distributed compute environment. Many departments, including OIT, have their own custom physical and virtual facilities for offering infrastructure to their units.

Division of Responsibilities: Each of the deployment choices shifts the responsibilities between Rutgers and its vendors. By adopting solutions higher on the cloud stack, Rutgers has the vendor handle more commodity IT tasks allowing Rutgers staff to focus on delivering unique business value.



Cost Factors for Running in the Cloud (PaaS and IaaS): There is an assumption that running services in the cloud is a cost saving move.

Factors that can reduce cloud costs:

- Leverage built-in services to reduce development effort.
- Use PaaS offerings where practical to reduce maintenance and development time.
- Choose software platforms where campus licensing agreements support cloud deployments.
- Consider SaaS offerings where they meet business needs.
- Use reserved instances to handle normal load.
- Use auto-scaling to handle peak load.
- Turn-off test and development tiers when not in use (40 hours/week vs 168 hours/week).
- Use object storage when possible.
- Take advantage of central cloud resources where available.
- Use open-source operating systems.
- Pay only for today's requirements.

Budget Planning Tools: All of the recommended cloud vendors offer on-line calculators to estimate project costs during the budgeting process. It is critical that all costs, including bandwidth and OS licensing be entered into these tools to ensure an accurate estimate. The Enterprise Cloud Infrastructure Team can assist units with these calculations.

- https://calculator.s3.amazonaws.com/index.html
- https://azure.microsoft.com/en-us/pricing/calculator/
- https://cloud.google.com/products/calculator/

Pricing for the in-house Rutgers OIT Virtual Infrastructure is offered by request after filling out an intake form.

- https://ei.rutgers.edu/index.php/virtual-hosting/

Recommendation 2: Rutgers should form both a "Cloud Center of Excellence" throughout all of Rutgers with specific dedicated subgroups focused on Research, Instructional, and Administrative computing as well as a central cloud infrastructure team.

A Cloud Center of Excellence (CCoE) is a cross-functional team, with executive support that leads other employees and the organization as a whole in cloud adoption, migration, and operation. Employees from many areas of OIT, as well as the broader institution, are key to the success of this effort.

The Cloud Strategy Committee also recommends that a dedicated team be formed in the Enterprise Infrastructure group to enable cloud adoption at the University. The dedicated resources will work closely with all of the Office of Information Technology to grow cloud capabilities throughout the division and support the CCoE in its mission.

Recommendations for the CCoE at Rutgers University: The committee recommends that this group start small, and scale as adoption grows at the University. The Rutgers IT Leadership Council (ITLC) should extend invitations to key staff throughout the university to develop and grow expertise at Rutgers, and be local advocates for the cloud within their own organizations. It is critical that this group receive broad participation by units interested in research, instructional technology, as well as administrative computing.

Rutgers University has a tradition of independent IT culture. The upside is a rich variety of micro strategies and tactics for technology solutions. Ad hoc communities have developed around these solutions. Top-down strategies have their place, however these have yielded limited results within the University. Top-down approaches are even less successful regarding cloud computing. Leveraging the path of least resistance, fostering a sense of community and partnership, and developing strong communication and socialization of successes will capitalize on the disruptive nature of this major technology advancement.

There are concerns which must be addressed as well. Many in the IT community sense the disruptive nature of cloud computing and, much like vendors, struggle to envision what their role will be in this new world. Traditional IT staff feel unprepared, untrained, or lack even a starting point for entry into cloud technology. Moreover, when they begin their journey into the cloud, they quickly discover policies and procedures are not compatible with cloud computing. Their partners in research, security, administration, and compliance all struggle to adapt to cloud computing from intellectual property and privacy concerns, to regulatory issues, policy compliance and security considerations.

The short-term strategy is to partner with various groups to develop early processes and relationships to manage early cloud adopters, learn from their processes, assist in their efforts, and prevent a dispersion of this technology that will complicate and dampen future collaborative

efforts. This will also assist in developing "lessons learned" at a small scale that could only be learned at a higher cost in the future.

Also critical is creating a cultural shift surrounding continuous improvement. There is no doubt that the cloud of today will not be the cloud of even one or two years from now. The recommendation is to move to a community-driven, iterative environment; one that evolves in small steps to reach a large common goal.

