GARDEN CITY
COMMUNITY COLLEGE

NON-ACADEMIC DEPARTMENTAL REVIEW TEMPLATE

May 2018

IT Department

GARDEN CITY
COMMUNITY COLLEGE

Non-Academic Departmental Review
Self-Study Template

Department: IT

Department Head: Andy Gough

Submitted by: Andy Gough

Submission Date: May, 2018

INSTRUCTIONS:

Complete this form using department documentation and your own observations. This self-study is designed to be a narrative document and all responses to questions should be supported by rationale, explanation and or specific documentation.

All documentation provided for the Non-Academic Departmental Review Self-Study should include the previous five years, beginning with the 2012-2013 academic year.

Component 1: Non-Academic Departmental Review Committee

List the names of the Non-Academic Departmental Review Committee and their association with your department (your department personnel who contributed to the writing of this report).

Name	Association
Andy Gough	Director of IT
Andrew Knoll	Network Administrator
David Larsen	Computer Technician
Review Advising Committee	
Samantha Sanger	Faculty
Colin Lamb	Adminstration
Cindy VenJohn	Faculty

Component 2: Department Profile

A. Mission/Purpose

1. What is the mission of the department and how does it align with the institutional mission and other strategic priorities?

The IT Department exists to provide stable, secure and up to date technology and support for GCCC students and staff.

B. Human Resources – combine all sub-units

1. How does the department assure that all personnel are qualified for their position?

Annual training is scheduled
Hiring process requires minimum standards met

2. Include an organizational chart with names and titles.

Andy Gough- Director of IT
Andrew Knoll- Network Administrator
David Larsen- Computer Tech

3. List departmental, divisional, College, professional, or community committee or board activities and leadership roles, if applicable, of each full-time employee for the past **five** years.

Andy – College Council
Website committee
Datacore
Instructional

4. List names and anticipated dates of retirement (month, year) within the next five years.

☒ None

5. How are the results of employee evaluations used in identifying professional development needs?

Evaluations are done on a yearly basis and once the data is collected based off of that information we then work with the individuals and get them the appropriate training.

6. What department-specific professional development opportunities are offered/provided by the department?

Vendor initiated Webinars
Manufacturer based Webinars and virtual trainings

7. Show evidence that employees have continued their professional development by attaching a list of current full-time employees who participated in professional development activities during the past **five** years, and those activities.

Andy Gough – Extreme Certified Professional Wireless
MCITP – Sharepoint 2010 Administration and Design
SANS – Ethical Hacking Course 501
Fortinet – Fortimail Anitspam training
VMware- VMware Virtual Training
Andrew Knoll – Extreme XOS fundamentals
Fortinet – Fortigate Virtual Training

C. Description of the Department and the Customers/Clients Served

1. What are the key functions, processes and services provided by the department? Include production level data such as students/customers served, transactions processed, etc. Explain any compliance duties or responsibilities.

Key Functions are to keep a high level of transparency between IT and Staff/Faculty/Students. Our key processes are to provide knowledge and information to the campus to ensure the safety of our data. Along with these functions and processes IT provides numerous services from maintaining hardware and software across campus which allows the campus to maintain a 24/7 status for information.

2. What impact do those services have on students and other key stakeholders? What are the department's enhancements to the institution?

The students are directly impacted with the services that are provided. As well as the technology must be sufficient to meet the needs of students, which includes the implementation of new hardware, software, and infrastructure.

3. Discuss how the department utilizes appropriate technology to provide services to its stakeholders.

The IT department utilizes technology to provide the quick resolution of issues on this campus. The technologies are, but not limited to Track-it (helpdesk software), EMS (Event Management), Emergency Phone, DameWare/Remote Assistance (Remote Access software), etc. IT also utilizes redirection technology to allow all users a secure storage means for data along with a backup strategy to help keep a worry free environment. Along with data protection, IT maintains network securities, which allow all of the campus to email, surf the internet, communicate externally, and remain HIPPA, FERPA and PCI compliant.

4. Describe any existing continuous improvement activities.

Current evaluation of Data storage, Network assessment, Security Assessment and Cameras by 3rd party and/or internal staff. Continuous rotation of staff/faculty/student computers to improve the overall user experience.

5. Provide any other relevant information needed for a complete understanding of your department.

Component 3: Resources

1. Describe the overall adequacy of resources (human, technological, capital, facilities, and fiscal) available to the department for providing effective service delivery and achieving outcomes. If additional resources are needed, please provide data and describe how those resources would improve services.

The need for at least 1 more person to even out the work load. Developed rotation on all infrastructure based on current budget.

Component 4: Departmental Innovation

1. Does the department engage in extracurricular activities as a service to the students and community?

   ☐Yes ☒No

2. What innovative ideas have been incorporated into the operation of the department during the last five years? Discuss the results and provide documentation.

In the last 5 years, IT has incorporated a higher-level firewall to help shape and secure connections to the campus along with a higher-level spam filter to reduce the number to total threats to the campus. Along with the firewall and spam filter, the datacenter has moved into a virtual environment to boost speed, security and redundancy of all applications.

Component 5: Intended Outcomes, Assessment Measures, Targeted Level of Achievement, and Prior Results

1. If data has previously been gathered, list the intended outcomes for the department for the past three years and cite the institutional Essential Skills and other Strategic Plan priorities that each outcome supports.

First year of comprehensive program review. No prior outcomes have been identified.

2. Describe the data gathering process and give results.

First year of comprehensive program review. No prior outcomes have been identified.

3. Analyze the data by comparing the actual results to the targeted levels of achievement and document what was learned.

First year of comprehensive program review. No prior outcomes have been identified.

4. The department will gather feedback regarding expectations and performance from stakeholders through interviews, surveys, focus groups or other appropriate measures. This feedback shall be considered when selecting performance measures and when continuous improvement plans are developed. Describe what changes have been made in response to these measures.

Assessments from AOS (Alexander Open Systems) for the IT department are Technical Data Center Assessment (appendix 1) and the Network/Security Assessment (appendix 2)

The Data Center Assessment was to determine the problems with our current Server/SAN configuration. The problems found were a failing SAN, out of warranty Servers, data access speeds slow, user experience poor due to speeds and speed of the internet including services across this medium. It was determined that the current Server/SAN configuration needed to be replaced and was replaced based off the recommendation of AOS to the reference architecture that is now implemented. The department is now looking at analytics and monitoring to see the performance of the data. Then a follow up survey will be sent out asking employees on their overall experience with data and the speeds. All information for the data center is in the attached document Labeled Technical Data Center Assessment.

The Network/Security Assessment was to determine issues related to our current infrastructure. It was determined that the IP Scheme needed updated, Migration to 10gig backbone, secondary internet connection, and patch management schedule improvement. Everything that has been recommended is in progress and should be completed within the spring of 2018. All information for the Network/Security Assessment is in the attached document Network/Security Assessment Documentation.

5. Use the results to develop a Continuous Improvement Plan for the department, improving efficiencies based on targeted outcomes. Include consideration for resources, processes, data collection, analysis and timelines for monitoring and assessing the results. List intended outcomes for the department that insure alignment with institutional Essential Skills and other strategic priorities.

   For each outcome identify at least one method of measurement that will be used to assess progress toward the outcome. Assessment is strengthened when multiple measures are used. An assessment measure should provide meaningful, actionable data that the department can use to assess efficiency and improve processes.

   Describe the target level of achievement for each measure. Levels of achievement shall be:

   - Specific and measurable.
   - Stated in numerical terms.
   - Stated in realistic terms.
   - Directly related to the outcome.
   - Inclusive of all aspects of the outcome.
   - Manageable and practical.

   To demonstrate efficiency, determine if external or internal benchmarks are available for comparison.

Based off of the assessment that was given to Information Technology the plan is to replace the current Server/SAN solution with a reference architecture. The reference architecture is a single chassis with 4 blade servers hosting 4 instances of VMware ESXi virtual environment. This also includes an all Flash storage based SAN to improve I/O and IOPS of all virtual machines and shares to the campus. This system also reduced the overall power consumption while boosting performance and redundancy. The network plan is within 5 years start a rotation based off budget to completely replace all switches to a 10gig backbone. As stated in the assessment improvements to our current patch management by utilizing Forticlient and WSUS this will be completed in 2018.

Component 6: Additional Comments

This space is for the department to add any additional comments to help clarify or explain its functions, if applicable.

Component 7: Executive Summary

1. Briefly describe how the department review was conducted:

This review was conducted by the IT staff and compiled by the IT director. Then reviewed by the team assigned to the review.

2. Describe the MAJOR conclusions regarding the present state of the department:

The major conclusions that the review has shown is that the Server/SAN needed to be replaced and plans were setup to work with a smaller budget to replace the current infrastructure.

3. Briefly describe the goals and objectives of the department:

The main goals of the department is to continue to rotate and plan replacement of the infrastructure that will allow performance enhancements to the entire campus.

4. Comment on the progress on previous Departmental Review Action Plans or Recommendations

Departments completing the review for the first time will not have these items and need not answer this question.

