Project Proposal

IIS Network Build

Alpha 490

Alex Ballard
Miquel Barlow
Ronald Boestfleisch
Noel Carr

Table of Contents

Executive Summary

The company Intelligent Imaging Systems (IIS) was established in 1996 as a public corporation in Dallas Texas. This corporation was the first to amalgamate Geographic Information System (GIS) and also real-time satellite imagery data for Military defense products with trademarked software algorithms to create the revolutionary "ThinkingNavigator" product line. This navigation system has achieved exponential growth since it was introduced. IIS has changed for the better and now find themselves in need to the highest level of network development and office building that will allow them to stay on top of market dominance. This development has brought about a blended hardware and application network that has frustrated their capacity to exploit the efficiency of their staff and encounter expanded levels of improvement.

Alpha 490 has taken the liberty to design a network project to take care of a wide array of tasks and deliverables that IIS has requested in order for them to succeed in the industry. IIS requests that we consolidate three offices in the Dallas TX into a new headquarters to their specifications of a new HQ that is 150,000 sq. ft. This new office was to house Sales, Engineering, Human Resources, and IT staff to create a unified network. With the new departments we have been given a 3-million-dollar budget to cover the updated networking equipment, applications, operating expenses, training, and support staff. **Alpha 490** takes their job very seriously so in order to get the most out the change we are replacing their old telecom system and standardizing their WAN infrastructure. The converged network must be future proof while still following designs to best accommodate the best value in performance. The team has been given a set of requirements to complete a comprehensive WAN infrastructure that can be maintained over a three-year period. The other departments must have access to the main network location that is positioned in Dallas Texas. Having the new departments set up will allow us to standardize remote user access and VoIP communications. The network would not be complete if it wasn't for security; we strive to create the best and most reliable network so it is important to us that security is number one on our list.

The Team is involved with a major project that will consist of improvements to the infrastructure to add and replace equipment so IIS can further expand. The Headquarters in Dallas Texas as well as the remote locations must have a secure field throughout the entire network. Accomplishing this would end any problems they have experienced in the past. We aim to bring in future proof options to increase productivity that IIS deserve. We have researched and encountered many different solutions but only a few stood to make this company what is should be. We have come to an agreement that Cisco's networking equipment for the routers and switches would be the best way to improve the infrastructure along with Avaya for VoIP and Dell for physical servers and Windows enterprise. IIS has given us a budget of $3 million dollars to put together a unified computer network and telecommunication system that has to be maintained over years to come. **Alpha 490** have not exceeded that limit provided so with everything you can see a total cost of $3,000,000 which has everything from equipment and specifications. We have given ourselves enough time to account for timeline delays so the project can be expected to finish in 6 months

The current state of technology IIS has been accustomed to is similar to the network infrastructure we have discussed and created with the wide range of equipment. After looking over their network we decided that it was functional to support branch offices in Shanghai, China and the different divisions like Commercial and Defense. It works, but unstructured to say the least for their different departments. Since they expanded into the global market they have found themselves in need of an updated, superior network. This is a must to allow them to continue to be a leader in the industry. When creating our network, we want to take everything IIS has told us into account of the new proposed unified telecommunications network. IIS recognize that they need to prepare for different environments to best fit the need of the company. The opportunity to grow and expand is something IIS could not refuse as we just want to better their system to their specifications that will be secure and allow for growth for the future.

Not only will this provide the highest benefit of all of our solutions but this will boost IIS into the future as they prepare each new location to function as their location in Dallas Texas. The best way to accommodate the brand new 150,000 square foot facility is to work from the beginning. **Alpha 490** will provide the installation, and configurations for IIS as required. Our overhaul of the network puts us in the best situation to get this project done on time. With each of the specifications in place as well as monitor management for the entire network. Having a base network design is tough when you have to determine the right equipment configuration. For IIS we have not only met the current standard of the network but also planned for future growth of the company to lesser any challenge that may come about. The equipment provided by Cisco and Dell will be managed by well trained staff that have the ability to solve any issue. We do not think problems will occur but having staff on all major systems provides additional support. Both of these vendors have equipment and systems that add to the growth to the company as they will not have to be replaced for an extended period of time. Everything that we have put together will show value in the coming years since nothing should break down. Once requirements are complete we will make sure everything is up and running without any faults. IIS will then assume responsibility over the network as their own once we are finished.

The budget gave us some time to really think about what we think the network should have and what IIS should have in order to move forward in their workforce. **Alpha 490** has picked an extensive variety of equipment to best suit the needs of IIS. With the given budget we are able to completely cover the base network with Cisco as they offer intelligent routers and switches. Having this vendor gives us the freedom to put future expenses to other needs as Cisco's equipment has a very long lifespan. Choosing Dell for the servers was the best choice because it was an affordable product with quality results that IIS could be proud of. Since IIS currently uses Avaya the integration of Avaya IP Office allows for a seamless transition. Utilizing Microsoft Windows Server is very cost effective compared to the other options, also it is compatible with other platforms to provide a solution that doesn't require too much management.

