

The Academic Cloud Computing Discovery Process

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About This Document

This document provides information that supports *Strategic Recommendations for Cloud Computing*, a companion to the IT Strategic Plan 2018-2024. The document describes the process by which faculty were interviewed to identify current uses of cloud computing technologies and to identify unmet needs. It provides a synthesis of the expressed needs of faculty into a better understanding of the opportunities that lay before the Division of Information Technology and Virginia Tech as they seek to fully leverage cloud computing in support of the university's mission in research, instruction, and outreach.

In this document we use the term *academic* broadly to mean those activities of faculty and students in which cloud computing technology is applied directly to a field of study, as opposed to those use cases in which it underlies the multitude of business functions which support the administration of the university.

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Introduction

The cloud provides ready-to-use computing resources on demand. It offers opportunities for higher education institutions to quickly explore, learn, develop, and instruct. The use of cloud resources in higher education has enabled faster academic and administrative innovation, optimized institutional spending, and improved user experience. Virginia Tech has adopted cloud services in major mission areas of instruction, research, and outreach, in addition to the use of cloud computing to support administration and operation. Some of the widely adopted cloud services include:

- G Suite for Education (productivity platform)
- Microsoft 365 (productivity platform)
- Canvas (learning management system)
- Zoom (peer-to-peer video communication platform)
- Kaltura (video content management platform)
- Slack (business communication platform)
- LinkedIn Learning (self-learning system)
- ServiceNow (IT service management platform)

Cloud services are increasingly important to the university's missions. Colleges, departments, and units are utilizing cloud services to enhance the effectiveness and efficiency of their operations. For example, our adoption of Canvas and Zoom provided significant academic continuity when the university moved all instruction online during spring 2020 due to the COVID-19 pandemic. Without these cloud services, the disruption to instruction, research, and the work of the university would have been much more severe.

About the Academic Cloud Computing Discovery Process

This discovery process was conducted during the spring and summer of 2020. By examining relevant service records from Collaborative Computing Solutions (CCS) and Advanced Research Computing (ARC) within the Division of IT, the development team identified 18 faculty and staff members who had utilized cloud consultation services for research, instruction, and outreach purposes within the previous four years. These individuals represented a wide range of functions within the university, including academic departments, academic support departments, and IT research and support units.

The development team contacted these faculty and staff members, and completed Zoom-based interviews with 14 of them. Nine of the respondents had research responsibilities, ranging from new faculty to more established researchers. Four were primarily IT professionals, and one person held a double appointment in both teaching and IT services. Most participants hailed from the Blacksburg campus with one from the Northern Virginia area.

The interviews included 23 questions in six categories: demographic information, history/experience, future and expectations, funding, financial questions for current users, and wrap-up questions. Most questions were open-ended. Follow-up questions were added during the interviews to clarify interviewee responses or share information with them. When a question did not apply to an interviewee, it was omitted. Each interview lasted about 45 minutes, with the shortest around 30 minutes and the longest around 100 minutes. The interviews were transcribed and a qualitative analysis was conducted.

Core Needs in Cloud Computing

The development team coded the transcripts and identified emerging themes across participants' answers. Eleven initial themes (see the table below and Appendix A for details) were identified from interviews with faculty and staff. Among them, the first theme was related to the existing status, and the remaining ten themes were related to perceived needs, and were consolidated into three core needs groups, outlined in the next section.

1. Cloud computing infrastructure and resources: University stakeholders expressed an interest in additional institutional cloud computing infrastructure and resources to meet needs that have not been effectively addressed through the currently available public cloud or other solutions.

2. Cloud computing support: University stakeholders expressed needs for orientation, training, consultation, ongoing technical support, documentation, and a cloud computing community of practice, especially in support of data management, security compliance, cloud tool applications, and improved IT procurement approval processes.

3. Awareness of cloud computing: There is a need to raise awareness of cloud computing options available across different university functions to enhance the university's competitiveness and excellence in instruction, research, outreach, and administration and operation.