5. Describe the department strengths:

This department is very open in the communication amongst themselves as well as keeping the campus informed of IT events. The staff's dedication to keep the campus running transparent with limited staff is a major strength.

6. Describe what areas need improvement:

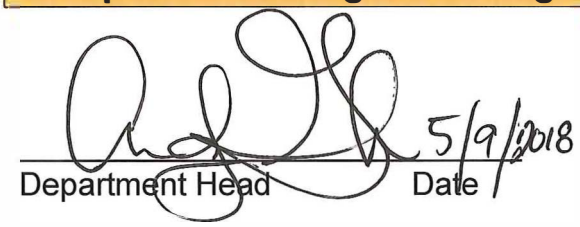
None at this time.

7. State the recommendations for the department:

Recommendations for the department is to acquire another employee to reduce workloads amongst other staff members and to make sure all IT staff is trained on all of the new equipment moving forward.

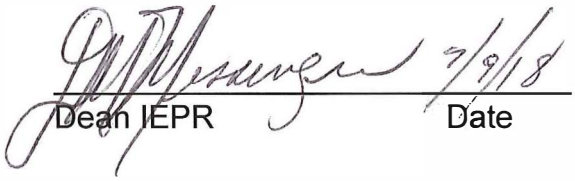
Component 8:	Action Plan (with timelines for recommendations)		
	Year 1	Year 2	Year 3
	Actions & Budget Implications	Actions & Budget Implications	Actions & Budget Implications
Recommendation 1:Replace Servers and SAN	Actions: Replace Servers/SAN Budget Implications: Timeline: December 2017		
Recommendation 2:Computer Rotaitions	Actions: Replace Faculty and Lab Machines Budget Implications: 114662.55 Timeline: July 2018	Actions: Replace Staff and Lab Machines Budget Implications: 115725.50 Timeline: July 2019	Actions: Replace Staff and Lab Machines Budget Implications: 108981.60 Timeline: July 2020
Recommendation 3: Wireless/Camera Upgrades	Actions: Replace both internal cameras with Extreme Camera/AP's and End of life AP's Budget Implications: 125,000 Timeline: December 2018		
Recommendation 4: Phone System Upgrade	Actions: Purchase new phones Budget Implications: 45,000	Actions: Purchase new phones Budget Implications: 45,000	
Recommendation 5: Classroom Upgrades	Actions: Update projectors,speakers,amps,cabling and document projectors Budget Implications: 2,500 Timeline: December 2018	Actions: Update projectors,speakers,amps,cabling and document projectors Budget Implications: 2,500 Timeline: December 2019	Actions: Update projectors,speakers,amps,cabling and document projectors Budget Implications: 2,500 Timeline: December 2020

Component 9: Signature Page and Archiving



Department Head Date

Next Level Supervisor Date



Dean IEPR Date

President Date

Archiving:

Division Leader submits to Dean of Institutional Effectiveness, Planning and Research.

1. A complete electronic version of the Non-Academic Departmental Review self-study
2. All documentation (electronic and print)
3. A signed signature page (electronic and print)

Appendix I

NETWORK/SECURITY ASSESSMENT DOCUMENTATION

Garden City Community College

Account Manager: Danny Spurgeon

Designer: Derek Bertz and Mike Mahurin

Date: 11/21/2017

AOS

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Network Assessment Summary

Garden City Community College (GCCC) requested Alexander Open Systems (AOS) perform a comprehensive Network Assessment and review to identify key business drivers and develop a strategic plan for network technology.

The topology of the Garden City Community College (GCCC) network is primarily hub/spoke with approximately 58 access layer switches located in remote buildings, dorms, etc. and connecting to a centralized modular Enterasys switch. Two wireless networks are provided by various access points and two wireless controllers. These networks have grown organically over the past several years without a centralized plan or standardized architecture. This has led to issues with performance, scalability and reliability.

AOS identified the following issues during our assessment:

- Extended login times
    - Reports of three minutes or longer were reported
- At certain times of the day web browsing was slow and/or ineffective
- High bandwidth utilization on the network
- Inconsistent wireless experience

AOS will make recommendations to correct the issues identified.

Assessment Area Specifics

Core Connectivity

The core network is comprised of multiple local area network (LAN) technologies that link all the College buildings back to the Technology building. The Technology building houses the core network and data center where most applications are hosted.

- The primary switching environment utilizes a single Enterasys S4 modular layer three core switch that provides internal network connectivity to various access layer switches providing connectivity throughout the campus.
- These access layer switches connect to the core switch via multimode fiber as 802.1q trunks. The college has purchased a new core switch in 2016 to replace the aging core and add additional functionality but this has not been implemented yet for various reasons. Connected directly to the core are the server and application farms.
- The primary core of the GCCC network is a single Enterasys S4 modular layer three switch. All remote access layer switches connect to this core switch via multimode fiber as 802.1q trunks. Approximately nineteen VLANs are configured on the core switch.

Internet Connectivity

Internet service is handed off to GCCC by KanRen who provides and manages their Internet edge router. The 300MB service is provided by Cox. Edge security is provided by a Fortinet firewall that provides remote access and traffic filtering. Publicly accessible networks exist and are configured on the core router.

There is currently no secondary internet connection for failover purposes.

IP Addressing Scheme

The current GCCC IP addressing scheme utilizes non-contiguous private and public IP networks. Several networks are configured with private class A, B and C IP addresses although there appears to be a significant number of networks using public IP space, including networks where many DHCP servers reside. DHCP servers should not be located in publicly accessible VLANs due to the inherent security risk posed by this practice.

Access Switch Infrastructure

The access layer switching infrastructure at GCCC consists of stackable devices distributed at strategic locations across campus which are at or are nearing end-of-sale dates. All switches currently support up to 1Mbps ethernet connectivity and have a single fiber connection to the core network switch. Some also support power over ethernet (PoE).

Wireless Connectivity

GCCC currently has a premise-based wireless solution. Enterasys HiPath access points are used throughout the environment. These access points are managed by two Extreme V2210 virtual wireless controllers.

Network Management and Monitoring

Based on the configurations observed there appears to be SNMP and Netflow configured on GCCC network devices.

Architecture Recommendations

Core Connectivity

AOS recommends implementing a 10Gbps-enabled core network fabric by replacing the existing single Enterasys core switch with a redundant core design of two (2) Cisco Nexus 93180YC-EX data center switches along with two (2) Cisco Nexus 2348UPQ fabric extenders. Cisco's NX-OS software is designed for performance, resiliency and scalability while fabric extenders would allow GCCC to simplify management while adding port density to the data center network over time. The dual-core design will also provide essential next-hop redundancy for all GCCC VLANs which does not exist today.

In addition, a second connection to all access layer switches should be configured to act as a secondary path in the event the primary fails. When adding a redundant core and access layer uplinks rapid spanning-tree protocol (RSTP) is necessary to help protect from layer 2 loops. It's important to note if spanning-tree is misconfigured it will cause state changes which in turn slows traffic flow causing users to notice "lag" on the network. Spanning-tree state changes can also alter root bridge elections and in turn alter which ports are forward and which ports are blocking in redundant links leading to sub-optimal switching paths. The core should be configured as the root bridge when proper design is in place. Currently there are very few redundant links, so spanning-tree path selection is not a concern. Host ports should be configured for port fast and BPDU guard. BPDU filtering should be performed on non-trunk links to terminate the layer 2 domain preventing unwanted root bridge election and help protect from man-in-the-middle attacks.

AOS recommends adopting and implementing a network-wide quality of service strategy. Quality of Service (QoS) refers to the capability of a network to provide better service to selected network traffic over various technologies. The primary goal of QoS is to provide priority including dedicated bandwidth, controlled jitter and latency (required by some real-time and interactive traffic), and improved loss characteristics. Also important is making sure that providing priority for one or more flows does not make other flows fail. QoS technologies provide the elemental building blocks that will be used for future business applications in campus networks.

Internet Connectivity

AOS recommends replacing GCCC's single Fortinet firewall with dual Meraki MX100 security appliances with advanced security licensing for redundancy and to create a unified threat management system complete with Advanced Malware Protection (AMP), intrusion detection/prevention (IPS/IDS) and content filtering. The Meraki solution provides layer 7 application visibility, traffic shaping and web caching to aid in identifying bandwidth-heavy applications while optimizing educational applications. All Meraki devices are managed using the award-winning dashboard.

AOS also recommends a second internet connection via a different provider be provisioned for internet redundancy. A redundant Internet architecture helps eliminate single points of failure, therefore improving the availability and resiliency of the network. When developing such a resilient design GCCC should take into consideration such items as:

- Dynamic routing protocols (e.g., BGP, EIGRP, OSPF)
- DMZ VLANs for segmentation
- High-availability protocols such as HSRP and VRRP
- Common platform services such as network time protocol (NTP) and authentication, authorization and accounting (AAA).