Section 1

1. 0 Revision History

Revision	Date	Author	Description
1	2/13/16	Noel Carr	Added drafts of sections 2.0-2, 3.1-2, 3.4, 11.1
2	2/14/16	Ronald Boestfleisch	Added Sections 4.1.0 – 4.1.9
3	2/14/16	Ronald Boestfleisch	Added Section 4.2 – 4.6
4	2/14/16	Ronald Boestfleisch	Added Network Diagrams to section 11.2
5	2/14/16	Ronald Boestfleisch	Added 11.3 Gantt Chart for project
6	2/14/16	Ronald Boestfleisch	Updated dates based off of Gantt Chart TimeLine
7	2/14/16	Ronald Boestfleisch	Added 5.2 and 5.3
8	2/15/16	Alex Ballard	Added Draft of 2.3 Chosen Solution
9	2/15/16	Alex Ballard	Added Draft of Executive Summary 5/6 complete
10	2/15/16	Noel Carr	Completed earlier drafts in assigned sections, minor review of overall project proposal
11	2/15/16	Alex Ballard	Added Draft of 9.0 Communication
12	2/16/16	Alex Ballard	Added Draft of 3.3 Solution Overview
13	2/16/16	Ronald Boestfleisch	Minor Grammar change for worked sections.
14	2/17/16	Ronald Boestfleisch	Updated Budget section 5.0 – 5.6 , added references and section 5.7
15	2/17/16	Ronald Boestfleisch	Updated section 8.0 Project Organization, Section 10.0
16	2/17/16	Miquel Barlow	Updated Project Scope
17	2/18/16	Miquel Barlow	Added section 7.0 Project Closeout
18	2/18/16	Alex Ballard	Completed Executive Summary & Solution Overview
19	2/19/16	Noel Carr	Reviewed grammar, adjusted sections
20	2/20/16	Ronald Boestfleisch	Corrected minor spelling, grammatical errors, document formatting and updated table of contents.

Section 2

2.0 Project Overview

2.1 Project Overview

Intelligent Imaging Solutions (IIS) was established in 1996 as a public corporation out of Dallas, Texas. They are among the first to integrate Geographic Information Systems (GIS) and real-time satellite imagery data with a proprietary software algorithm, which is known as the “ThinkingNavigator”. This revolutionary product has allowed IIS to dominate the customer-oriented navigation systems, or GPS, market. Their model, TN-1, remains a step above and ahead of the competition as other companies are just now starting to implement the capabilities that IIS has already mastered.

The Corporate Headquarters located in Dallas Texas, where Intelligent Imaging Solutions was first established, houses the Design, Engineering, and Customer Sales and Support departments. Since then, IIS has expanded into the global market with branch offices in Shanghai, China where most of the manufacturing is done. The workload is split, where in Dallas, they build and test prototypes, then Shanghai’s manufacturing engineers are responsible for taking the prototype specifications and creating the engineered products both efficiently and cost effectively. In London, IIS houses their Distribution warehouse and a Sales division. Both Shanghai and London features branch offices for international Customer Sales and Support. All three sites make up the Commercial Division.

In addition to the Commercial Division, IIS also houses a Defense Division in Fairfax, VA. This division does their own Design work, which is completely separate from the Commercial Division. The engineers that work out of this facility team with the Military Security Agency (MSA) and other defense contractors to design and produce highly sophisticated algorithms and models. Recently the Defense Division was awarded an all-inclusive contract with the MSA to integrate IIS’s proprietary algorithms and GIS model with MSA’s real-time image extraction processes to create an automated threat detection system.

With recognition from the Working Woman Magazine as a Top 10 best place to work and receiving high marks for their support of virtual sales offices in both the U.S and Europe, IIS has taken the time to look to the future. This includes a complete overhaul of their business structure to better meet the needs of their expanding customer base, both in the Commercial and Defense Divisions. IIS looks to consolidate their Dallas offices into one large headquarters, which would house Sales, Engineering/Design, Human Resources, and an IT department. This massive change will look to improve customer relations and the working environment, but it also gives them the time to redesign their network infrastructure and shift to an Enterprise wide telecommunications network shared by all sites globally. The difference in technologies is a primary concern with each location having different standards that need to be met, especially around the topic of security. With a well place security solution, all components of this project will come together to make this project a success.