1. Cloud computing infrastructure and resources	<ol style="list-style-type: none"> 1) A need for cloud computing resources for instruction 2) A need for research computing resources 3) A need for large research data management 4) A need for data access for research collaboration with external partners
2. Cloud computing support	<ol style="list-style-type: none"> 5) A need for cohesive training programs for cloud computing technologies 6) A need for consultation in data management and security 7) A need for cloud computing documentation 8) A need for a community of practice for cloud computing 9) A need for a faster IT procurement approval process

Core Needs in Academic Cloud Computing Further Explained

This section provides more detail on the core needs expressed by interviewees.

1. Cloud computing infrastructure and resources

University stakeholders often find it difficult to accomplish tasks without university-level solutions or support. They either have to spend valuable time to seek out their own solutions or cannot find a solution to their problems due to lack of IT knowledge or capacity. The following needs could be addressed by the expansion of institutional resources for cloud computing:

Instruction

Currently, most instructional needs are met through a combination of cloud solutions, including Canvas, Zoom, Kaltura, G Suite for Education, and Microsoft 365. However, there are unmet needs in cloud computing resources for instruction.

Cloud computing, machine learning, artificial intelligence, big data, and other technologies have transformed many fields and enabled new ways to explore subject areas that were not possible in the past. Faculty in various fields wish to provide their students practical learning experiences that apply these technologies to real world problems, not only to enrich the learning experience, but to ensure that their students are well positioned in the job market.

However, faculty have found it difficult to make use of these technologies at Virginia Tech due to a lack of institutional support for student use of cloud computing and technologies that rely on it. The utility model of cloud computing implies that any use of public cloud for these purposes results in billable charges payable to the provider. Faculty that have employed cloud computing services in student coursework have often resorted to using "spare" resources from other projects or research work. Others have taken advantage of free credits offered to educators by cloud providers to offset some of the cost incurred. In the absence of operational support for cloud computing used in instruction, faculty expend valuable time and effort configuring and managing the technology itself rather than focusing on its use in the field of study.

Research

Cloud computing and related technologies have enabled novel and faster ways to conduct research. While ARC has empowered many researchers and supported the university's research mission, there are still unmet needs associated with cloud computing.

- **Cloud computing resources:** Some faculty indicated that there is a high demand for the university's high performance computing resources and that the waiting time for access is often long, leaving them in a position where they have to purchase and maintain their own hardware, which is not ideal for them. They would like the university to provide readily available resources that allow them to focus on research instead of on setting up and maintaining IT infrastructure. With the public cloud, they have to become knowledgeable in cloud IT, including how to configure and set up the environment. They believe that cloud computing resources are infrastructure and should be provided to them (like desks, chairs, or electricity). In addition, some funding agencies would prefer to pay for physical hardware instead of services, so it is difficult to justify the use of the public cloud from a grant-management perspective. Furthermore, faculty indicate that sufficient institutional cloud resources are a major factor in helping to attract and retain talent.
- **Cloud data storage solutions for large research data:** G Suite for Education provides unlimited storage to meet teaching and administrative needs. However, there are some unmet needs for research in cases where: 1) sensitive data should not be stored on the public cloud; 2) it is costly to store Terabytes or Petabytes of data on public cloud services other than G Suite for an extended time period; 3) it is difficult to maintain a local copy once the size of the data exceeds a few Terabytes; 4) users need easy solutions for data storage and access for collaboration needs; and/or 5) users need ways to back up systems and servers, not just regular data.
- **Cloud data access for research collaboration with external partners:** Many Virginia Tech researchers have collaborators outside the university and across the globe. Since the university does not provide an easy solution, researchers utilize non-VT-provided cloud services to fulfill collaboration needs for shared file access, storage, backup, and archival. They want better ways to share data with collaborators outside of Virginia Tech so they can work efficiently and expand their partnerships and capabilities.

While many institutions have adopted a cloud-first strategy, our assessment and analysis indicate that public clouds cannot meet all of our stakeholders' needs and are not cost-effective for some situations. Therefore, Virginia Tech should engage more users to understand their needs and then conduct a cost-benefit analysis to determine the best ways to address these needs.

