Network Design Concept

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Background and Purpose

It was 1998 when the District stood at a crossroad of technology, contemplating whether to upgrade the legacy system in order to maintain our then current Enterprise Resource Planning system (ERP) or to move to a new technology and a new ERP. Choosing to leave the old system behind, the District discovered that the implementation of Banner, along with the required technology to support it, opened a new world of services to students, faculty, and staff. Today these technologies, including access to the internet, server farms, wireless networks, and online registration are services we take for granted. The crossroad we now face is whether to upgrade our legacy network equipment and maintain our older environment or to redesign the network to meet current and future needs including cloud and mobile computing. It is time to once again to leave the legacy behind and move ahead toward a new world.

In 1998 the District embarked on the journey to develop an implementation plan for a completely redesigned district-wide network. The primary objective of this network was to provide access for students, faculty, and staff to timely and accurate information using state-of-the-art information systems. As the new network project was in progress, the Banner ERP system was also being implemented. There were two major phases to the project: 1) install a Telecommunication Infrastructure consisting of inter- and intra-building cabling at each campus and Wide-Area Network links for inter-campus communication and 2) implement a Logical Network consisting of network equipment and network configurations which provide the communication flow for data, voice, and video. It was the objective of the project to create three separate campus networks—one for Cypress College, one for Fullerton College, and one for the District offices—that would perform as one network when needed. For purposes of being concise in this document, this will be called the "three-as-one" design. As the Logical Design was developed, there were six goals set for the new network: Reliability, Supportability, Open Architecture, Upgradeability, Security, and Configuration Management. The new network infrastructure was fully implemented in 2001. These six goals remain relevant in our current environment and, therefore, will serve as the basis for this concept paper.

Since that time, the network has become a necessary utility to provide services for instruction, learning, and the business functions of the district. Students and staff take network connectivity for granted just as they do with electricity and running water. When the network stops working, so does the mission critical work of our institutions. In his EDUCAUSE Review article on IT infrastructure projects, Jerrold Grochow (2015) states that "critical infrastructure refers to those infrastructure assets critical to the functioning of society. While this traditionally has referred to infrastructure dealing with necessities such as the water supply, electricity, transportation, and food supply, the federal government now includes information technology in critical infrastructure, both in terms of the organizations that supply IT and the organizations that use IT" (p. 2). The utility of the network has now moved beyond an *expectation* to an *assumption*.

Although the network has performed well and met the original objectives, it is time to reassess its functionality for the future. There are several factors that are driving this reassessment and it is the purpose of this concept paper to present these factors and to recommend a framework for developing a new network design. It is not the intent of this paper to advocate for immediate implementation of all the functionality

described, but to design a network environment that can be adapted as these future functionalities become necessities.

Factors Driving a New Design

There are three primary motivators for reassessing and redesigning our current network:

1. *Replacing core switches*. The network core switches at each of the campuses will reach end-of-support in December 2017. These switches have been upgraded several times over the past 15 years and there is no longer an upgrade path; these switches must be replaced in order to continue vendor maintenance support and to receive critical software updates.
2. *Providing a more responsive support structure*. Currently each campus network is managed separately and when multi-campus network issues have occurred, there is often two different approaches and no central coordination to resolving the issue which have resulted in delays to finding a solution.
3. *Preparing for cloud computing*. Over the past few years, there has been an increasing prevalence of cloud computing solutions. A network redesign can take advantage of cloud technologies that we have already implemented and apply them to a district-wide private-cloud design. Additionally, public-cloud computing offers many options for us and the network redesign will optimize the network to take advantage of these offerings.

> "The most effective IT architecture is one that works for the whole enterprise, rather than being a glove-fit for several individual areas" (Grajek, 2015, p. 36).

Another factor influencing the concept of a network redesign is the District Technology Roundtable's (DTR) and Technology Coordinating Council (TCC) discussion of technology projects that could be funded by the bond issue Measure J. In concept, it was agreed that major network projects such as upgrading the wireless network, expanding the use of Voice over IP (VoIP), and replacing the network core switches should be joint projects with central coordination from Information Services.