The CCoE's goal will be to create an infrastructure and community that meet these needs and address these concerns. This community should develop training, foster innovation, and encourage collaboration. These innovations and wins should be showcased back to the community to recognize and encourage involvement and to inspire even more. A community-based approach creates a more stable ecosystem, disperses training and knowledge base.

Town Halls: The CCoE will be expected to produce town-hall style meetings each year. These meetings will be facilitated by the Enterprise Cloud Infrastructure Team and the CCoE and should leverage the big-three cloud vendors for support. These meetings should be structured with multiple tracks following traditional IT silos, specific cloud technologies, and the special interest communities of research, instructional technology and administrative computing.

Special Interest Areas: During its research, the committee recognized that there were areas of special interest at the University. Part of the CCoE's outreach will be to provide an opportunity for staff in these areas to collaborate and share lessons from their own unique cloud journeys.

Some examples of unique concerns are:

Research:

- Use of large memory instances
- Use of special high performance equipment such as graphics processing units and field programmable gate arrays
- Use of Spot Instances and check pointing workloads for reduced pricing
- Institutional review board and other grant compliance requirements
- Grant accounting for cloud
- Machine learning and "big data" platforms
- Large scale databases and data processing for graph databases, shared data, etc.

Teaching and Learning:

- Use of automation for setting up student virtual environments
- Strict provisioning controls for budget management of student environments
- Virtual desktop environments for specially licensed student software
- Accessibility concerns
- Distance learning

Administrative Computing:

- High availability
- Disaster recovery and business continuity
- Change management
- Compliance and audit
- Data security
- Software licensing

Cloud Team Charter: The Enterprise Cloud Infrastructure Team, part of the Enterprise Infrastructure System group in the Office of Information Technology is charged with facilitating the appropriate adoption of cloud technology into the Rutgers Campus Environment. The team is expected to partner broadly with existing specialist communities in the security, development, ITSM, telecommunications, database administration and research areas in forming a Cloud Center of Excellence to support successful cloud transitions of both new and existing campus services.

Cloud Job Descriptions:

Cloud Architect: Develops and performs ongoing maintenance for architecture and design of the cloud environment, keeping design in line with the overall business IT standards and working with other stakeholders to keep cloud architecture aligned with service tiers, internal SLAs, and business goals.

Cloud Engineer: designs and maintains the cloud infrastructure components, including network design, virtual machine resource allocation, storage, and security. Different engineers may focus on specific areas within the overall engineering category.

Recommendation 3: Rutgers should establish centrally managed formal business relationships with Amazon Web Services, Microsoft Azure, and Google Cloud Platform integrating procurement, on-boarding, and billing into a seamless experience for the Rutgers community.

Along with the new cloud technologies, comes the need to establish new on-boarding and billing processes to accommodate the pay-as-you-go usage model. Cloud vendors typically bill for usage on a monthly basis. While there are established processes for monthly payments, there are additional considerations for cloud services that need to be addressed.

Cloud services procurement has a number of new issues to consider:

1. It is new technology with various purchasing models requiring a new process.
2. The ease of DIY services can easily bypass existing governance and controls.
3. The shared responsibility between the cloud vendor and the university presents the opportunity for significant potential risks when sensitive data is involved.
4. There can be unexpected costs when service limits are not understood.

Enterprise Agreements and Business Associates Agreements with the big 3 cloud vendors:
The committee has worked with the Office of General Counsel in negotiating and establishing the basic legal agreements needed for Rutgers University to use Amazon Web Services, Microsoft Azure, and Google Cloud Platform. We have sought to include contract terms such as discounts and data egress charge waivers that our peer institutions receive.

The committee looked at the Internet 2 Amazon Web Services offering, but after consulting with other BTAA members who are moving away from those contracts, we recommend establishing our own direct agreement. A direct relationship allows for the full use of billing APIs to automate bill payment where possible.

This work is in process and all three agreements are expected to be in place shortly.

Vendor Billing Options: The committee heard consistent complaints by users from peer institutions about vendor billing. Many users were caught off guard when they received huge bills due to a lack of understanding the details of the usage billing. Bills were often difficult to interpret.