2. Cloud computing support

This effort will include training, consultation, ongoing technical support, documentation, building a user community, and promoting a faster IT procurement process. The major support topics requested include data management, security compliance, and the basics of how to use cloud tools.

Training

This need involves both professional development for faculty and staff as well as training for students. Cloud computing and related technologies are new and different from traditional platforms. Even experienced IT professionals need training to use cloud platforms. Currently, there is no cohesive training strategy across the university. IT professionals and faculty find their own training resources and rely on trial and error to learn and solve problems, which is often not effective. Moreover, faculty comment that the university frequently provides infrastructure but not training or support. Users are on their own to figure out how to use the tools and get the best value out of the services. Faculty also wish there were training or tutorials for students so that they can learn how to complete tasks using cloud tools. University-level training resources may release faculty from teaching responsibilities related to cloud tools/procedures and achieve better efficiency.

Consultation

Faculty indicated a major need for cohesive data management and governance strategies, including cost-effective and computing-efficient ways of storing and managing data for research projects with different life cycles. Faculty also identified security compliance needs associated with different responsibilities, such as teaching and research, and want clear and easy-to-follow instructions. They also think that the security issue should be handled at the institutional level instead of at the individual researcher level. While the security issue is difficult to handle at the university level and should be a shared responsibility, university-level support to faculty is essential.

Documentation

Users want video tutorials and good documentation to facilitate their learning of cloud tools. Currently, the Division of IT provides abundant resources (for example, through comprehensive knowledge base articles and tutorials) on widely adopted cloud tools, such as Canvas, Zoom, and G Suite for Education. However, there is a need for good documentation on using Amazon Web Services (AWS), Google Cloud, and Microsoft Azure for computing purposes.

Community of practice

Users would like to have a cloud computing user community to share information and learn from each other. While the university offers various communication and collaboration platforms that have enabled the formation of a user community, dedicating some effort to initiating and managing such a community of practice is needed to ensure its success.

Faster IT procurement and approval process

One of the benefits of cloud computing is that it enables faster academic, research, and administrative innovation through quick prototyping and experimentation. For example, in an ever-changing market, SaaS (software as a service) allows users to try software solutions without upfront purchase and installation. The existing IT procurement approval process requires reviews and approvals from various departments on campus, not just IT units. While the thorough process is intended to protect both the interests of the university and the

departments and individuals involved, it is often quite lengthy and presents a barrier to quick prototyping and experimentation -- inadvertently discouraging innovation. Faculty and staff strongly desire a faster IT procurement approval process to realize the benefits of cloud computing and enable them to innovate.