It is the contention of this paper that in order to provide a network that serves as a utility throughout the whole district, there is a need to move beyond just replacing old equipment. The purpose of this paper is to present a framework for redesigning our network based on assessing current technologies in light of our original six goals.

Goal 1: Reliability now requires Redundancy

The *Reliability* goal states, "The design is to include redundant paths for major routes, service contracts for equipment or services that the district cannot provide ourselves and high quality components. The District will need to provide 7 day by 24 hour reliability." This remains a high priority goal for the new network. However, without *redundant* systems it is impossible to provide this 7x24 reliability for 365 days a year. There are two areas where redundancy can provide benefit for our district: *System Maintenance* and *Disaster Preparedness*.

System maintenance: There is a need to perform system maintenance and without full redundancy, systems must be taken off line. For example, Information Services performs major server maintenance twice a year which requires us to shut down essential services including Banner, Degreeworks, and myGateway. Although downtime can never be totally eliminated, this major server maintenance could be accomplished without interruption to services if full redundancy between campuses is provided.

Disaster Preparedness: A catastrophic event at one of our campus data centers, such as a long-term power outage, flood, or earthquake, could shut down access to critical systems. By providing redundancy between campuses for critical servers, these systems could continue to function from another campus. Although this doesn't address all disaster preparedness issues, it can be an effective solution for disasters local to a campus.

The new network design should allow for virtual servers to move between data centers at two different campuses. The current limiting factors that prevent this from happening today include the three-as-one network design, some unimplemented features of the VMware software, and the readiness of some applications. A major limiting factor is that Banner currently runs in an HP-UX environment and cannot be run in VMware. However, work has begun to move Banner to a new operating system environment which will allow it to run on VMware. By working together, the three campuses can provide the redundancy needed.

We also need to consider *Software Defined Networking (SDN)* in our network design. "Gartner defines SDN as a new approach to designing, building and operating networks that support business agility" (Lerner, 2014, p. 7). There are few standards for SDN and vendors are producing their own implementations of it. As the network design is in process, it is important that we question network equipment vendors about their SDN solutions, consider what it can do for us, where it can be implemented, and assure that our design takes SDN into consideration for future implementation.

Goal 2: Supportability now requires Responsive Support

The *Supportability* goal states, "The design is to provide functionality for failure isolation, rapid repair, hot swappable components, and automated paging for failures." Although this remains as an important goal, there is a need to elevate this goal from its reactive posture to a proactive one. Responsive support means that when there is a network problem, the support team takes a unified approach to resolving the issue. The network redesign should address this issue through the selection of new *Network Core Switches* and a reassessment of our *Network Support Structure*.

Network Core Switches: At the headend of the network at each campus, connecting the campus backbone to the wide area network, is a high capacity switch called the core switch. These devices have been upgraded several times over the past 15 years and now need to be replaced since they will reach end-of-support in December 2017. Since replacement of these switches is a major investment and undertaking, this is a good time to reassess the core of our network design and develop a configuration that will allow us to grow our network for the future.

Network Support Structure: The utility of the network requires not only that the network is supportable, but that the support team is responsive. Susan Grajek (2015), in her article *Top 10 IT Issues 2015 - Inflection Point,* states that "centralizing and standardizing further simplifies the ability to respond quickly to changes." The current network was implemented with each campus core switch configuration invisible to the other campuses. The purpose of this design was to allow each campus to maintain their own network to meet site-specific needs. However, it was also the intention of the three-as-one design that the separate campus support groups work together when issues spanned campuses. One problem that has resulted from this segmented design is the different devices, configurations, and methodologies that have been implemented without regard to how these changes affect the other campuses. The new network design should allow visibility to all network staff from all campuses. A new cooperative network support structure would need to be established; support staff from all campuses would work as a single team to support the network and coordination could be centrally coordinated by Information Services. In this way, when network issues occur,

there would be a single and coordinated approach to resolving the problem, improving the responsiveness of the team.