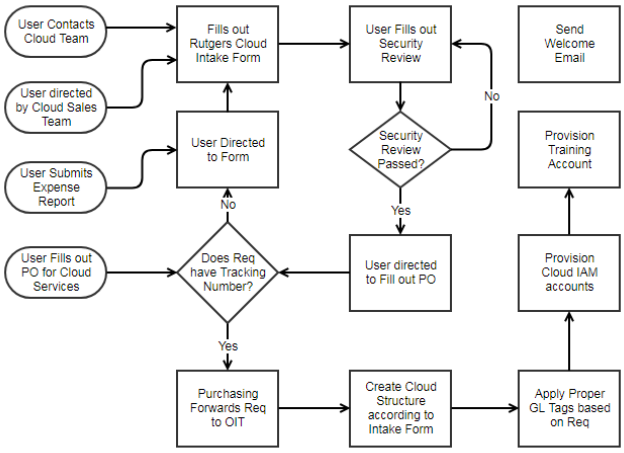
The committee recommends that Rutgers set up a master billing account with each vendor. The OIT Cloud Infrastructure team will create a cloud asset tagging convention for all cloud resources. These tags will be used to subdivide the bill and will be mapped to a University GL string. The OIT financial office will bill those budgets as needed. This approach helps protect departments

from service disruptions related to unpaid bills from other units, and allow for pooling of purchases for larger volume discounts.

In order to ensure that the central master account is used, it will be necessary for Procurement to block quick orders and credit-card payments for cloud purchases moving forward and transfer those already engaged in the service.

Several sources interviewed by the committee recommended the product "CloudCheckr" to provide the needed billing reports. The Office of Information Technology Enterprise Infrastructure is purchasing a license to cover the University's expected first year use.

Onboarding: The committee met with Procurement to discuss how to integrate on-boarding with purchasing. Our recommendation is to use a process similar to the existing third party security reviews and the software portal. Ideally, the Rutgers user will start the process through the Enterprise Cloud Infrastructure Team, who will guide them through the steps. They will fill out an intake form, develop a budget, fill out the security reviews, and submit a PO. The Cloud team will establish the GL tags, and provision the initial users into their cloud area.



Budget alerts will be set up based on the requisition amount. CloudCheckr will manage these alerts.

Recommendation 4: Governance should be made flexible enough to still realize benefits from cloud technologies while effectively mitigating risks to the university.

The same speed that compels organizations to migrate to the cloud, and enables the rapid delivery of business value to users, presents unique challenges for risk management. The committee recommends that existing control processes be updated for the cloud, and that pre-vetted reference architectures be created, to manage risk without eliminating the benefits of cloud migration.

Governance: The committee recommends that cloud computing be part of the overall IT governance structure of the University. Until that overall structure is formally established, we recommend that Rutgers should form a standing committee comprised of OIT EAS, EI, IPS and ITLC leadership to provide governance over cloud computing and implement best practices with our cloud infrastructure strategy. Additional ex officio members will be made up of cloud architects and implementers from around the University. The committee will provide regular updates and propose recommendations for cloud services to the ITLC.

Governance for the cloud should take note of the following concerns:

- Speed of innovation: The cloud is currently evolving much more quickly that traditional IT. Policy reviews will need to take place more frequently.
- E-Discovery: It is essential that the University be able to comply with discovery requests for information. A central inventory of data stored in the cloud will protect the university.

Recertification: The committee recommends that each provisioned unit be asked to verify their cloud usage semiannually due to rapid development cycles and changes. An email will be sent to the registered contacts for the unit showing their previous cloud inventory. Units will be required to update that inventory to accurately show what data assets have been migrated, and review their cloud spending and budgets to project any shortfalls.

Change Control: The committee recommends that cloud projects be subject to the same change control requirements as on premise projects. A member of the cloud services team should be part of the current ITSM planning efforts for rolling out change control at Rutgers.

In addition, projects that take advantage of cloud architecture need to consider the following when planning change management:

- DevOps: Many successful cloud projects are built around small teams that take total ownership of the technology resources needed. With release cycles measured in hours to days instead of months, change management must be flexible in order to be successful. Teams should consider building a library of ITIL Standard changes, where the process, not the change itself, is reviewed and approved.