2.2 Project Description

The consolidation of IIS does produce some challenges that would have negatively impacted the current Network infrastructure that is in place. Disparate systems between the sites do not necessarily mesh well when you try to consolidate into one location. Each site produces their own advantage, but at the same time they bring additional baggage. IIS has been able to recognize this from an early stage of the development and have thus presented us, **Alpha 490** with the opportunity to come in and restructure what was once unstructured. With the architectural design already complete, our project will be able to kick off immediately as they are at the stage where cabling and wiring can be completed. IIS has urged us to implement a solution that will not only be secure, but functional, extensible, and future-proof.

Creating a secure network will be the first priority with consideration of the Defense Division. The type of work included here is crucial to the overall success of the company and will be a commonplace in determining the success of the project. For the network to be functional, IIS is holding onto the idea that we will be able to incorporate Unified Telecommunications network, which would allow them to merge telephone, email, and other collaborative tools into one solution that the entire company will be able to use. The goal is to be able to communicate anytime and anywhere with these tools at their disposal. Implementing these new functions will call for a serious upgrade to the bandwidth requirements. Creating a standardized Wireless Area Network (WAN) will aide in producing the available bandwidth

needed to make the network more readily available. Standardization of the WAN will also have to think of the future state of IIS and the possibility of growth. Having an extensible solution takes into consideration the uniqueness of IIS, the type of service they provide for their customers, and what they look to expand upon in the future. **Alpha 490** looks to avoid any solution that would create a roadblock on the path to success for IIS. Planning for the future is crucial for a company that has been named as a Top 10 Place to Work. Considering any expansion that could occur within the next 6 months and onwards will have to be a baseline question asked when building a successful solution.

Consolidation also brings a need to build upon the mobility of IIS employees. More and more employees will see a need to work from home as well as on the go. Exploring this new challenge, a combination of VLANs, VPNS, and other mobile solutions will allow us to meet the business' needs. Being a mobile company means introducing new technologies, which would affect the interoperability of different platforms on the network.

A complete overhaul of the current networking infrastructure is crucial. This solution will make use of the data center space already built into the plans of the new 150,000 sq. ft. headquarters. On premise equipment will be managed by a well trained staff capable of resolving any issues in house or through contractors whenever necessary. IIS will assume control and responsibility by ensuring the appropriate standards and laws are followed for effective operation of their equipment. Secure connections throughout the network provide the peace of mind of an in house operation. The project looks forward to a large return on investment with better standardization, better interoperability, and easy to use collaborative tools that will allow IIS to plan for now and the future.

2.3 Chosen Solution

Alpha 490 put plenty of thought into the solutions for IIS. We decided to work with a complete overhaul of the networking infrastructure. By doing this we have control over how the network will work in the end to their specifications. Creating secure connections within the network is our number one concern when making solutions for a data center. Creating the equipment list became more of a checklist as to what we had to figure out. We put some thought into these options as they would benefit IIS the most. We would have Cisco for the switches and routers as they are admired by technology professionals and will provide extensive coverage for what we have planned. The collapsed core switches will be connected using a layer three 10 Gigabit Fiber connection bundled together to offer additional

redundancy which is exactly how we want this network to function. The different software and services will provide some flexibility when it comes to their computer systems. Since they are used to Microsoft we kept Windows server and exchange server. The servers will be virtual machines running on top of a highly redundant Dell PowerEdge server system. For WAN Connectivity, 100 Mbps connection is required. This solution proposes a 100 Mbps dedicated internet access connection with Ethernet Virtual Private LAN (EVPL) connection using Level 3 Communications. EVPL will permit all locations to associate over the WAN to IIS's new headquarters. The creative thinking of new solutions for the overhaul of the infrastructure came out to $ 2,998,814.08 giving us room to work with the specifications required from IIS.

Section 3

3.0 Solution Strategy

3.1 Project Definition and Kick-off

Alpha 490 will work closely with Intelligent Imaging Systems (IIS) personnel during this time to review the technical, cost and schedule baselines of the project. The project requirements will be reviewed with IIS to ensure all aspects of the project are covered in **Alpha 490**'s scope. Points of contact will be finalized, a preliminary schedule will be discussed and project team member roles and responsibilities will be discussed.

3.2 Business Needs

- Consolidate three offices in the Dallas TX into a new headquarters.
    - Consolidation will give IIS the opportunity to standardize their network equipment
    - New HQ is 150,000 sq. ft.
    - Will house Sales, Engineering, Human Resources, and IT departments
    - Hub site to which all branches connect to via WAN

- Remain within $3 million budget
    - Budget has already been increased once from $2 million, **Alpha 490** will have to plan to spend and reserve funds where needed. Planning for unexpected changes in the project will be beneficial.
    - Budget to cover capital, operating expenses, training, support staff for a 3 year period.
    - Failure to stay within the budget would be an immediate failure of the project as there will not be any reserve funds for emergencies.