3. Awareness of cloud computing

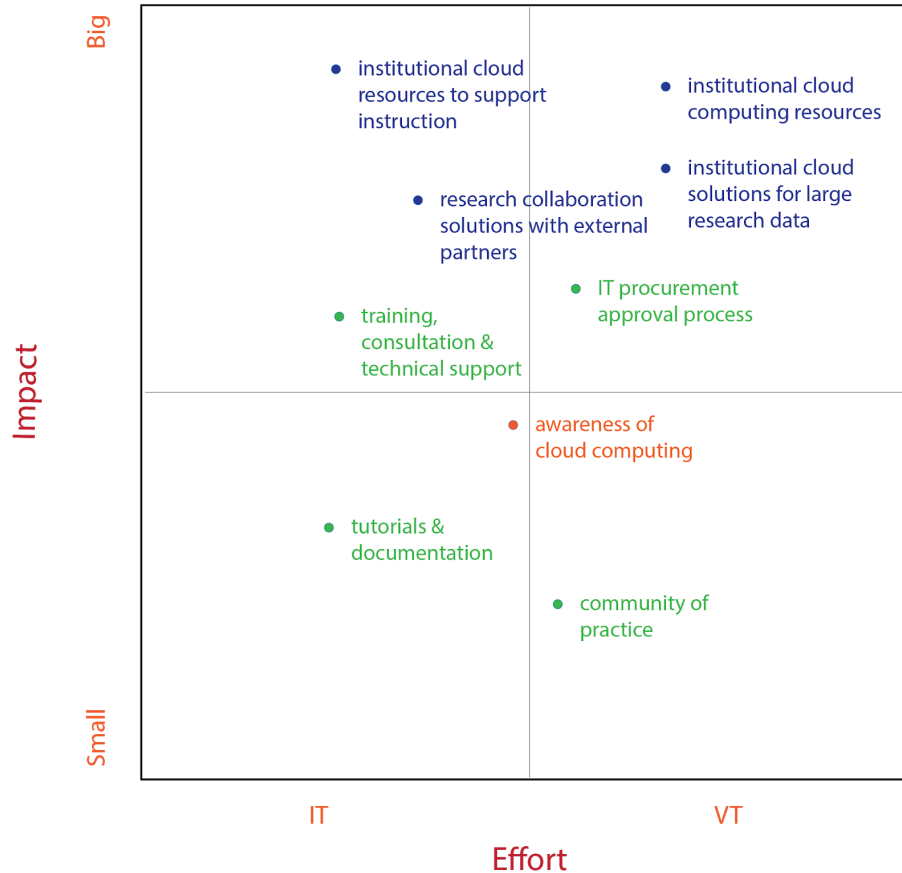
The Division of IT currently provides cloud-related consultation through two of its subunits—Collaborative Computing Solutions (CCS) and Advanced Research Computing (ARC). However, offering consultations is not the same as providing active outreach, and there is the perception of a lack of awareness among faculty about what IT offers (both generally and specific to cloud computing). Also, in comparison to web hosting, data storage, and other IT resources, cloud computing is not yet widely adopted by researchers, though many are exploring it. The university may consider active promotion of cloud computing, thus empowering the university community to solve problems with new approaches and tools.

An Initial Effort-impact Analysis

Not all efforts create the same impact. Therefore, the development team conducted initial analyses of both the effort and impact of addressing the university's cloud computing needs. They were evaluated based on the level of involvement and investment required, with classification of the efforts mainly falling under the Division of IT or at the university level. Each effort was also evaluated to see how much impact it would have, both in terms of the number of people affected and the impact on institutional excellence. The initial results of the analysis are presented in the chart below.

- **Dark blue** corresponds to core needs 1: Cloud computing infrastructure and resources
- **Green** corresponds to core needs 2: Cloud computing support
- **Orange** corresponds to core needs 3: Awareness of cloud computing

It should be noted that a more in-depth analysis should be conducted, involving more university stakeholders to more accurately evaluate the effort and potential impact.



Limitations

The development team identified 18 potential participants who had utilized cloud consultation services offered by the Division of IT, assuming that their past experience in cloud computing would yield insights on the needs and challenges that they have faced. While the interview response and completion rate was high (14 out of 18 or 77.78%), it should be noted that their perspectives represent only a small subset of the overall university community and thus may not be representative.

The development team suggests a wider engagement with different types of university stakeholders through additional formats (such as online surveys and focus groups), which should help validate current findings and better inform strategic decisions regarding cloud computing.

Appendix A: Initial Findings

The initial findings are summarized in the eleven themes listed here - these themes offer a brief representation of the current status and needs in cloud computing as indicated by interview participants:

Wide adoption of university-provided cloud solutions: Members of the university community have broadly adopted general-use cloud-based solutions to address needs in instruction, research, outreach, and administration, including G Suite for Education, Microsoft 365, Canvas, and Zoom.

Need - cloud computing resources for instruction: Faculty wish to provide students more experiential learning opportunities enabled by cloud computing resources in areas of cloud computing, machine learning, artificial intelligence (AI), big data analytics, and beyond as related to their subject areas.

Need - research computing resources: Researchers want to have ready-to-use research computing resources at the institutional level so they can spend less time finding, setting up, and learning how to use them.

Need - large research data management: Researchers need cost-effective data management solutions for large research data to address needs currently not met by existing solutions.

Need - data access flexibility to enable research collaboration with external partners: Researchers seek easy data access, storage, backup, and archival solutions to simplify research collaboration with partners outside the university.