- Separation of Duties: With smaller teams and infrastructure as code, maintaining traditional separation of duties can be a challenge. Teams should consider making extensive use of deployment automation, to build a verifiable audit trail without giving unnecessary direct access to backend infrastructure.
- Auto-Scaling: A number of cloud components will continuously right-size themselves. Teams should take advantage of tools which subscribe to these events, so that they can be easily seen during troubleshooting efforts.
- Changes to Infrastructure: The committee recommends that OIT maintain a tool like "CloudCheckr" that integrates with the cloud vendor APIs and provides a dashboard of changes to the cloud infrastructure. This can be used to alert management to changes in environments and satisfy audit concerns.

Recommendation 5: Rutgers organizations should look to modify current practices to fully leverage the advantages of cloud computing.

A key value proposition of cloud computing is the ability to deliver business value in much shorter timeframes. The following areas of IT practice should be reviewed before a Rutgers IT unit engages on their cloud journey in order to increase chances of success.

Project Management: Currently for IT projects, project management methodologies can be broadly broken down into two strategies:

- Waterfall: In a Waterfall project, each stage generally finishes before the next one can begin. This method focuses on identifying dependencies and critical path in order to bring a predictable timeline to IT efforts. Significant effort is put in up front on requirements in order to control the typically higher cost of late changes in design. Projects typically run for multiple months or even years depending on scope.
- Agile: This approach emphasizes the rapid delivery of a project in complete functional components. Rather than creating tasks and schedules, all time is "time-boxed" into phases called "sprints." Each sprint has a defined duration (usually in weeks) with a running list of deliverables, planned at the start of the sprint. Deliverables are prioritized by business value as determined by the customer. As work is completed, it can be reviewed and evaluated by the project team and customer, through daily builds and end-of-sprint demos. Agile relies on a very high level of customer involvement throughout the project, especially during the reviews.

The rapid availability of cloud infrastructure, combined with reduced effort when using prebuilt cloud platforms, can benefit from agile techniques. Where staff are trained in Agile, the committee recommends IT units consider their use for cloud projects.

Dev/Ops: DevOps is reaching over the IT wall between development and operations. It is the combination of cultural philosophies, practices, and tools that increases an organization's ability to deliver applications and services at higher velocity: evolving and improving products at a faster pace than organizations using traditional software development and infrastructure management processes. This speed enables organizations to better serve their customers and produce more effective solutions to meet growing demands.

The methodology consists of delivery and feedback paths.

1. Delivery Path: Enterprise Organization -> Build -> Test -> Release -> Customer
2. Feedback path: Customer –> Monitor -> Plan –> Enterprise Organization

Under a DevOps model, development and operations teams are no longer "siloed." Sometimes, these two teams are merged into a single team where the engineers work across the entire application lifecycle, from development and test to deployment to operations, and develop a

range of skills not limited to a single function. Quality assurance and security teams may also become more tightly integrated with development and operations and throughout the application lifecycle.

These teams use practices to automate processes that historically have been manual, slow, and error prone. They use a technology stack and tools which help them operate and evolve applications quickly and reliably, removing the typically high cost of late requirements changes. These tools also help engineers independently accomplish tasks (for example, deploying code or provisioning infrastructure) that normally would have required help from other teams, and this further increases a team's velocity.

The increase in velocity, and ability to safely make late changes reduces risk and encourages innovation. The committee recommends that IT units consider the potential benefits of DevOps to their areas.

Disaster Recovery: The committee recommends that all University cloud migration projects do a review of business continuity and disaster recovery needs. Projects utilizing the cloud have the same needs, but special consideration should be given to features and risks of the cloud.

Special Cloud Disaster Recovery Considerations: There are a few special factors for the cloud that the committee recommends be considered when deploying services to the cloud:

- DNS: Many cloud services rely on DNS to stitch resources together. Making sure that reliable DNS is available needs to be balanced with the need to receive private DNS information to integrate with Rutgers services. The committee recommends that OIT provide Rutgers private DNS information to each cloud vendor as demand for service grows.
- Legacy Disaster Recovery: As services are migrated to the cloud, units should inventory existing contracts to see if they are still needed or still meet the requirements for the service.
- Platform as a Service (PaaS): Units should investigate where PaaS providers host their underlying infrastructure and make sure no unintentional dependencies are created. For example, storing backup data for AWS with a vendor that stores those backups on AWS could result in data loss.
- Software as a Service (SaaS): Disaster recovery should be part of the purchasing considerations for these hosted solutions.