- Enterprise wide telecommunications network.
    - Security is important with regards to the type of business that is conducted by IIS. Being able to handle Government work safely and securely is a very important consideration when building the network.

- New telecom network to replace current and aging telecom system that may not be compatible with the upcoming standardization of network equipment. Replacement of legacy equipment will be important from the start of the project lifecycle. Missing any equipment that needs to be replaced could be crucial to effective operations of the final network.
- Proper placement of firewalls and IDS hardware
- Standardize WAN infrastructure.

- Standardized remote user access with security
  - Establishing a security team would be helpful in maintaining a secured network. The team will be responsible for developing security policies, creating a standard security practice across the enterprise, and developing/responding to various security events.
  - Corporate wide directory services such as Active Directory, Email and file storage.
  - VoIP communications

3.3 Solution Overview

Alpha 490 proposes the following general solution to meet the criteria given by Intelligent Imaging Solutions (IIS). We will provide installation, configuration, pre and post installation testing, and training for Intelligent Imaging Solution (IIS) at Dallas, Texas.

1. Consolidate three offices in the Dallas TX into a new headquarters.

The new facility of 150,000 square feet will become the new headquarters for IIS that will house Sales, Engineering, Human Resources and IT departments. For the project we will design and optimize the new system to best suit the needs of IIS's business. Everything we have prepared completely fits the layout of the new location as it allows us the freedom to install a standardized network.

2. Remain within $3 million budget

Our solution has equipment like Cisco 6513 switches and Cisco ASR 1000 Series Aggregation Services Routers for WAN Connectivity that will show great return on investment as operating cost will be down after the first year. The chosen software and services will also benefit IIS as Microsoft, Samba, Avaya and many others all provide the flexibility

required while still respecting that 3 million budget. Everything we have gathered still remains under budget so assembling the equipment and software is completely feasible. With a total of 2,998,814.08 we have remained under budget while providing the best of the best.

3. Enterprise wide telecommunications network

Replacing their telecommunications network will allow us to create a system as effective as the overhaul we are replacing. The Dallas location will have WAN connectivity, 100 Mbps connection is required for optimal performance. With 100 Mbps of dedicated internet access the Ethernet Virtual Private LANs will allow all sites to connect over the new headquarters. This will be possible due to our operating expenses of engineers and combined support service.

4. Standardized remote user access with security

Security will be a huge part of the network because of the business they handle every day. We believe that in an enterprise environment it is important to stay on track with your work so we do not want to hinder IIS's business when we are finished. Once complete the remote workers will be able to communicate to any of the remote sites. Our capital expenses along with our software and operating expenses will allow us to build the infrastructure at an affordable price.

3.4 Organizational Benefits

The newly designed network for IIS will offer a vast amount of benefits to the organization. These benefits can be classified as:

Tangible benefits:

- Savings from structural changes
- Decreased cost of service provided
- Increased productivity for employees
- Savings from business process improvements
- Reduced errors, duplication, and needless work
- Replacement of old systems with newer systems
- Savings from optimized information or information storage
- Cost avoidance – reductions of operating costs in the future

- Reduced staffing costs, including overtime and reduced turnover
- Elimination of duplicate IT applications used to support the business
- A lower total cost of ownership by using industry standard products and services.
- Improved decision making by providing timely, integrated, comprehensive and accurate information
- Standardized design allows for future upgrades to network to be cost effective by only upgrading equipment instead of whole infrastructure

Intangible benefits:

- Improved reputation
- Regulatory compliance
- Improved communications
- Faster adoption of new technology
- Better customer and staff satisfaction
- Enhanced ability for the customer to meet their business goals
- Improved staff morale and reductions in staff stress and turnover
- Improved quality of information and decision-support capabilities
- Elimination of duplicate IT applications used to support the business
- Increased knowledge of technologies, resulting in improved staff efficiency
- Improved efficiency or effectiveness of the employees by allowing for unified communications and systems.

Section 4

4.0 Solution Scope

4.1.0 Solution Details

Alpha490 will provide installation, configuration, pre and post installation testing, and training for Intelligent Imaging Solution (IIS) at Dallas, Texas. Details of the project are as follows:

IIS is consolidating their three offices located within the Dallas Texas area into a brand new 150,000 square feet facility. This facility is to become the new corporate headquarters for IIS. The scope of the project is to design, install, configure and optimize a new telecommunications system that fits the needs of IIS as a whole. The solution that has been chosen is the whole network overhaul, building their network from scratch for the headquarters and connecting the rest of the branch offices and remote employee's located in Fairfax Virginia, London England and Shanghai China using a unified WAN connectivity solution.