Goal 3: Open Architecture now requires embracing Mobile Computing

The *Open Architecture* goal states, "To avoid the constraints and problems of proprietary components, the design is to be an open architecture. The district wants to be able to provide logically independent services, provide standardized functionality to all locations in the District, and provide any service from any location if properly authorized." Mobile computing has taken open architecture to a new level. Students and staff now bring their own devices—of various makes and operating systems—and use them for personal, instructional, and business purposes. Where once network design was based on meeting the business needs of the organization, now the consumers are defining the parameters for our network. In his EDUCAUSE Review article, Confalonieri (2015) states, "now a core part of our lives, technology blurs the previously well-defined borders between different aspects of our days and shifts power from organizations to individuals" (p. 1). The new network needs to address the mobile needs of our students, faculty, and staff by providing uniform access across campuses, in all classrooms, conference rooms, and offices. Having a unified, single sign on process for those who traverse campuses is essential to providing the open access that is assumed to be readily available.

Goal 4: Upgradeability now requires Increased Bandwidth

The *Upgradeability* goal states, "The design is to be scalable. As technology changes and as the use of technology increases, the district needs the availability of easy upgrade paths. The Infrastructure design must provide the ability to upgrade both technology and performance without significant network outages." Upgradeability can take new forms in today's computing environment. In addition to procuring more powerful servers and storage devices, which require increased bandwidth in order to fully utilize their power, upgradeability can be achieved by sharing resources between servers, even between the campus data center and cloud provider. As mobile device users and cloud computing demand increased services, there is a corresponding demand for increased bandwidth. A significant step in this direction was taken when the CENIC fiber ring was implemented by Information Services for our three campuses. Bandwidth was increased to gigabit speeds for our internet and internal networks. The new network design must provide for the increasing bandwidth needs in order for the network to continue to be upgradeable.

> *"Mobile devices and cloud computing as well as video viewing may drive network requirements to new and unseen levels" (Delcroix, 2013, p. 3)*

Goal 5: Security must now address Cloud Computing

The *Security* goal states: "Security is a critical component of the Infrastructure. Over the same logical and physical network, the district will have Student, Faculty and Staff accessing academic resources, student services, administrative information, and electronic communication internal and external to the network. The district needs the ability to authorize and provide any service from any location, security levels must be appropriate for the service or function being accessed, and information exchange between services provided over the Infrastructure must be secure." Security is a critical and essential part of the new network design and must address the new challenges, threats, and regulations facing us today.

Cloud Computing: Cloud computing is now becoming part of the daily activity of our technology groups and is changing how security is addressed in a network environment. New requests for external cloud applications such as the Applicant Tracking System, SmartThinking, and Comevo require high levels of scrutiny to assure the security of the stored data. Users of external cloud services require authorization from within the district network; securing access to this authorization is crucial. Gartner states that "increasingly, enterprises are seeking to optimize the placement of IT services across public cloud and on-premises private clouds" (Scott, 2015, p. 1). The district's approach to incorporating cloud computing into our enterprise system must be intentional and guided. Vendors are going directly to end-users with their cloud solutions, so there is a great need for Information Services to provide guidance for the security of our data and for integration with Banner. Internal private cloud services providing the redundancy detailed in Goal 1 above require new approaches to network security; the new network design needs to accommodate the security requirements of cloud computing.

Other challenges: In addition, there needs to be a fresh look at how network security is provided. Regulations such as the Payment Card Industry Data Security Standards (PCI DSS), Family Educational Rights and Privacy Act (FERPA), and various confidential information regulations are moving targets and require security staff to be involved in the network redesign project. Some of the old security methodologies, such as firewalls and DMZs, are no longer effective in their traditional forms. Although not a single solution for all security risks, a next-generation firewall should be considered in the new design.

Goal 6: Configuration Management now requires Cooperative Support

The *Configuration Management* goal states: "The design is to include the necessary components to properly manage the Infrastructure. The district must be able to isolate traffic to appropriate domains. Real-time information on network components must be available. Automated network performance measurement and reporting must be available. In addition, network management procedures must be uniform across network components." This is still an important goal, but we must add another component to it: cooperative support. The new network design approach needs to move us from a "three-as-one" network to a "one-as-three" network, one network across three campuses that will meet the needs of the individual campuses. This requires a significant change in how our network support works presently; it is necessary in order to move us to a cooperative support model. A key component of this design is to put together the team which will support the network. It requires someone to centrally coordinate the team for issues that cross campus boundaries. It requires maintaining a change log so that all changes can be tracked. It requires resourcing the network support team by providing new management tools and providing training where necessary. Most of all, it requires all network support staff to work together as a team, keeping in mind that ultimately we exist to support our students all across our district.