IP Addressing Scheme

AOS recommends modifying DHCP servers to utilize private IP addresses wherever possible. Remove any old or inactive helper IP address configurations in the core router. Re-IP internal networks with a contiguous range of RFC 1918 network space in an organized fashion. The following is a list of acceptable ranges:

- **10.0.0.0** to **10.255.255.255**
- **172.16.0.0** to **172.31.255.255**
- **192.168.0.0** to **192.168.255.255**

An example of an organized network scheme would be the following:

VLAN 15	Test	10.240.15.0/23
VLAN 30	VOIP	10.240.30.0/22
VLAN 60	Servers	10.240.60.0/24
VLAN 70	Ccmachines	10.240.70/0/28
VLAN 101	Student/Wireless	172.16.101.0/24
VLAN 103	New Wireless	172.16.103.0/24

Access Switch Infrastructure

A network refresh of access layer switches at some point is recommended since several devices are nearing end-of-life/end-of-support and are not able to provide the performance enhancements available on newer switches such as 10G uplinks, RSTP, manageability, etc. Replacing existing access layer switches with Meraki MS225 switches is recommended. The MS225 switches provide power over ethernet (PoE) gigabit access switching in 24 or 48-port models, 10G uplinks, rapid spanning-tree protocol (RSTP) for redundant links and physical or virtual stacking which significantly simplifies management. As previously mentioned, all Meraki solutions are managed from a single intuitive dashboard.

Wireless Connectivity

A wireless survey is recommended prior to upgrading access-points to make sure they can account for proper coverage on all required areas. AOS understands a survey was recently conducted but suggests a follow-up assessment be conducted by an AOS wireless specialist. New network drops will most likely be required at several locations to accommodate proper wireless coverage on all buildings. In the interest of being able to manage a large portion of the network in a single dashboard, AOS recommends installing Meraki MR-series access points. Model specifics would depend on results of the assessment. In addition, Cisco Identity Services Engine (ISE) should be implemented for RADIUS authentication and the creation and enforcement of security and access policies for endpoint devices on the GCCC network.

Network Management and Monitoring

AOS recommends implementing a proven monitoring solution for servers and network devices for management/monitoring of the GCCC environment.

- Some of the features to look for when choosing management tools are as follows:
  - Bandwidth reports
  - Link utilization
  - Centralized logging
  - Configuration repository
  - SMTP or text alerting
  - Netflow collection

Security Review

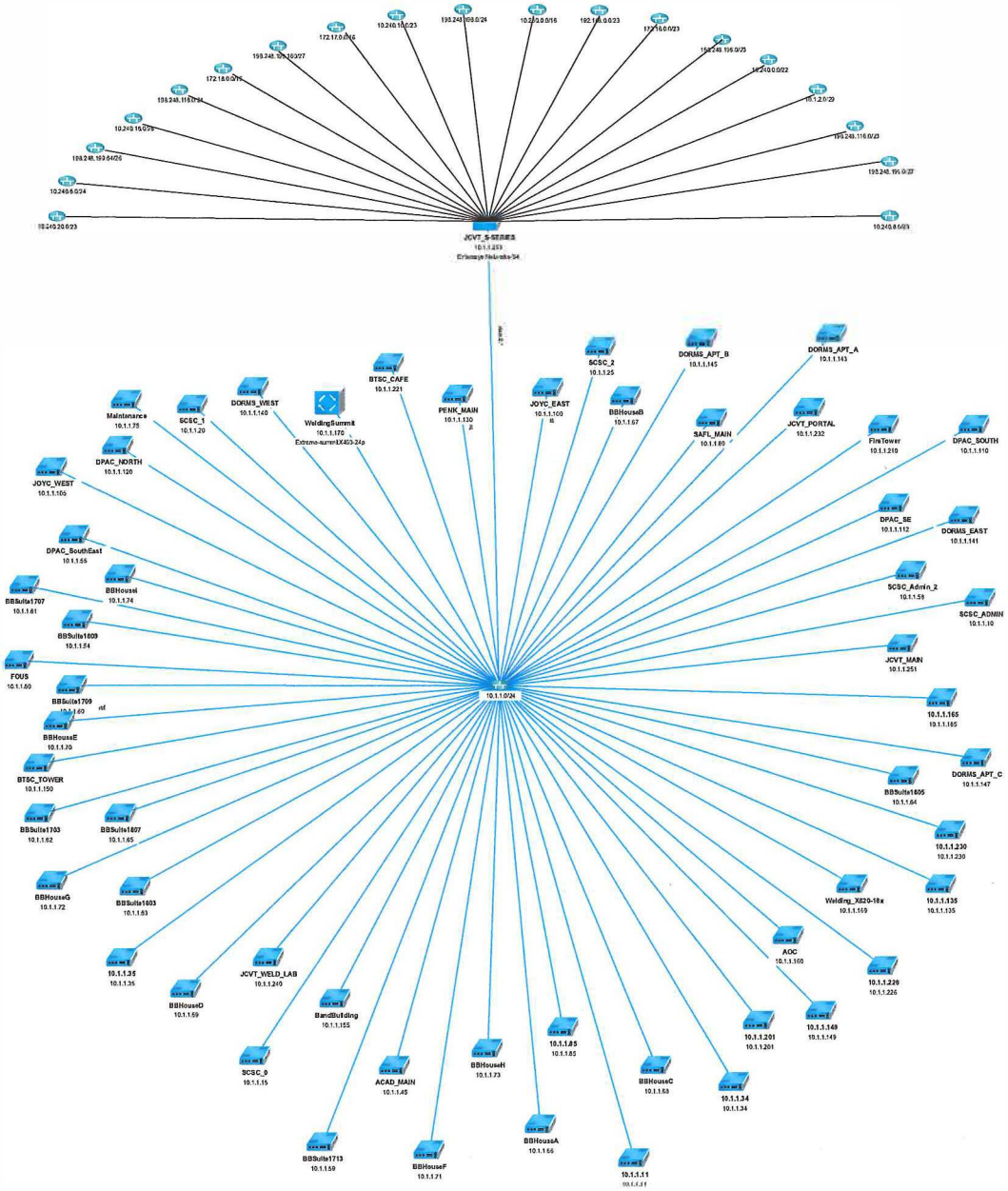
A basic review of the network security posture was performed as part of this assessment. The organization is using a Fortinet based solution for firewall, URL filtering, and endpoint security. Network Admission Control (NAC) is being used to control access to the wired and wireless network. These technologies help provided a layered approach to security in the environment. While these technologies are effective, several vulnerabilities were identified that should be resolved.

Key vulnerabilities that were identified include:

- External perimeter vulnerability scanning using a commercial scanner is not performed. This increases the likelihood a vulnerability will be exposed to the public Internet.
- A single ISP and firewall is in use today which does not provide redundancy. An additional ISP is planned to be added.
- Some Internet facing services terminate directly into the internal network instead of a DMZ network. This creates a situation where compromised Internet facing servers may not be effectively contained.
- Internet facing devices do not utilize a hardening standard. The Center for Internet Security (CIS) standard should be used for perimeter device hardening.
- The patch management schedule is at two months unless there is an outbreak. This should be reduced to a regular monthly patching window. Network security and infrastructure should be updated on a monthly schedule as well.
- DR plans have not been effectively communicated and tested in the environment.

Network Diagram

The following diagrams display a cross section of the current network topology for GCCC and how all devices are physically connected to one another. This should help in understanding all the devices that are currently in place and help for designing a newer and improved network.



Map name	GCCC L3
Print time	10/23/2017 16:55:58
Author	sushil.deshpande

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Sudhir Deshpande Sudhir.Deshpande@aos5.com Ph: (913) 307-2330	Sr. Systems Engineer Alexander Open Systems	AOS Implementation Engineer Contact

AOS Support

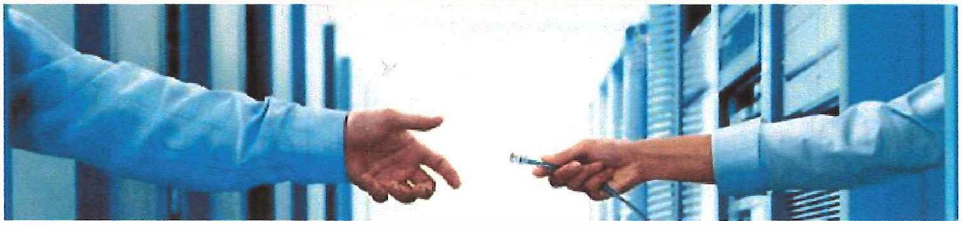
AOS scheduling can be reached during normal business hours Monday through Friday 8am-5pm CST by calling 913-307-2330. AOS helpdesk support can be contacted 24x7 by calling 913-307-2366. Helpdesk support rates may apply.

Vendor Support

Cisco Technical support can be contacted 24x7 by calling 1-800-553-2447, or through the Cisco CCO support website http://www.cisco.com/support. Your Cisco SmartNet contract number will be required in order to open a case with Cisco technical support.