The overall requirements for the project is as followed:

- Budget $3,000,000 over a 3-year period.
- Budget to cover capital, operating expenses, training, support staff, etc over a three-year period.
- Security is of high importance.
- Network must be standardized to allow for communication between headquarters and remote sites and remote workers.
- Corporate wide directory, email and file storage solution must be implemented
- Unified Communications systems.
- Must have redundancy and fault tolerance.

In order to meet the requirements of IIS, the current network design and structure will need to be modified. Figure 1 shows the new WAN connectivity mapping. It shows the new Dallas, TX headquarters connecting to the WAN which connects the Fairfax, London and Shanghai offices and remote workers together.

Figure 1 Logical Wan Diagram

Figure 2 shows a fully redundant and scalable network utilizing a three layer network design. The new network highlights all access layer switches connecting to the collapsed core switches using 10 gigabit per second fiber connections while utilizing redundant connections. The collapsed core switches are linked together using multiple 10 gigabits per second fiber connections that are arranged in an ether-channel bundle. From the collapsed core switches, each switch connects to separate edge routers, which connects to the ISP. The ISP of choice is Level 3 communications. The connection type will be a multi-homed internet connection utilizing an EVPL connection to all branch offices.

Remote workers will connect to IIS using a Secure IPSEC VPN tunnel utilizing the IKEv2 encryption protocol to ensure the security requirements are met. Within the headquarters, OSPF will be handling all dynamic routing between routers and layer 3 switches to ensure fast failover and routing. The collapsed core switches will be responsible for first hop redundancy using Hot Standby Routing Protocol.