Need - cohesive training strategies in cloud computing technologies: Faculty and staff need professional development opportunities to better utilize cloud computing tools. Faculty also seek training opportunities for students that allow them to gain practical experience in cloud computing.

Need - consultation in data management and security: Members of the university community require cloud consultation services specifically in areas of data management and security as related to different aspects of their job responsibilities.

Need - documentation in cloud computing: Members of the university community desire quality documentation and tutorials to facilitate their learning of cloud tools.

Need - a community of practice in cloud computing: Members of the university community wish to have a user community where they can exchange and share information and learn from each other.

Need - faster IT procurement approval process: Faculty and staff strongly desire a faster IT procurement approval process to realize the benefits of cloud computing and enable them to innovate.

Need - to raise the awareness of cloud computing: Members of the university community need to have a better awareness of cloud computing potential, challenges, resources, and support services to improve the utilization of cloud computing resources.

Appendix B: Interview Data and Analysis

This section documents and summarizes the interview responses from faculty members. It aims to provide interested readers with more of the "raw" data in the form of faculty responses to interview questions.

The results below show the interview findings, Demographics

- 1) There were eight power users and six regular users among the interviewees.
 - 2) The interviewees were from a variety of departments/units, including academic departments, academic support departments, and IT research and support units.
 - 3) The interviewees included both new faculty who joined Virginia Tech in fall 2019 and more-established researchers.
 - 4) Nine of the 14 interviewees had research responsibilities.
 - 5) The work functions of the interviewees included teaching, research, research support, and outreach.
- A. IT Services and Cloud Services Used or Currently Using
- 1) The most commonly utilized IT services included G Suite for Education, Microsoft 365, Canvas, and ARC services. Interviewees acknowledged that since some of the services run very well, they may not think about them much.
 - 2) Other services mentioned include Zoom, Overleaf, Slack, Kaltura, Piazza, Globus, GitHub or GitLab, Jupyter Notebooks, etc.
 - 3) Some faculty were aware of ARC services and utilized them for both research and technical purposes. Some faculty felt there was a high demand for the university's high performance computing resources and that since the waiting time was very long, these services did not meet their needs, hence they had to purchase and maintain their own hardware.
 - 4) Canvas met faculty's teaching needs. There were no complaints or concerns. Some faculty have adopted GitLab for teaching. Computer Science professors would like the Division of IT to provide Jupyter Notebook instances that are easy to set up and access for teaching and learning purposes.
 - 5) Virginia Tech employees utilize public clouds for different purposes, most often for web hosting, data storage, and backup. Cloud computing is not yet widely adopted, though many are exploring it. The most commonly used public cloud is AWS.
 - 6) Many Virginia Tech researchers have collaborators outside of the university or across the globe and they utilize cloud services not provided by Virginia Tech to fulfill collaboration needs, mainly for file access, storage, backup, and archival. The external services are provided by public clouds, such as DropBox, Box, or those provided by funding agencies or partner' institutions in the forms of private cloud, or community cloud. Commonly used cloud tools include DropBox and Overleaf.

B. Data Storage

- 1) Generally, interviewees stored data both locally and online. They had different preferences. Some users preferred online storage due to its easy accessibility and a sense of security (of not storing important data on a laptop that may get misplaced). Others preferred local storage due to data security and compliance considerations or just out of personal habit. Most used either local or online storage as a backup.
- 2) Users stored data online for both teaching and research purposes. University-provided data storage services met teaching and administrative needs, but did not fully address research needs.
- 3) There were needs for research-related online data storage, such as for Terabytes or Petabytes of data. Users reported that public clouds, such as AWS, were cost prohibitive for large volumes of data and were seeking cost effective solutions provided by the university. Reasons for such solutions included: 1) storage of sensitive data that should not be stored on public cloud; 2) the cost to store Terabytes or Petabytes of data on the public cloud; 3) the difficulty of maintaining a local copy once the size of data passed a couple of Terabytes; 4) the need for easy solutions for data storage and access for collaboration needs; 5) the need for ways to back up systems and servers, not just regular data; 6) the users perception that it was easy to control the security of data when they stay on university cloud infrastructure.
- 4) Users want the data to be close to where the computing power is located. For example, a user had to download online data to a local computer to process and then upload the processed data back online. Users seek more streamlined processes.
- 5) Users want data management or governance consultation to help find the right solution for their needs, which generally means storing and accessing a lot of data in cost-effective ways. Users are aware of the different levels of costs associated with data storage and backup on public cloud services such as AWS. The nature of their research data may change from active to inactive, or vice versa, so they want to figure out the best ways to manage the data on the public cloud to realize computing as well as financial gain.
- 6) Users are aware of cloud security issues but do not necessarily know how to implement the right measures in their work. They complain that lengthy documents on security are not helpful.
- 7) Users commented that the university provides tools but not the necessary education or training on how to best utilize the tools.