Appendix 2

Garden City Community College Data Center Assessment



GARDEN CITY
COMMUNITY COLLEGE

Technical Data Center Assessment

Assessment, Discovery, and Design by:
Mike McElravy, Architect

August 30th, 2017

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Table of Contents

Data Center and Business Value Assessment

Garden City Community College (GCCC) requested Alexander Open Systems (AOS) to perform a comprehensive Data Center architecture review to identify key business drivers, expectations for services, and the strategic plans for information technology. Once these were identified, AOS reviewed the current architecture, technologies, and operations. An analysis was performed to identify key architecture changes, new technologies, and new operational methods needed to deliver the information technology capabilities required to meet the identified business drivers. These items were then prioritized based on level of effort/cost and presented as a strategic plan.

Customer Business Drivers

Garden City Community College is an accredited Kansas Community College that offers credit and transfer programs, career and technical learning, and business and workforce training. Some of their programs are Nursing, Administration of Justice, Cosmetology, John Deere, and various AG programs provided to a student population of approximately 2500 students with 650 administrative and faculty staff. AOS met with key stakeholders from Information Technology (IT), Payroll, Student Accounts, Registrar, Financial Aid, Admissions, Dean of Academics and Technical Education, as well as the President and Executive Vice President. Several key business drivers and constraints were identified.

Student, Faculty, and Staff Faculty Expectations

Drawing from interviews with various stakeholders, the following common key items were identified regarding expectations:

- There is an expectation for the timely delivery of key information and content across a wide range of platforms and delivery methods. Examples include; emergency notifications via various mediums, access to materials via the internet – wired or wireless, reliability and continuous availability in the core and ancillary systems, high speed internet access, and better mobility experience on and off campus.
- There is an expectation of the ability to interact with the College, Professors, Staff, and fellow students using common technologies in use in other areas of life. Examples include; access to course materials, grades, enrollment, automated self-service portals, and the ability to pay for billed services using new technologies. Faculty and Staff expect system availability, flexibility, resiliency, customizability, interoperability, and so on across a varying array of Tier 0 through Tier 3 applications.
- There is an expectation of reliable and high-quality delivery of College services in a timely manner. Especially in the case of Enrollment and Life/Safety events, with Faculty and Staff personnel having access to information in the most efficient way possible to serve the College. Examples include; timely state and customized reporting, interaction and collaboration within these groups, reliable access to business applications and current computing platforms.
- There is a consistent expectation of speed in delivery of services across the campus network and internet. This can be internet and network based services.

Departmental Common Themes

Discussions with College departments yielded several common themes. The following is a list of items that employees feel limits their ability to deliver services to meet college and student expectations. These items are not a complete set of department issues, but a collection of common themes found across departments.

- Mobility, either laptop or mobile device, for core applications
- Enhanced Extranet capabilities
- Manual processes, lack of current technology, understaffed
- Integration between systems internal and external
- Portal for students and staff
- Reporting either customized or built in
- Accuracy and availability of company data
- Collaboration and prioritization between IT and the business
- Responsiveness from systems and IT
- Current systems under-designed for voice/video/big data/next gen applications
- Current staff needs leadership and technical training
- Current Systems beyond useful life injecting risk in day to day operations
- Increased reliance on software-as-a-service (SaaS) and external providers
- Increased demand for internet-facing applications
- Readiness for next generation technologies (private cloud, platforms, and applications)

Constraints

Like all organizations, the College must operate within a set of constraints. The list below defines key considerations when planning and developing a strategic plan for IT-as-a-whole.

- Staffing levels dedicated to providing services are minimal. Therefore, solutions should be developed that are highly automated with low management overhead.
- Improvements will need to be phased-in in such a way that meets the budgeting cycle and provides the greatest value with the least amount of effort.
- Security needs to be designed into all solutions to meet business and regulatory requirements in addition to providing a safe operating environment.
- Due to the size of the organization, projects must be implemented using a methodical and controlled approach. Focus on the core foundation then focus on technologies that build upon each other to minimize investment and maximize return on investment.

Assessment Area Specific Findings

AOS performed a high-level review of the organization's architecture and technologies in use. This included; automated scanning, manual inspection, review of existing documentation, and interviewing key personnel. The goal of this review was to identify major architecture components at a macro level. This assessment was not focused on identifying all devices, applications, or devices that are considered unmanaged. Performing a detailed site by site inventory was beyond the scope of this engagement and is not recommended due to the size and complexity of the environment.

Foundation

The core network is comprised of multiple local area network (LAN) technologies that link all the College buildings back to the Technology building. The Technology building houses the core network, data center, and much of the applications that are used.

The internet service is handed off to the College by KanRen that provides and manages their edge router. Internet service is provided by Cox at 300MB. Beneath this router is their core firewall that provides remote access, traffic filtering, and is the front line for their security. From there, they employ various security technologies following a defense in depth approach.

Their primary switching environment utilizes a core switch that provides internal network connectivity to various access layer switches providing connectivity throughout the campus. The college has purchased a new core switch in 2016 to replace an aging core and add additional functionality. This technology has not been implemented yet for various reasons. Connected directly to their core begins the server and application farms. Their compute environment consists of roughly 50 servers, half of which are physical with the rest virtualized on a proof of concept (POC) developed VMware farm that transitioned to house production workloads. The decisions regarding which types of servers, and to a broader extent, how these were architected out. Have been driven by organic growth, technology availability, and funding choices. A compute or virtualization technology standard has not been developed.

From a business continuity and disaster recovery perspective, the primary systems used to back up to their primary IBM Storage Area Network (SAN). Due to capacity, age, and technical issues. It was decided to move the backups from the SAN to a managed service provider's appliance that replicates their backups based on a defined schedule to a secondary location that is not owned or managed by GCCC. There are gaps in this method in which recovery times are extended far beyond industry standards. They do not have a complete backup of their systems, which does not allow systems to be recovered or tested on a timely basis. They do back up their system data. However, in the event of a server failure they would have to rebuild the server then restore the data back to the servers to regain availability. Taking advantage of current business continuity technologies would improve their ability to recover their systems in the event of an outage.

The College implemented their current Student Information System in 2004. Datatel, Inc. was a private company that provided fully integrated software and professional services to build enterprise education platforms for higher education until it combined with its competitor SunGard Higher Education to form Ellucian in 2012. The primary module within the application suite is referred to as Colleague. Colleague consists of integrated modules to manage student academic records, financial information, and human resources records. This suite of products would be considered their primary business system and classified as Tier 0. Tier 0 applications are a group of applications that are vital to the business and any interruptions to these applications would have a detrimental effect on the organization. Essentially ceasing the ability of the business to function. A detailed value chain analysis of these applications should be completed by a cross-functional team to document and architect a highly resilient architecture. Disruption of these systems could have major impact on the students, faculty, and staff. Their primary systems utilize a rack server architecture that does not take advantage of High Availability (HA) and Fault Tolerance (FT) capabilities that are built into a virtual server environment. The server farm that provides the core applications and various ancillary applications are directly connected via 1GB copper to their primary core switching infrastructure. Access to this environment is provided by the existing network infrastructure throughout the campus.

General Architecture

The GCCC network has grown organically since its inception without a centralized plan or standardized architecture. As a result, there are architectural issues that have a negative impact on the reliability, scalability, and performance of the services provided. This section outlines key elements that have an impact.

Age of Systems

The average age of the server compute platform is 7 years. This means that many of the systems were implemented in the 2010-time frame. There is a mix of HP and IBM servers. A server vendor standard and rotation plan has not been implemented. The primary storage environment (SAN) has had multiple failures and there is a concern for vendor support due to the age of the system. Coupled with the questions surrounding the backup and recovery environment, there is a genuine concern of a catastrophic failure where systems fail and there are little to no options to recover the systems. The environment has the following major issues:

- Age of the systems can be directly tied to availability. Components will start to fail and since vendors have moved on to more current architectures, there will be a constraint in the supply of parts to replace failed components and support for these platforms will diminish
- Yearly maintenance will be significantly higher as vendors no longer source these components and have difficulty maintaining a supply of replacement parts as time goes on. Software updates will be frozen and the systems will be considered end of life
- This drives consumers to essentially roll the dice and try to source parts from the "Grey Market". This leads to inconsistent results as these parts are essentially the same age of the systems

where failure rates are higher. No support is offered for these components causing greater strain on the staff to maintain availability of the systems

- Vendors will cease support of the platform software as the cost to maintain this service increases. This translates into the lack of ability to call the vendor for support in the event there is a need during a critical time of need. This causes additional strain on the technical staff to resolve the issues and extends the time to resolution or in some cases there is no resolution. Causing extended downtime, loss of data, and system failure beyond the capability or the technical staff to repair.

Business Continuity and Disaster Recovery

Businesses demand their systems are continuously available and accessible regardless if it is during normal business hours or not. Having scheduled or unscheduled downtime is no longer the norm in today's marketplace. Therefore, Businesses need a highly resilient architecture from the application, through the network, to the server room, essentially top down. If internal and/or external customers have difficulty interacting with the business, this will have a direct impact on profitability and reputation among other things. This process starts with the ability to recover individual files or entire systems quickly and from various points in time. Businesses need to ability to recover individual files or entire systems quickly with minimal downtime. Businesses that consider themselves a 24x7 operation, need to build into their systems a highly resilient architecture and maintain standards to ensure uptime and system availability. To build the "right" amount of architecture and resiliency, businesses start with determining their RPO (Recovery Point Objective) and RTO (Recovery Time Objective). The RPO is the amount of data that the business is willing to lose. How many transactions will be lost since the last backup? The RTO is the amount of time the business is willing to be down as the systems are being brought back online.