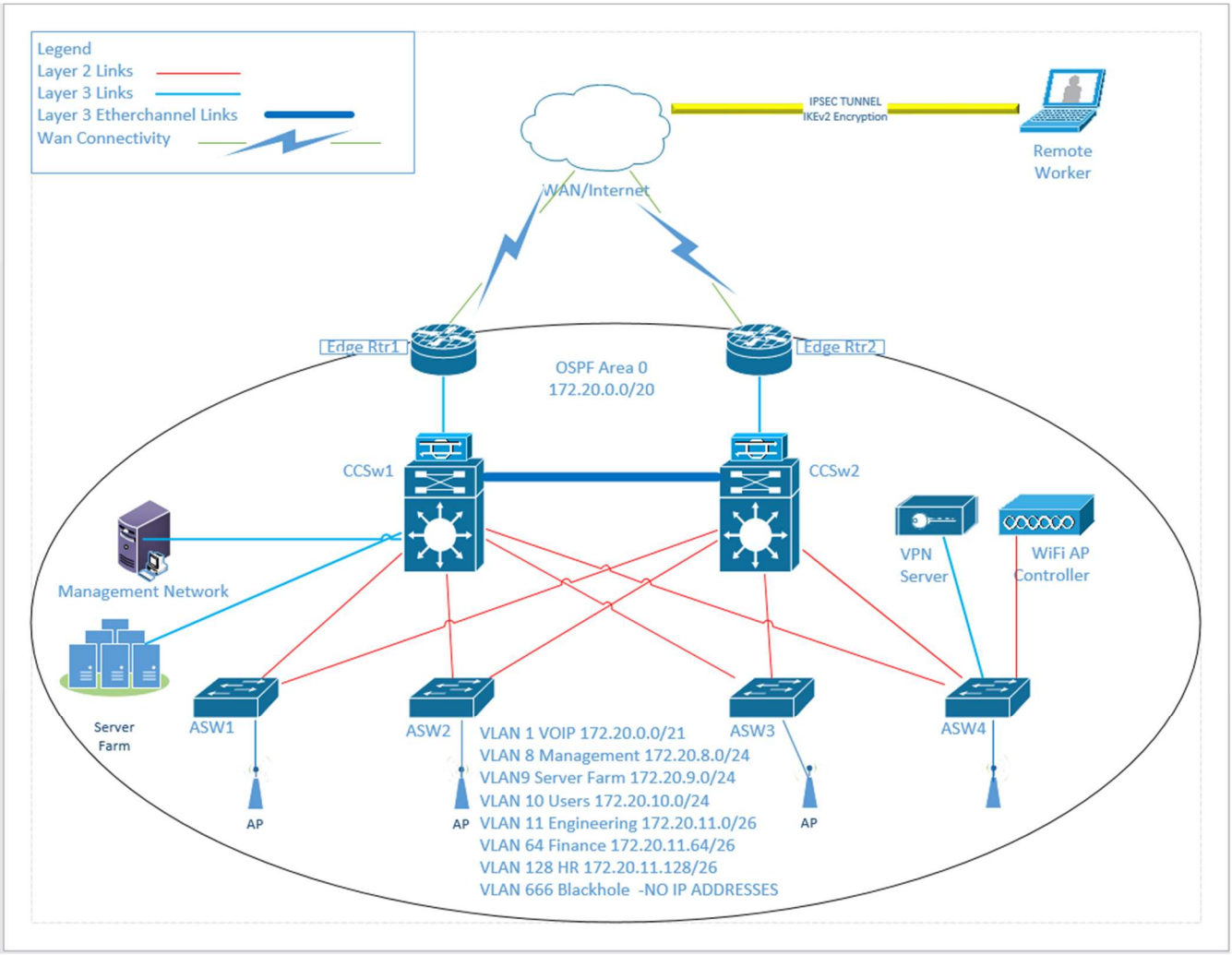


Figure 2 Logical Network Topology

All in house services hosted for IIS will be managed within the server farm. The server farm will house a fully redundant switch block connecting directly to the Collapsed Core in a redundant manner. The servers that will be used are rack mountable servers utilizing redundant hardware and virtualization software to effectively utilize hardware resources.

The management Network will be used to monitor and manage all equipment within the network. A network management system will be in place to monitor all networked resources from provisioning, operation, maintenance and troubleshooting.

4.1.1 Detailed equipment list

Below is the detailed equipment list for IIS network

- 2 Cisco 6513 switches for Collapsed Core featuring dual supervisor engines, and multiple switching line cards.
- 25 Cisco 3650-48 Poe Switches for Access Layer Connectivity
- 2 Cisco ASR 1000 Series Aggregation Services Routers for WAN Connectivity
- 30 Ubiquity networks Pro AC access points for Wi-Fi connectivity
- 2 Dell PowerEdge R630 Rack Server housing (12) 400GB Hard Drives for storage

4.1.2 Ancillary equipment and items

Below is a list of additional equipment and items

- 18 two-post Telecom Relay Racks.
- 20 APC Smart-Ups 3000VA LCD RM 2U 120V with NMC Installed
- 18 APC Vertical Cable Manager for NetShelter SX 600mm Wide 42U

4.1.3 Software & Services

- Microsoft Windows Server 2012
- Microsoft Exchange Server 2016
- Microsoft Active Directory
- Microsoft DNS Service
- Microsoft DHCP Service
- Microsoft Remote Access Service
- PFSENSE – IPS -Service
- CENTOS Linux
- Snort
- Apache Web Server
- MySQL
- Samba

- Avaya Aura Platform
- OpenNMS (network management software)
- Cacti (Network Management Software)
- SpiceWorks (network management/inventory/ticketing system)
- Observium (network management system)

4.1.4 WAN Connectivity

- Level 3 Communications Ethernet Private Virtual LAN for Site to Site Connectivity
- Level 3 Communications Dedicated Internet Access

4.1.5 LAN Routing, Switching and Settings

- OSPF Area 0 within Headquarters
- All other branch offices will be different OSPF Areas.
- 172.16.20.0/20 network for Headquarters IP Addressing Scheme
- Subnet Chart below for IP Addressing Scheme.

Subnet Name	Address	Mask	Dec Mask	Assignable Range	Broadcast
Voip	172.20.0.0	/21	255.255.248.0	172.20.0.1 - 172.20.7.254	172.20.7.255
Management	172.20.8.0	/24	255.255.255.0	172.20.8.1 - 172.20.8.254	172.20.8.255
Server Farm	172.20.9.0	/24	255.255.255.0	172.20.9.1 - 172.20.9.254	172.20.9.255
Users	172.20.10.0	/24	255.255.255.0	172.20.10.1 - 172.20.10.254	172.20.10.255
Engineering	172.20.11.0	/26	255.255.255.192	172.20.11.1 - 172.20.11.62	172.20.11.63
Finance	172.20.11.64	/26	255.255.255.192	172.20.11.65 - 172.20.11.126	172.20.11.127
HR	172.20.11.128	/26	255.255.255.192	172.20.11.129 - 172.20.11.190	172.20.11.191

Table 1 IIS Subnet Chart

- Collapsed Core Switches will perform Routing based on the supervisor engines installed.
- Collapsed Core Switches will utilize HSRP for First Hop Redundancy Protocol.
- Collapsed Core Switches Connected to each other using 10G fiber configured in a Ether channel Bundle utilizing a layer 3 routed link.
- Collapsed Core Switches terminate VLANS and perform interval routing and Security policies including Intrusion Detection and Prevention Systems.
- Access Layer Switches connected to Collapsed Core Switches using redundancy trunk Links.
- Access Layer Switches will connect to core using 10g fiber links.
- Each Fiber link will utilize ULDL for unidirectional link failure detection.