C. Cloud-based needs

- 1) Cloud computing needs are at different service levels, including infrastructure as a service (IaaS), platform-as-a-service (PaaS), software as a service (SaaS). Some users require self-supported, self-operated, or self-configuring virtual infrastructure (IaaS) while others may need substantial assistance to start using a service.

- 2) Faculty find it challenging to locate resources to help students gain practical experience in cloud computing and related fields or become more computer literate. University should provide free resources for students to prototype and play with. Students should also be supported in the use of cloud tools.
- 3) It is challenging and time-consuming for faculty to set up and configure the right type of cloud servers/services for teaching purposes, so they end up not providing this beneficial experience to students.
- 4) Cloud computing, machine learning, big data, and other technologies have transformed many fields, enabled new ways to conduct research, and reduced entry cost. Better cloud services encourage researchers to utilize cloud technologies. However, researchers face new challenges in data storage, backup, management, analysis, and utilization. They want institutional cloud services that are ready to use so they don't need to purchase, install, and configure resources like they have to do when setting up their own hardware or using public clouds, such as AWS.
- 5) Researchers need better ways to share data with collaborators outside of Virginia Tech so they can work efficiently and expand their partnership capabilities.
- 6) Faculty and units have needs for dynamic web hosting for different purposes, including teaching, research, and outreach. Some departments provide some services, such as the Computer Science Department, but others are left with no easy solutions or any solution at all. Faculty feel that doing something outside of the university-provided services is hard.
- 7) Sufficient cloud infrastructure and cloud computing resources can help attract faculty talent and provide students the practical experience that makes them more marketable.
- 8) Faculty want to have stable institutional cloud services. Some funding agencies are not interested in paying for public services.

D. Concerns about cloud-based IT services and support needed

- 1) Cost: With public cloud, it is hard to control cost and it can get quite expensive quickly.
- 2) Security needs:
 - users want clear and easy to follow instructions, including for sharing data across borders and educating graduate students (for research);
 - users need guidance on compliance requirements as associated with different aspects of their job responsibilities, e.g. teaching or research
- 3) Security concerns include:
 - a clear understanding of who owns the data when putting them on public clouds;
 - ensuring data security and removal after contract ends with a vendor
 - conducting ongoing assessment of security;
 - making sure vendors do what they say they are going to do;
 - maintaining trust with collaborators over the security of shared data;
 - helping users understand that data security is a shared responsibility;
 - understanding that faculty members do not consider themselves security researchers;