A large-scale example of this is the district's internet service provider, CENIC (Corporation for Education Network Initiatives in California). CENIC provides a centrally coordinated state-wide network that serves the needs of diverse institutions including the California K-12 system, California Community Colleges, the California State University system, California's Public Libraries, the University of California system, Stanford, Caltech, and USC. Each of these institutions is represented on a technical advisory committee in order to address the needs of each institution. A similar cooperative concept could be used within our district to form a Steering Team for addressing the network needs of each of our campuses.

Next Steps:

The following is a list the major project phases that need to take place in order to properly design and implement a new network. It is recommended that a consultant be considered for running each of these

phases; an outside consultant can draw from experiences with other institutions of similar size and structure. ACT and IS staff need to be intimately involved in the development of each of these phases for three reasons: 1) the input they provide will be invaluable to the process, 2) our staff will gain a great deal of understanding throughout the process, and 3) this will help to build the teamwork necessary to support the new network. The following phases are essential to a successful project:

1. *Network assessment.* This phase will evaluate the current district-wide network to obtain an understanding of the infrastructure, hardware, software, configurations, topologies, tools, and support practices. The outcome of this phase should be a document that will form a basis for the network design phase. (Estimated cost: 100K)

2. *Network design.* This phase will evaluate the current and anticipated networking needs of our institutions, evaluate current technology trends, and determine what equipment and telecommunication infrastructure need to be upgraded. The outcome of this phase is to provide a recommended network design document based on those findings including functionality-based specifications for equipment, tools, training, needed services, and a cost estimate for allocating funding. It should also provide guidelines for creating and maintaining the team-based support structure. (Estimated cost: 300K)

3. *Procurement.* This phase will determine the best process for competitively bidding the equipment and services, selecting a vendor to provide the needed implementation services, and selecting and procuring equipment, tools, and training. (Estimated cost: 100K)

4. *Implementation.* This phase will include developing a plan, executing the plan, and testing/verifying that the network is functioning as designed. The outcomes will include: a) forming the implementation and network support teams, b) creating an implementation project plan, c) scheduling the delivery and installation of equipment, d) installing the equipment, e) testing and verifying the installed infrastructure, and f) completing the training and knowledge exchange. (Estimated cost: 23,300K)

Conclusion – A New Network Design

Having achieved over fifteen years of service from our network without a major replacement of equipment, it is time to develop a plan for the next 15+ years. The six goals set during the first design continue to be valid and appropriate for our new network. But changes in technology demand new approaches to how we address the network's reliability, supportability, open architecture, upgradeability, security, and configuration management. It would be a mistake to limit the scope of this project to a network refresh and only replace aging equipment. The proper approach is to develop a new design to meet the needs of the future by escalating the project scope to also address redundancy, responsive support, mobile computing, increased bandwidth, cloud computing, and cooperative management.

> *"Digital transformation must be understood as the journey to acquiring digital maturity and not just a technology modernization initiative" (Confalonieri, 2015, p. 3)*

Key to the redesign is the development of a new network support structure. Future functionality of the network requires cooperation and coordination between all three campuses. The concept of forming a support team from staff members across our campuses is a concept whose time has come.

Attachments 1 and 2 are graphical models of our current and new network design concept.