4.1.6 Active Directory Setup and Services.

- Primary Active Directory Domain Server: 172.20.9.10
    - Hostname IIS-DC1
    - DHCP Service
    - DNS Service
    - Remote Access Service
    - WINS Service
    - Ubiquity Wifi AP controller software
- Secondary Active Directory Domain Server: 172.20.9.11
    - IIS-DC2
    - DHCP Service
    - DNS Service
    - Remote Access Service
    - WINS Service
    - Ubiquity Wi-Fi AP controller software
- Exchange Server: 172.20.9.12
    - WAN IP TBD
- Backup Exchange Server 172.20.9.12
    - WAN IP TBD

- Domain IIS.NET
- Username structure: First Initial Last name (IE John Doe = JDOE)
- Password Requirements: 8-16 Characters, Mixed Case, Alpha Numeric with at last least 1 special character. Three or more repeated numbers or sequential numbers not allowed.
- Permissions: Based on which department the user is member of.
- Group Policy Objects will allow for greater control of access, permissions and overall functionality.
- Network Drives will be available for users.
    - T Drive = Team Drive quota and permissions
    - I Drive = User Storage with quota and permissions
- Host Name Requirements
    - User Computers: IISHQ-PCXXX (where XXX = an incremented number)
    - Server – IISHQ-SRVXXX (where XXX = an incremented number)

4.1.7 Server Configuration

- Dell PowerEdge R630
    - Server 1
        - Running VMWare ESXI 6.0
        - IP address 172.20.9.5
        - Hostname IIS-VM1
        - Data Store = (11) 400 gigabyte SSD drives
        - Pooled resources with IIS-VM2
    - Server 2
        - Running VMWare ESXI 6.0
        - IP address 172.20.9.6
        - Hostname IIS-VM2
        - Data Store = (11) 400 gigabyte SSD drives
        - Pooled resources with IIS-VM1
- Network Management Servers.
    - All Virtual Machines running on Dell Power Edge R630's

- VM Server 1
    - Running CENTOS
    - Hostname Observium
    - IP Address 172.20.8.10
    - NM Software Observium
- VM Server 2
    - Running CENTOS
    - Hostname Cacti
    - IP Address 172.20.8.11
    - NM Software Cacti and OpenNMS
- VM Server 3
    - Running Windows 10
    - Hostname NMS
    - IP Address 172.20.8.12
    - NM Software Spice Works
- VM Server 4
    - Running Windows 10
    - Hostname PRTG
    - IP Address 172.20.8.13
    - NM Software PRTG

4.1.8 Wireless

Ubiquity Networks Wireless access points will provide wireless throughout IIS. Each access point is lightweight provisioned. Each access point is managed from the management software installed on the Windows Domain Servers. Each access point allows for multiple SSID configuration and Trunks to appropriate VLANS.

- Access Point Configuration
    - Hostname AP-X (where x = hostname ID)

- IP Address DHCP from NM Management VLAN 172.20.8.0/24 Starting from 172.20.8.200 – 172.20.8.254
- VLANS HR, SALES, FINANCE, AND USERS trunked to Access Point Switches.
- End devices connect Via DHCP
- Security is WPA Enterprise using Radius to authenticate to Domain Controllers.

4.1.9 Wiring

IIS will have a third party company install, terminate and certify all network wiring and drops. All drops and wiring will need to be EIA/TIA compliant and conform to local building codes. The price per drop will be 200 dollars for cat 6a copper and 250 10G fiber Connection.

There will be a total of 15 Wiring Closets on Premise. Each closet will handle 10,000 Square Feet. Each Closet will be cross connected using Fiber. Each end user device will be connected either wirelessly or wired using 1 Gbps copper of 802.11 AC wireless. Additional fiber drops will be installed and hooked up but not configured as it will be used as dark fiber for failsafe should a fiber line get damaged or additional bandwidth is needed.

4.9.10 VoIP and Unified Solutions

IIS currently utilizes the Avaya PBX phone system. They currently have multiple sites within the Dallas TX site which utilizes the current system.

Since IIS is currently combining three locations into a single location, IIS can take advantage of the Avaya IP office system. This system easily integrates with the current PBX system and IIS can use the existing trunk lines and services to provide the phone service in which they are requesting with little to no additional costs in the services itself.

4.2 Testing before installation

Alpha 490 will conduct offline testing, according to the following schedule, prior to installing the system.