Disaster Recovery is another component of this. Businesses design their backup systems to keep a certain amount of backup data at their primary location and then replicate portions or all their data to a secondary location; usually across town, out of region, or to a cloud provider. This provides them the ability to recover from a site outage, where all their primary systems are unavailable, they can restart these services at another location.

Ultimately the business will have to determine where they fall and what levels of protection of their primary systems that they choose. Uncovered during the assessment is an RPO of 24 hours of data for anything outside of the financials, where an RPO of 1 Hour is acceptable. An RTO of 4 hours was deemed acceptable. The images below explain this further and gives guidelines on how to plan the architecture.

- The systems are currently being backed up by a managed service provider
- Due to SAN difficulties, backups are created and stored directly to a separate appliance
- Image level backups are not performed, only file level
- RPO and RTO is inconsistent. No standard has been adopted or followed

- There are concerns over the ability to recover systems in a timely manner that satisfies business availability requirements
- Backups have not and are not tested on a regular basis
- There has not been a Disaster Recovery location designated to restart application services
- No Disaster Recovery plan has been identified

Figure 1 – Cause of Downtime

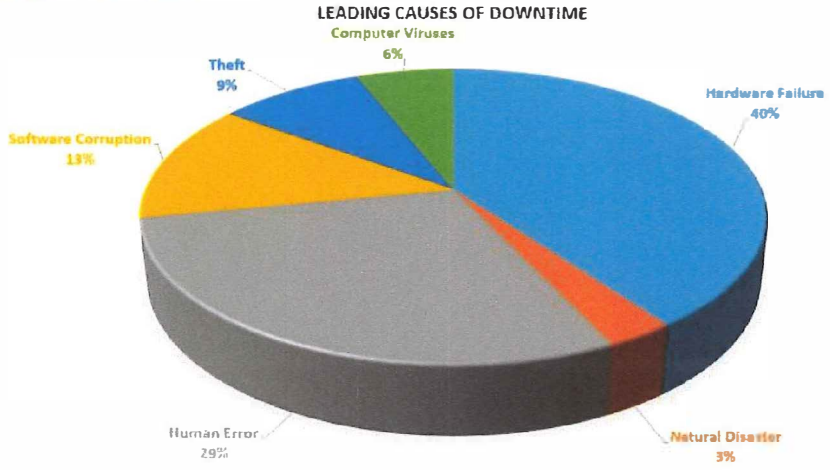


Figure 2 – Business Risk

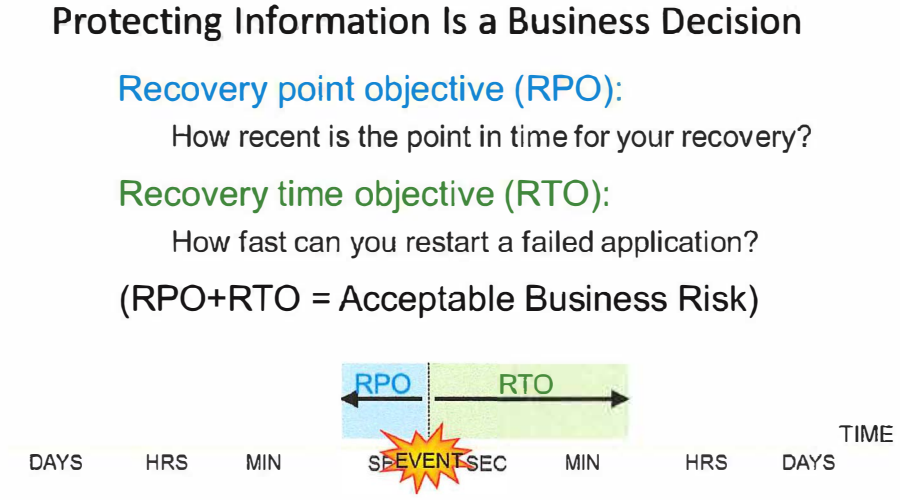
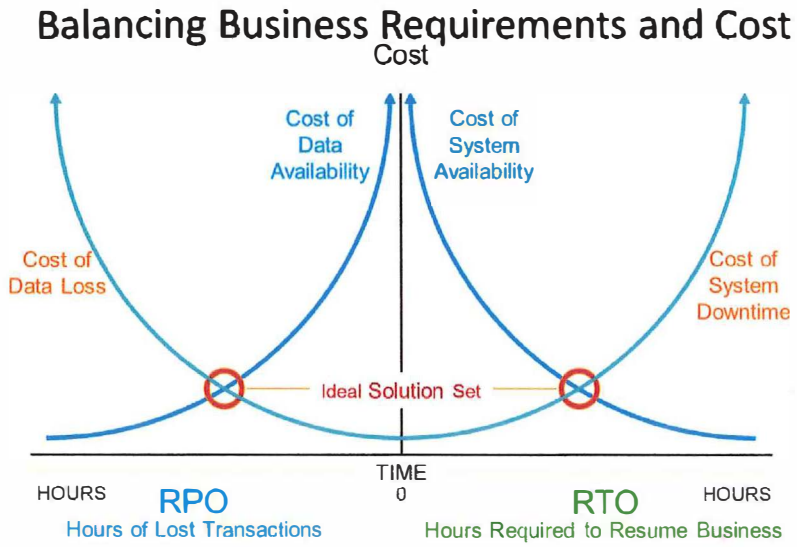


Figure 3 – Balancing Business Requirements and Cost



Enterprise Computing

The velocity of change within the endpoint computing and mobility environment; is changing at a rate where internal IT departments will never be able to keep up with provisioning, maintaining, and retirement of these systems on a timely basis. To manage the constant churns, businesses implement a standard based model and attempt to classify their endpoints based on a class of user. In this instance, there would be a standard for the administrative staff, faculty, classrooms, and student labs.

A standard endpoint, mobility, and mobile device plan has not been implemented or documented. This would be partnered with a scheduled rotation to ensure current computing systems and technologies are made available to the business users. In discussions with the staff, who are primarily remote workers, an issue was expressed that their mobile devices were not adequate to do their jobs. And that they did not have the technology that is needed while at various remote locations. This resulted in rework and manual effort which delayed their correspondence with their prospects (customers). This injects risk of customer frustration, waiting for correspondence back from the college.

- Implement a standard based on class of business user.
- Implement a remote worker plan to ensure staff that move beyond the walls of the college have the technology they need to conduct business in remote locations.

- Implement a rotation plan that would cycle out old equipment based on a defined time frame with guidance based on the depreciation schedule provided by the Finance Department
    - Consider rotating out a third of the endpoint fleet yearly
    - Consider leasing these endpoints through an operational lease to maintain a consistent cost structure, supportability, and refresh rates. This will also alleviate the additional costs associated with destroying older devices in the field
    - It will also drive the rotation of these devices and lesson the likelihood that they will continue to be in service past their useful life
- Consider a managed service for printers and multifunction devices. The costs associated with a procurement model versus a per print option should be investigated.
- Having standards and ensuring those standards are followed and backed by the business will allow the technical staff to develop streamlined support models, reduce support costs, and speed the time to resolution.

Observations

- A combination of Dell 2-n-1 laptops are being deployed for faculty
- Optiplex thin PC's are being deployed for the staff
- A combination of desktops and surface books are still in service
- A fleet of laptops are designated for checkout. Feedback from the business is, these are not adequate. Consider replacing mobile user's primary devices with laptops that they can use, on and off campus, and retire these older systems
- Faculty use a docking station in their office and in the classroom. Consider implementing a system that can be mobile enough to move between the office and classroom without the additional cost of a docking station. The technology in the classroom should have the same interfaces as in the office. This provides seamless movement between office and classroom. There are port replicators that have a USB connection that interfaces with multiple projection systems at a fraction of the cost of a docking station.

Virtualization

Upwards of 95% of the businesses today have adopted a virtualization strategy. Virtualization is the process of creating a software-based (or virtual) representation of something rather than a physical one. Virtualization can apply to applications, servers, storage, and networks and is the single most effective way to reduce IT expenses while boosting efficiency and agility for all size businesses. Businesses drive their virtualization percentage above 90% where a majority of their server environment is virtualized.

- Out of the 50+ individual servers in the environment roughly half are still physical machines on aged equipment. This injects unnecessary costs into the IT operating budget. It also increases the likelihood of failure since there is more hardware to manage

- The existing virtual infrastructure was built on older equipment which reduces the amount of consolidation that could be attained with current architectures. This needs to be changed out with a new highly resilient architecture
- 2 hosts or servers house roughly 25 virtual machines
    - These virtual machines are unique instances of the operating systems and applications
- Consider building out this environment with newer hardware and then virtualize most of the physical machines to this environment. There are many benefits in virtualizing these systems such as lower operating costs, flexibility in the architecture once these systems are no longer bound by the physical limitations of standalone servers.
- The primary storage array is implemented with 10GB iSCSI over the same overworked network causing slowness and inconsistent performance at the application layer.