REFERENCES and RESOURCES

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2015 North Orange County Community College District Administrative Reviews:

- Educational Services and Technology
- Human Resources
- Printing and Design

Cypress College Strategic Plan 2014-2017

Fullerton College Strategic Plan 2013-2015

Information Services Technology Plan 2011-2015

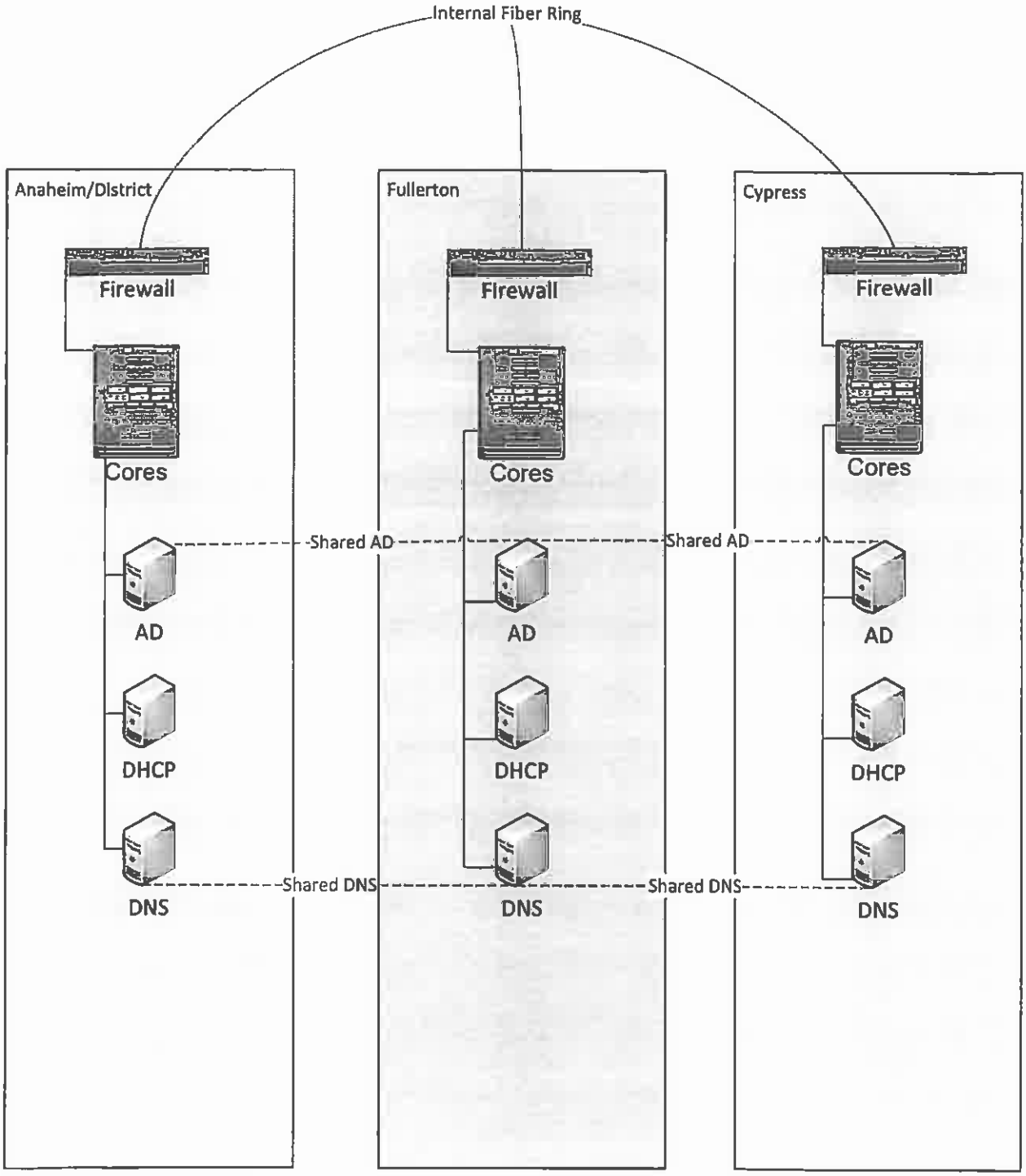
NOCCCD District-wide Strategic Plan 2014-2017