Security: The committee recommends that all cloud projects follow, at a minimum, all security policies that apply on campus. Cloud deployments must be at least as secure as on-premises deployments.

In addition, projects which take advantage of cloud architecture need to consider the following when planning security:

- Third Party Security Reviews: As per University policy, all projects placing University data in the cloud must complete a third-party security review before university data is sent to the cloud. The Cloud Infrastructure Team, in conjunction with the CCoE, should produce sample forms that fill in the non-changing vendor details for popular services from the three cloud vendors. Where possible pre-approval for specific techniques and data classifications will be done.
- Two Factor Authentication: Cloud vendor management portals are typically open to the world, and do not offer IP whitelisting. Relying on traditional passwords is inadequate to protect these resources and two factor authentication should be used where appropriate.
- Security Best Practices: The committee recommends that CloudCheckr be used to automatically scan Rutgers cloud deployments for security best practices. Violations should be sent to the Security Incident Management System for monitoring of remediation. Given the rapid changing nature of the cloud continual automatic checks are essential.
- Reference Architectures: The Cloud Infrastructure Team should produce reference architectures which pass University and industry security and compliance guidelines that units can leverage for their deployments where applicable.
- Periodic Data Inventory Review: A central inventory of all University data located in the cloud should be maintained. Units will receive a copy of their inventory semiannually to recertify as accurate.
- Training: Central funding for cloud training should be provided to help ensure that units in the early stages of migration are familiar with cloud risks and security.

Recommendation 6: Rutgers should make cloud training broadly available to the IT community.

Rutgers staff are knowledgeable, experienced professionals. However, because the cloud is a different environment, requiring more in the way of business analysis, policy/regulatory understanding, and contract analysis over technical skill, they may lack the knowledge and skills to operate in the cloud. Cloud technology is very different from what they know and do today; it requires a cultural shift. It is incumbent upon the university to develop a robust plan for addressing this major change in skillset requirements as the transition to the cloud progresses.

Training for the cloud should be developed for two tracks:

- A general introduction to cloud technology track that covers the framework, structure, benefits and operations in the cloud.
- A cloud technology track for IT staff that focuses on vendor certifications.

Just-In-Time Training

With some units already utilizing cloud services and many more poised to do so, it is important to start the retooling of IT staff as soon as possible. To jump-start the process, the committee recommends that a subscription for "Cloud Academy" be funded centrally for each new unit on-boarded for the cloud. This product includes modules on general cloud topics and certification preparation for our recommended cloud vendors. Groups that want to train multiple staff will be given the option to purchase additional seats and renew for subsequent years.

Following staff training, the committee recommends initiating an incentive management program for staff retention purposes. Trained cloud technologists are in short supply and the market will be tempting. Rutgers should be proactive by having the retention program in place when the training program begins.

Multiple Training Options

To support a cultural change of this magnitude, we should consider multiple options for training:

- Vendor supplied –Vendors offer top-level overviews of their products for free; paid, coordinated and more detailed training classes are also offered. Our BTAA peers report successful outcomes utilizing vendor training.
- Rutgers IT central – "Intro to Cloud" and "Train the Trainer" classes to support the transition
- 3rd party training companies –Paid self-service or in-house classes
- Subject Matter Experts – unit or individual mentoring
- Cloud community – the proposed Cloud Center of Excellence is expected to share information and lessons learned with the community

Ongoing Training

The fast pace of change in the cloud technology area requires ongoing monitoring, updated training and materials to ensure staff stay abreast of the latest changes. This might be a CCoE activity, periodic reviews of technology advancement in the field might include recommendations for changes to the training program.

Documentation/Communication/Education

The importance of documentation, communication and education cannot be emphasized enough. These are key factors in a successful transition. The quality of documentation, the frequency and clarity of communication and the support of several education options will serve as the foundation for a positive outcome to our cloud implementation.