Networking

The networking environment was not reviewed during this assessment. It is highly recommended that GCCC pursue a full network assessment that includes their wireless infrastructure. During discussions with the various business units, trends started to emerge that pointed directly to the networking environment. I would not recommend having the IT staff pursue this assessment on their own for various reasons. It is better to have an outside source conduct this assessment which would bring in their own toolsets and are highly certified experts in their field in creating and maintaining highly efficient and resilient networks. Some items were observed during this assessment are as follows.

- Public IP addresses are used within the environment.
    - Refer to RFC 1918
    - The college should develop their own internal private addressing scheme
    - Internal routing and public/private services are more difficult to manage
- Extended login times
    - Reports of 3 minutes or longer were reported
        - Might also be tied to the primary authentication systems or endpoints
- At certain times of the day, browsing was slow and ineffective
    - Reports of end users not able to browse and ultimately gave up
- High bandwidth utilization on the network
    - GCCC has a 300MB internet connection that is shared with the faculty, staff, and student population
    - Backups are extended
- Inconsistent wireless experience
- Quality of service was not implemented to industry standards and best practices.
- Voice over IP phones are having clarity and availability issues. There is hesitance to roll out any more handsets due to perceived networking problems.

- GCCC purchased a new data center core switch that has not been implemented a year after it was purchased. They are still on older switch hardware which limits interoperability with newer technologies
- Turnover in the staff resulted in current staff being unfamiliar with the network and its operation
- Commodity networking was used instead of enterprise grade. This translates into a lack of feature set, visibility, reduced vendor/partner support, and constraint in available resources that have the knowledge to administrate the environment
- No internet proxy was in use
    - Internet proxies cache or store redundant data that is requested from user browsers. This improves response time and limits the number of requests for data from internal and external websites. This will also have a positive effect on internet bandwidth limiting the amount needed and prolonging the decision to increase bandwidth.
- Consider replacing these commodity systems with a more efficient switching infrastructure to ensure interoperability, availability, and ease of management.
- Consider a network assessment to ensure operational readiness in these systems

Application Delivery and Foundational Services

These services include Active Directory which is the primary authentication system. The Voice and Collaboration, DNS, DHCP, NAC, etc. These were not reviewed during this assessment. However, trends started to emerge and key risks were uncovered during the review of the architecture. As with the network assessment, an assessment of these services is highly recommended. Issues within these systems would have a ripple effect within the environment and would cause other services to fail or not perform optimally. Essentially these are foundation services that they infrastructure, applications, and networks build upon. I would not recommend having the IT staff pursue this assessment on their own for various reasons. It is better to have an outside source conduct this assessment which would bring in their own toolsets and are highly certified experts in their field in creating and maintaining highly efficient and resilient services. Some items observed during this assessment are as follows.

- Slow login times as previously discussed
- Only a single Domain Controller that services primary authentication while DHCP services are broken out to a separate appliance.
    - This was done due to performance issues with having a single Domain Controller on older hardware
- SCCM is used for endpoint management, packaged applications, endpoint imaging, and reporting
- SSRS is used as a reporting engine from various systems. This is used for custom reporting
- Power BI is in the process of being implemented. There are concerns over the ability of the systems to handle these analytics and reporting systems
    - Consider building a resilient foundation that these systems can be built upon
- KMS is not used only MAK for Microsoft Licensing

IT Security

IT security was reviewed as it pertains to the scope of this assessment. A detailed security review was not conducted but strongly encouraged. When architecting and managing an environment, security should be at the forefront of every design and management decision. With the ever-present threats from a financial, reputation, and availability perspective these are of the utmost importance. Previously, business designed their security with a secure perimeter approach with antivirus or network admission controls protecting their various systems. As threats have evolved, a defense in depth and holistic approach has emerged as an industry standard in dealing with these threats. The primary threats seen today involve malware designed to extract financial payments to the attacker with the threat of destruction or lack of availability to their core systems. The cost to recover their business from these attacks far outweigh the cost to implement strategies to counter them. Items that were observed during this assessment were.

- No snapshot and replication capability within the systems
  - No ability to roll back to the last known good for primary systems
- Network admission control appliances were in place but question the effectiveness
  - No endpoint interrogation
  - If a device is unknown, it places it on a separate virtual network and is only allowed access outbound
- A Fortinet firewall is in place suppling basic filtering and remote VPN access
  - Lack of capability within these systems were observed
  - The rule sets are configured to allow all outbound
- Endpoint Antivirus was utilized

Campus Security

Unfortunately, this has become a greater topic of discussion. Businesses are implementing video surveillance and various alerting and paging systems to communicate in mass should there be an event on premise. These systems should be designed to communicate with many employees as soon as possible. This is usually followed up by an evacuation or shelter in place plan that has been designed by security personnel and the board with the guidance of legal counsel. Employees demand from the business a level of security be provided by the business since they are not allowed, for fear of losing their job, to take protective measures themselves. Only after an event and subsequent lawsuits have the businesses responded by taking reactive measures. Items that were observed

- Aging video system that does not have the capability to record for the required length of time and adequate resolution to be of use.
- A call tree or hot phone is used for qualified events with phones distributed to key personnel
- No internal weather alerting system is in use instead relying on a siren provided by the City.

- No paging or alerting system for the campus
    - Not tied into the phone systems, desktops, overhead
- No automated method to alert people and have them move to a sheltered area
- No video for primary common areas or outside high traffic areas
- No badge cameras for full time or part time staff
- No central monitoring station to maximize visibility for minimal staff
- No automated lockdown of external doors
- No lockdown of the administrative building protecting key college personnel

Collaboration

Quick and effective communication between various business users have a resounding affect in the efficiency in which business is conducted. Companies utilize; voice, instant messaging, and collaboration spaces to collaborate amongst themselves and external parties. The collaboration stack was not assessed during this engagement, however trends started to emerge during the overall assessment. As part of the network and foundation assessment these areas should be investigated

- Exchange for faculty and staff and Google mail for students
    - Consider the faculty and staff to Gmail along with the students. This allows for a host of features capabilities that would be difficult to provide having divided collaboration systems
- No Instant messaging or presence capability. Business collaboration utilize email.
- No mobile access to email. Only through outlook client on company owned systems
- The voice system is not integrated into the email system
- Not able to transfer calls, dropped calls

ITSM

IT service management (ITSM) refers to the entirety of activities – directed by policies, organized and structured in processes and supporting procedures – that are performed by an organization to plan, design, deliver, operate and control information technology (IT) services offered to customers. IT Service Management is key to running an efficient organization. It provides visibility into trends and reporting that assists the business in identifying areas for improvement. Provides a central tracking system for service desk calls, projects, systems documentation and configuration and helps quantify additional resources needed. It provides data driven analysis to backup claims from the business or IT. Some items observed were.

- A service desk ticketing system was implemented but is no longer in use
- This system was home grown and developed and has not been kept current.
- It is easier for the business to pick up the "hot phone" for assistance
    - If everyone calls the hot phone for critical issues only then it is not a hot phone and just another phone just like their desk phones.
    - Consider developing a system that the business finds easy to use reinforce its use

- Emails are used in place or trouble tickets.
- "Drive by" are common where people "swing by" to discuss their issue with IT
- Same with the service desk ticketing system, a project tracking system was implemented but never used. During observations, post-it notes and multiple notebooks were used to track projects and tasks. This is not an efficient way to move project through to completion and causes lag in the systems. It may also cause an incorrect implementation due to the lack of methods to capture business requirements causing further delay.

The current process is inefficient and drives a negative perception of IT. The business feels IT is tone deaf to their issues and finds other ways to solve their problems. This may or may not be the correct way to resolution and cause additional rework or availability constraints. Essentially shadow IT emerges from a few technically minded people and they begin to make technical decisions and configuration that may not be best for the business.

IT Council

As technology becomes more of a business enabler rather than a cost center. Businesses are looking more to IT to assist them in competing in the market and assist them to differentiate themselves amongst their competitors. The Business and IT needs to be brought to the table during these planning sessions to ensure they are working on the right things and to give a feedback loop from IT and from the business. This is important in running a highly effective organization. If there is a wall between these groups the organization becomes disjointed, business leaders and IT are not in alignment with the strategy of the organization, and in some cases a higher than normal turnover is observed.

Some considerations are below:

- GCCC has implemented a DataCore group that only focuses on their primary system.
- This group was primarily defined to manage implementation and enhancements of DataTel
- Consider expanding this to a defined group that has representatives from the business and IT
- This group will be chaired by an Executive VP from which IT reports
- This group will have the decision rights on bringing new technology to the business and discuss/approve/deny enhancements to the current systems.
- Business leaders (Deans, VP's) and IT should present their technology needs to the group based on defined criteria such as but not limited to business impact, cost, student welfare etc.
- If a cost savings is suggested it should be followed up with justification and hold that group accountable for any savings they present. If the thought is it will save $100,000 in a year then at the end of the year the business should see a reduction at or greater than what was expressed.
- Any new project will have a cost justification, resource plan, project plan, and impact analysis.
- The group will vote and prioritize these projects based on total business value
- The chair will submit a report to the President/Board for approval and will stand behind the recommendation of the business.