- understanding that users want security to be handled at the institutional level instead of at the individual researcher level.
- 4) Some interviewees feel that beyond infrastructure there is no real technical support for cloud computing at the university and it is difficult to get the right person with the right skills to help. The Division of IT should be a liaison for follow up services as departmental IT may have to learn a new service just to serve one faculty member.
 - 5) Users would like to have a user group to share information and learn from each other. However, experience from one user group showed that this may also turn into a situation where the helpless are led by clueless.
 - 6) The majority of interviewees would like the university to provide training in cloud computing. Even experienced IT employees expressed a need for training in new cloud computing platforms. The training needs mentioned by interviewees include:
 - a good AWS training;
 - basic training for students on completing tasks so faculty do not need to provide it; topics includes Intro to Cloud, Intro to AWS;
 - cloud potentials (what's available and how the services and solutions can or cannot be used by end users) and best use practices, so users know what they are getting into;
 - training that consists of different tracks;
 - training that focuses on solving real problems.
 - 7) Training concerns expressed by the interviewees include:
 - That they currently utilize trial and error or written documentation to figure out things and deem these methods inefficient;
 - The insufficiency of provided articles and documentation.
 - 8) Documentation needs include:
 - tutorials for cloud-based IT solutions;
 - video tutorials on best practices;
 - tutorials to walk students through basic tasks.
 - 9) IT outreach or in-reach to increase faculty's awareness of what IT offers. Faculty could also invite IT professionals to attend their departmental meeting to understand their needs and help answer questions.
 - 10) Vendor sustainability: data usage and data agreement for grants require continuous existence of vendors.
 - 11) Vendor lock-in: there is a concern that credits offered to educators by cloud providers will tend to have a "lock-in" effect; creating program dependencies on unique proprietary services/features offered by a given provider that make it difficult to move to another provider.
 - 12) When data needs to be used on multiple platforms, users want mechanisms for doing so that minimize work disruption. This is especially important for large data sets which are difficult to transfer from one platform to another.
 - 13) Users want cohesive strategies for accessing, backing-up, and managing online data. They now rely on piecemeal strategies.

14) IT procurement approval process is lengthy and obstructs innovation. It takes too long and people don't want to bother to experiment innovative approaches.

15) Other topics include:

- availability of cloud services;
- privacy and compliance related to cloud services;
- latency: when everybody in the class accesses the same dataset remotely, it takes longer for the dataset to load.

E. Benefits

1) Top benefits of cloud computing mentioned by interviewees include:

- increasing efficiency;
- saving time;
- simplifying maintenance and upgrades;
- better backup of data for disaster recovery;
- mobility/portability;
- lowering needs for hardware and maintenance, which can snowball into saving space, heating and cooling.

F. Life Cycle

- 1) Teaching: generally the life cycle is the entire semester, with increased needs during the end of a semester.
- 2) The life cycle for research projects varies and depends on several factors: 1) conference deadlines, for example, every four to five months; 2) grants: commonly last from one year to five years; by adding the preparation stage and data management phase, it may go up to 10 years; 3) some researchers use data that is 15 years old or use some data forever.

G. Funding

1) Funding resources for cloud computing vary, including

- no funding;
- fully internal: from the department/unit budget;
- mostly external: outside of department/unit budget;
- hybrid: both internal and external to the department/unit.

2) Cloud does not mean money saving. Money gets shifted from one spending item to another. Funding model varies depending on the funding source and purpose.

Generally,

- hardware spending is considered capital;
- maintenance and use of cloud are considered operational.

3) Some funding agencies do not like to pay for services, as opposed to physical hardware.

4) Faculty think that the grant overhead (61%) has paid for IT services, and Virginia Tech should provide cloud services like infrastructure.

- There is resource inequality across colleges, departments and units. Some departments offer some resources while others do not have much set aside for IT

and thus it is difficult for them to get things done without university level resources.

- Grant may not pay money or enough money for data storage.
 - Some grant agencies do not like to pay for services (they pay for hardware or personnel).
 - Faculty generally do not have grants to pay for cloud computing for teaching and learning purposes.
- 5) Most interviewees agree that cost-sharing from Virginia Tech would be helpful in obtaining grants and enable more resources. Some federal agencies expect the purchase of institutional infrastructure to support the completion of a project. However, NSF prohibits cost-sharing.

H. Cloud Expenditure

- 1) The expenditure on cloud computing varies.
 - Enterprise solutions: Learning Management System related IT spending is around \$1 million/year at Virginia Tech.
 - For individual units or projects, it is in the ballpark of \$1,000 to \$50,000 per year. However, there are outliers, for example, one unit pays \$350,000/year for AWS.
- 2) There are other costs associated with cloud adoption, such as training cost, migration cost, opportunity cost. Opportunity cost is things that you did not do because you chose to do something else. However, it is difficult to put a dollar value on that.