NOCCCD Infrastructure
Network Services
2015

*All connections 1G unless otherwise specified

Last Modified: Aug 14, 2015

Attachment 1 - Current Network Services Environment



Made By: Boaz Carmi

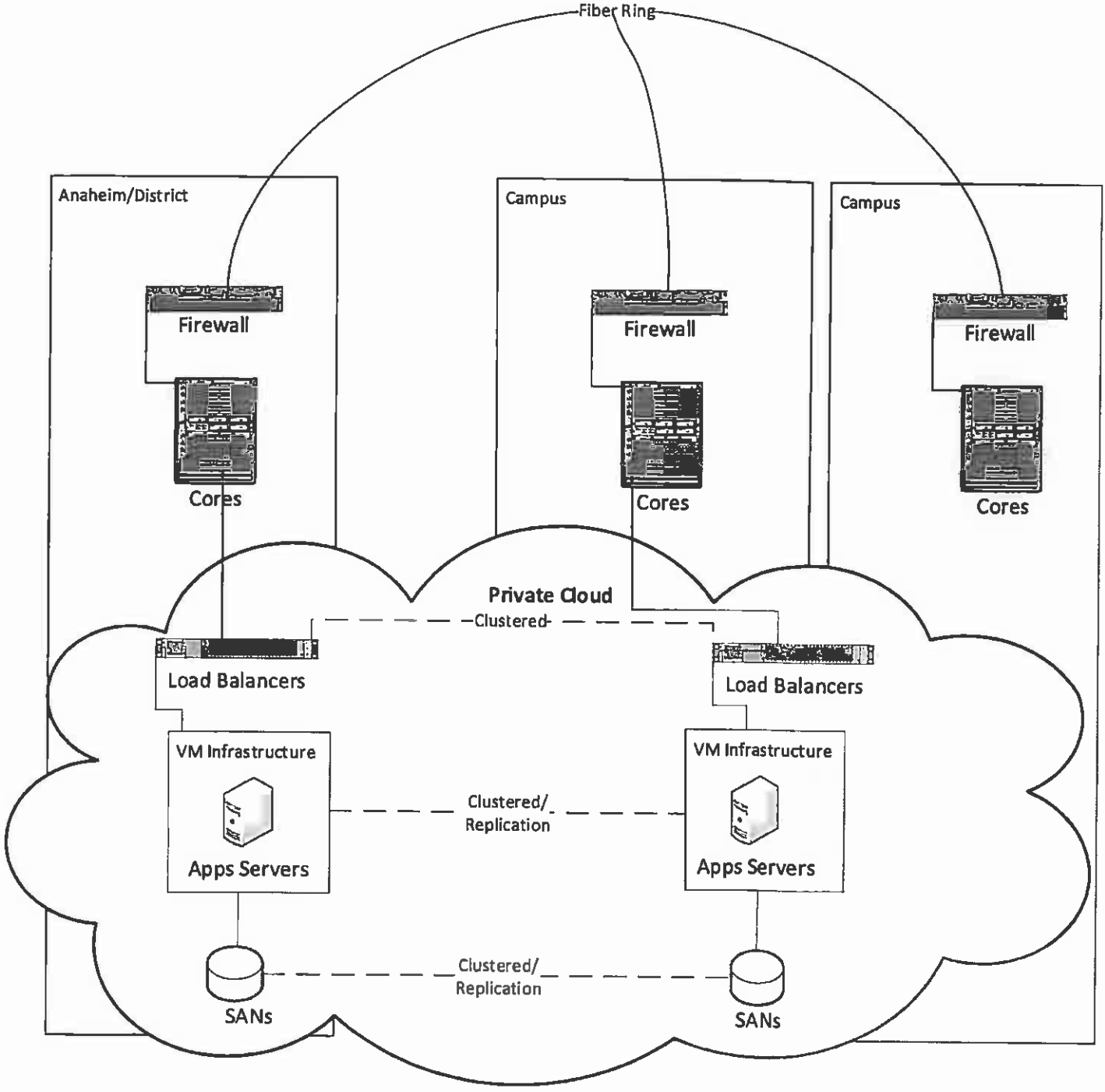
NOCCCD Infrastructure 2015

*All connections 1G unless otherwise specified

*Unfinished Draft

NOCCCD Network Utility Concept

Last Modified: Aug 14, 2015



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