Reporting

Visibility and the ability of the Business to mine the data is important and vital in the decision-making process. This could be accurate billing, predictive analysis, determining which programs are profitable, etc. Data driven decisions are defended easily and justified. The outcome not so much. A consist theme emerged when talking with the business. "We need better reporting", followed closely by "The Data needs to be accurate". This can be done with Analytics engines like Tableau, Hortonworks, Hadoop, PowerBI or with reporting that comes within the various applications or custom-built reporting. The problem with the latter is it only gives one view out of a single application rather than a broad view over the entire ecosystem of business applications. Some highlights were observed below

- This is not so much reporting as it is custom development. There is an initiative underway to develop a Portal for students. This portal is being developed in SharePoint by internal staff. The strategy is to make a one stop complete view for the students.
    - Consider extra resources specialized in SharePoint and application development to move this project to completion
- A business analytics initiative has been started within the Institutional Research organization
    - Consider a jumpstart with a provider to assist in getting this project underway. These can be intensive and needs a methodical approach to work to gain actionable results
- A majority of the reporting is done via custom development with a designated staff member wearing multiple hats with additional support from a backup resource.
    - Multiple departments requested enhanced reporting
    - Prioritization of report requests was not observed
    - Consider adding additional resources or a reporting engine that can offer custom reports so the business can create their own reports or temporarily add resources to address current requests
    - Long term resolution would be to offload the additional duties from the developer, create a separate reporting capability, or look to a specific vendor reporting engine designed for enterprise reporting in this market segment.

Training

This is an ongoing investment in the effectiveness of the staff. This is key in running highly efficient organizations. A development plan should include training within the field (Security, Architecture, Applications) and business based training (Mini-MBA, CMD). Employees that manage people should have a blend of both. Just because they are good at their jobs on the technical side does not mean that they will be effective leaders and able to contribute to the organization. Business communication, Soft Skills, Budgeting, Cost Analysis, managing people are some of the most important areas to focus on. Some areas observed

- Knowledge is primarily gained by on the job experience versus a defined structured training regimen
- Heavy reliance on "Google" or peer groups translates into extended time to resolution

- Fulfillment issues with current staff
- Flipside is the business has concerns that key staff members would leave
- Consider this approach
    - During yearly appraisals. Review with the employee their training needs. They will come up with the technical training and the supervising manager will come up with the business training. Agree to a plan and course of action
    - Training requests should be justified.
        - Have the requester write a one-page professional paper requesting training
        - Make sure it covers
            - How this would benefit them
            - How this would benefit the business
            - How this cost would be justified, (Cost savings, Efficiencies)
            - If it is not professional then deny training and have them try again. The business is investing in their future and they should take it seriously
    - Hold them accountable
        - The training must pertain to their job
        - They must be able to show an improvement – Discussed during appraisals
        - They must be better in how they get things done.
        - They must take ownership of the outcome. Study, Application of new skills, etc.
        - If they meet the requirements set forth then we can talk about additional training
    - Any new training that the company pays for will result in a contract with the employee that if they should leave before 2 years they will have to pay back the cost of the training
    - Pay for the exam that they pass. Not every attempt. That way they have ownership on the outcome
- When purchasing new equipment or capabilities. Ensure that training is included

Architecture Design Summary

GCCC's current architectural design is like many non-traditional designs that have grown organically over a long period of time. Recent changes in technology including virtualization, data services, application advances, and other advanced technologies have driven the need for design changes. Major technology disruptions are occurring with the Internet of Things, increasing user mobility, big data analytics, and cloud technologies that will introduce additional disruption as time goes on. The following design recommendations reflect changes that need to occur in people, processes, and technology to allow the College to embrace technologies that will enhance end user experience and increase GCCC's attractiveness to the administration, faculty, staff, and students.

Design Objectives

The primary technical goals for the design are to directly enable the business goals of the organization. These are summarized into the following key technical objectives:

- Resolve technology issues that could pose a risk to the College.
- Enable the infrastructure to support modern data, voice, video, Internet of Things, and big data and/or enterprise applications to deliver data driven services to administration, faculty, staff, and students in the most efficient way possible.
- Provide the ability to allow mobility of these systems giving the business users access to key systems while offsite on any platform at any location. The goal being to provide application access to any user, in virtually any location, in a secure manner that is both easy to use and easy for IT to manage.
- Develop a framework that allows the effective adoption of advanced and emerging technologies to make GCCC a leader in technology.

General Architecture Fundamentals

This section identifies technologies, processes, and methodologies that can affect the entire infrastructure. They include one-time actions as well as recurring items that need to continue over time. These items are not listed in order of priority, they are organized by general technology or action that will need to be taken. Examples are provided that can be used to spark conversation. Most organizations choose to identify key stakeholders to encompass an Enterprise Architecture team responsible for developing formal standards.

Enterprise Architecture Standards

Enterprise Architecture (EA) standards are key in every organization, as well as organizations that have business units that make independent technology decisions. When adopted, these standards keep technology consistent throughout the organization, facilitate rapid response to changes or growth, simplify decision making, reduce administrative overhead, and ultimately provide a better customer experience. These standards are best defined as simple macro-level rules for the design, procurement, and implementation of technology.

Best of Breed versus Standardized Architecture Strategy

A best of breed architecture is defined as standardizing on products that are the best in class for a specific function to realize the technical advantages of a specific IT component. Organizations that elect to standardize on best of breed technology tend to embrace emerging technologies and are early adopters of new technologies. For example, using one vendor for servers, another vendor for storage, and a third vendor for networking. The goal is to have the best product in each category deployed in the organization. The many costs of this strategy include a large amount of overhead in product selection, testing, head-to-head comparison, and pricing procurement tasks. It results in additional administrative

overhead for day-to-day administration, integration of dissimilar products, troubleshooting between products, and it complicates staffing by requiring a wider range of skill sets that may be rare in the community. The result is that best of breed strategies drives larger IT departments and larger consulting costs to supplement staff.

A standardized architecture takes advantage of diverse portfolios in a small number of vendors that are rated either number 1 or number 2 in their respective markets across product lines. Technologies should be proven, stable, and predicable over time with common management and administrative interfaces. The benefit of this approach is that fewer IT staff are needed due to lower administrative overhead, lower procurement overhead, and hiring and staffing are easier due to more commonly found skill sets in the community. The disadvantage of this approach is that it may result in slower adoption of emerging technologies and dependence on a smaller group of vendors.

AOS recommends GCCC use a standardized architecture strategy. Due to the limited number of staff, size and diversity of the systems, and complexity, an effective best of breed approach would require significantly increasing team staffing. More staff would be required to spread effective skills sets between team members, require additional training time and cost, require complex system integration time, and increase time spent troubleshooting dissimilar system issues that arise. Standardization, with a focus on heavy automation, will speed up the implementation of new services that enhance business operations.

The recommended approach is to develop the following device standard vendors:

- Server
- Storage
- Virtualization
- Endpoint/Mobility
- Network

Application Classification Model

Due to the diverse nature of applications that are offered to many different departments, a classification system should be developed to establish type and priority of each enterprise application as it relates to GCCC operations. This classification is then used to determine the technology that will be deployed, level of redundancy, and priority of service restoration in the event of a disaster. This system should be kept as simple as possible with the absolute minimum number of classifications necessary. It will also require political decisions be made regarding prioritization. The business should agree to this classification. Effective prioritization is key to allocating resources within resource constraints. The list below provides an example of a 3-tier classification scheme:

- Gold Tier 0 Level – Core applications that are critical for business operations
    - Will have redundant components.

  - Resilient architecture to withstand multiple failures. Or no single point of failure
  - Target uptime is "five nines" (99.999%) availability (5 minutes 16 seconds of unplanned downtime per year).
- Silver Tier 1 Level – High Priority for business operations
  - Target uptime is "three nines" (99.9%) availability (8 hours 45 minutes of unplanned downtime per year).
  - Baseline cost to establish and operate.
- Bronze Tier 2 Level – Important, but not essential
  - Redundant components optional and at business discretion.
  - Target uptime "two nines" (99%) availability (3 days 15 hours 39 minutes of unplanned downtime per year).

This model will be referred to throughout this document when referencing tiered architectures.

Equipment and Vendor Standards

GCCC maintains a primarily a best of breed approach with multiple vendors supplying key components and applications. Standards should be implemented to standardize GCCC on enterprise class products with partners that have proven and verifiable expert level experience with a given product. A detailed solution architecture should be defined by the College, or a partner, prior to releasing an RFP. Most organizations like GCCC set the following basic equipment/vendor standards:

- Products must be identified as a leader by Gartner and/or Forrester.
- Partners must have expert level certification in the product they are proposing to install.
- Installers must hold certification in the technology they are implementing.
- Solution must meet the Businesses architectural requirements which will reflect the approved products/architectures.
- Provider must have multiple customer references for organizations of a similar size and complexity.
- Provider must have proven fiduciary position and financials that reflect a low likelihood of the organization exiting the market within the next 2 – 5 years.

Equipment Standardization

Equipment standards should be created for Gold, Silver, and Bronze tiered applications. This information should be provided to procurement and department leaders across the College. Using this method will allow solutions that are sub-contracted or initiated independent of IT to maintain the current architecture. Examples of equipment standards are as follows. Please note, these are only examples of what the standards will look like. Finalized and approved standards for each level will need to be developed and agreed upon as a team.

- Gold Level - Require IT Design and Approval

- Silver Level – Requires IT Review
- Bronze Level – Requires IT Standard Compliance

Centralized Management

Develop standards that require all technologies be managed by a centralized management solution where possible. All efforts should be made to consolidate as many devices as possible onto as few management platforms as possible. This should align with equipment standards to establish a situation where only centralized management platform may be used. Centralized management platforms may be on premise or cloud based solutions. Examples could be that all servers will be managed by a single management platform like UCS Manager, all servers will be managed by vCenter, all tickets, projects and configurations will be managed by a single ITSM solution. Consolidating to centrally managed solutions will drastically reduce the administrative overhead associated with day-to-day support, which will in turn create the cost savings that will offset the additional hardware or software costs associated with obtaining the centralized platform.

Planning Standard

Continual planning for the future of the technical environment should take place. Alignment with planned business objectives should be regularly evaluated. Quarterly or semi-annual IT internal reviews should be performed to measure and report on the planning progress that is being made. Annual reviews should be conducted where the IT department meets with key departments to raise awareness of new capabilities, identify pain points, and to help develop planning objectives for the next year. A review from outside of the College is recommended every 18 – 24 months to provide an advisory perspective of new industry technologies.

Data Center Network Standards

Major technology shifts have moved the primary focus in the data center from being north-south traffic flow oriented, to being east-west oriented. Heavy virtualization and hardware consolidation has driven the data center to a traffic model where large amounts of traffic flow between blade/hyper-converged infrastructures. In addition, new orchestration technologies have been developed to leverage Software Defined Networking to automatically provision network, storage, compute, and operating system software in way that increases application delivery speed and reduces administrative overhead.

Implementing these standards over the next 1 – 2 years will provide the College with a wide range of improvements and capabilities. This will establish a highly agile, easy to manage, high performance, and highly reliable data center network infrastructure. This will in turn enable greater virtualization, consolidation, and the ability for IT to quickly deliver additional advanced applications. Virtually all network performance bottle necks encountered in today's data centers are eliminated by this technology.

Advanced Technology Projects

Advanced Technology projects are defined as projects that utilize emerging technologies to deliver next generation functionality enabled by low cost hardware, highly mobile, centrally managed, and that take advantage of advanced data analytic capabilities to provide real-time actionable information to individuals as well as other applications.

Key technologies that fall into this category are Smart technologies, Advanced Management, and Internet of Things. The earlier recommendations in this document are designed to provide a network infrastructure that can support these applications, and the systems that are required to run them. Key themes of these technologies are the high speed, high prevalence, and highly flexible systems required to support these initiatives.

IT Transformation Planning

A key theme is has emerged in IT around the concept of orchestration and automation being central to IT operations across IT infrastructure disciplines. Orchestration and automation technologies have been developed for the network, storage, compute, and application levels of the traditional IT hierarchy. The primary goals being to:

- Increase the speed of application delivery – new applications that cross different IT silos should be able to be deployed in minutes, not weeks or months.
- Reduce administrative overhead – IT staff should be discovering ways to enhance the organization with technology, not figuring out how to manage technology.
- Deliver applications universally – applications should be available anywhere and on any device.

These factors transform the way IT works in the organization, and the job of IT practitioners in the organization beyond the IT team. Success with these trends will require the College to aggressively embrace these technologies across the various IT functions. AOS recommends the College conduct data network and application delivery assessments to align with this Data Center assessment. Key items such as wireless, local area networks, external networks, remote access need to be addressed with a 1 – 3-year strategy for implementation. Deploying a highly virtualized data center, and embracing a highly resilient architecture, are the first steps in embracing this transformation.

An education and awareness program of these technologies for staff should be created. There is a tendency for people to view automation technologies as vehicles to replace staff. Studies have shown this is not the case. Automation technology changes the role of IT to be more business focused as opposed to technology focused. This results in IT staff providing a more valuable service by having time to develop relationships and define business problems outside of IT. They can then use their technology knowledge to solve business problems. This provides much more value to the organization than having an employee perform behind the scenes actions that can be automated. The end goal is the development of an employee training program to enable adoption of these technologies, but also includes the increasing business analytic skills for the future.

Implementation Recommendations

Approach to Implementation

AOS has structured the implementation of these architectures as a series of projects. The architectures outlined in this document provide the high-level roadmap of the solutions, whereas upcoming individual projects will provide the detailed, lower level configuration.

Short Term Tasks

Short term tasks are foundational projects that are required to fix major underlying systems issues. These are recommended to be completed within 12 – 18 months. Most of the projects in this section can be worked simultaneously.

Blade Server Architecture

Plan to consolidate, modernize, and optimize the data center. Many of the physical rack servers are having idle capacity that is going unused. By creating an IT transformation and virtualization strategy to increase virtual server consolidation ratios, the business can reduce their data center throughput and recognize significant cost savings.

All Flash Storage

This is part of a data segmentation plan where we place application data on highly efficient systems to speed response times within the application layer. These systems are designed to be highly resilient, easier to manage, and will speed application performance. This storage will be where the virtualize infrastructure will be built. Systems that require high performance such as SQL and Oracle will also take advantage of this storage.

Storage for Unstructured Data

This class of storage is would house the rest of the storage like stale data, extracts, images, video surveillance footage, etc. Data that needs to be kept but does not need the speed and additional data services the all flash storage provides.

Business Continuity, Backup and Recovery Methods

These systems are needed to recover the business from a localized or complete outage. These systems should be highly resilient and flexible that are designed to change with the business. Their purpose is to house recovery points of systems that will be used for recovery. They will provide a platform to test and validate system backups at regular intervals. Theses should be considered vital to daily operations and are important components in providing the recovery points and recovery times the business demands. Once backups of the systems are stabilized and validated, these systems can replicate data to a secondary location to ensure the business can recover from a localized outage.

Standards Development

Develop and implement the standards listed previously in this document. Once the standards have been developed, they will need to be disseminated across the organization.

- Develop a process for standards approval and dissemination.
- Develop the standards based on industry best practices, expert recommendations, similar standards in other local/state governments, and best fit for the College.
- Submit standards as a package for approval.
- Disseminate within the College to operationalize the standards for all new projects.

Other Items

Other items that should be implemented in the next 12 – 18 months are the following

- IT council
- Endpoint rotation and refresh plan
- Network assessment
- Business applications assessment

Medium Term Tasks

Medium term plans are the next priority of projects that need to be executed. These require the projects in the short-term section to be complete. Installation of these projects will require significant capital costs due to the number of devices that will be refreshed. Cost estimates are not provided on these items because that requires the results of decisions made on the short-term projects.

IT Transformation Strategy

Identify a multi-department team that can review, identify, and build cross departmental support for new technologies to enhance operations. Initiatives performed in the Short-Term section of this document can be leveraged to build good will and entice membership/participation in this team.

- Identify ideal team members across several key departments.
- Develop a project agenda for the team identifying a high visibility/high interest project as the first project.
- Stage agenda to provide basic discovery of the technology and capabilities.
- Identify benefits IT could provide to the organization.
- Integrate findings into strategic planning.

Long Term Tasks

Refresh Standards

Over the course of 3 – 5 years, several major factors will require the review and revision of the standards agreed upon by GCCC. Advances current and new technologies, additional application capabilities and requirements, and the changing workforce will drive the re-evaluation of current standards. These changes will have a significant impact on the architecture and the products listed in the IT standards.

- Develop minor and major review cycles for these standards.
- Review these standards within the context of stability and emerging technologies.
- There is a high likelihood that new technologies in the business environment will drive significant architectural changes in the infrastructure.

Reassess and Realign

Adoption of these new technologies and the growth/maturity of IT transformation in the market, will have a dramatic impact on the way technical services are delivered in the organization. This will change job roles for network/IT staff, drive focus from infrastructure to applications, and require business analytic skills beyond those previous needed. A key focus needs be on staff training and the use of automation technologies to reshape the culture from IT simply providing infrastructure, to instead working in collaboration with the business to define application requirements.

- Develop training plans that include business analytic skill sets.
- Develop skill sets to identify business drivers and leverage SDN for business agility.
- As direct infrastructure support times reduce, integrate infrastructure staff operating as business analysts into more departments.

Once this is done, reassess where IT and the business has come. Ensure that strategies put forth align with business objectives and puts the College in the most competitive position as possible. Adopt a three-stage approach of where we are at, where we are going, and ensure you have the right people. Processes, and technologies to get you there.

I want to thank you for the invitation to meet with the key stakeholders and allow me the opportunity to review the processes and technology to give you an objective opinion.

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