Test Detail	Proposed Date
Current Network Benchmark Location 1	2/29/16
Current Network Benchmark Location 2	3/1/16
Current Network Benchmark Location 4	3/2/16
Equipment Inventory	3/3/16

4.3 Installation details

Alpha 490 will install the hardware and software listed in the budget as follows:

Installation Detail	Proposed Date
Wiring Install Headquarters	3/7/16
City Inspection of Headquarters	3/11/16
Cable Certification	3/11/16
Equipment Installation	3/14/16
Router, Collapsed Core Switches, Access Switches Configuration	3/15/16
Dell Power Edge VM server Installation and configuration	3/18/16
Windows Servers, Unix Servers, and Network Management Server Installation and Configuration	3/21/16
Unified Communications System installation and configuration	3/21/16

4.4 Post-Installation Testing details

Alpha 490 will conduct online testing, according to the following schedule, after installing the system.

Test Detail	Proposed Date
Network Stability Test	3/28/16
Network Baseline	4/4/16
Network Management System Audit and Inventory	4/11/16

4.5 Network Documentation details

Alpha 490 will provide IIS personnel with the following network documentation upon completion of this project:

- Logical Network Diagram (updated)
- Physical Network Diagram (updated)
- Basic Network User's Manual
- Administrator's Manual/
- IP Address Listing
- Hardware Inventory
    - In Use
    - Available in storage
    - Other

4.6 Training details

Ronald Boestfleisch will train IIS personnel on maintenance, troubleshooting, and configuration. Training will be scheduled to meet both the teams and clients scheduling limitations. The following training documents will be provided:

- Logical Network Diagram (updated)
- Physical Network Diagram (updated)
- Basic Network User's Manual
- Administrator's Manual/
- IP Address Listing
- Hardware Inventory
    - In Use
    - Available in storage
    - Other

The proposed training plan is:

Topic	Customer	Date	Time	Location
Support Staff Basic Training	IIS IT Staff	4/18/16-5/2/16	8 AM - 4PM	HQ IT Department
Support Staff Advanced Training	IIS IT Staff	4/25/16 - 4/29/16	8 AM - 4PM	HQ IT Department
Moves Adds Chances	IIS IT Staff	5/2/16	8 AM - 12 PM	HQ IT Department

Section 5

5.0 FINANCIALS

5.1 Customer Budgetary Guidelines

IIS has a budget of $ 3,000,000 US dollars.

The budget is to include Project Capital, Installation, training and Operating Costs for a three-year window.

5.2 Materials

The table below outlines the complete budget for IIS's network installation. Included within the table is the category of expenses such as Capital, Misc, and Operating Costs. In addition to the category the table shows the Hardware item name, quantity, per item price and total price. The chart below also supplies the grand total of the project which conforms to the budgetary guidelines set forth by IIS.

Capital Expenses

Hardware

Item Name	Quantity	Price	Total Price
Cisco Catalyst 6513-E with Sup Engine 2t and policy feature card 4	2	$ 44,000.00	$ 88,000.00
Cisco Catalyst 6500 Series Supervisor Engine 2T - control processor	2	$ 20,024.99	$ 40,049.98
Cisco 48-Port 1 Gigabit Copper Ethernet Module with DFC4 - expansion module	2	$ 10,727.99	$ 21,455.98
Cisco Gigabit Ethernet Transceiver Module	104	$ 711.99	$ 74,046.96
Cisco Catalyst 3650-48PS-L - switch - 48 ports - managed - desktop	25	$ 4,404.99	$ 110,124.75
Cisco ASR 1002 VPN Bundle - router - desktop, rack-mountable - with Cisco A	2	$ 50,658.99	$ 101,317.98
Dell Power Edge r630 Rack Server Customized with 12TB storage and VMWare ESX 6 Hypervisor	2	$ 19,248.50	$ 38,497.00

APC Smart-Ups 3000VA LCD RM 2U 120V with NMC Installed	20	$ 1,732.22	$ 34,644.40
StarTech.com 42U Adjustable Depth Open Frame 4 Post Server Rack Cabinet - Flat Pack w/ Casters, Levelers and Cable Management Hooks	20	$ 219.99	$ 4,399.80
APC Vertical Cable Manager for NetShelter SX 600mm Wide 48U (Qty 2)	20	$ 205.70	$ 4,114.00
Ubiquiti UniFi AP-AC 3-pack, UAP-AC 3 pack Dual Band Access Point AC 3x3 PoE+	10	$ 801.99	$ 8,019.90
AVAYA DL360PG8 SERVER ENT	2	$ 14,694.99	$ 29,389.98

Software

AVAYA IP OFFICE R9+ SELECT IPO SL9	2	$ 965.99	$ 1,931.98
Microsoft Exchange Server 2016 Standard - license	2	$ 667.99	$ 1,335.98
Microsoft Windows Server 2012 R2 Standard License 2 Processors	2	$ 878.99	$ 1,757.98
Microsoft Windows Server 2012 R2 Standard Box Pack 5 Users	240	$ 587.99	$ 141,117.60
Microsoft Exchange Server 2016 Standard CAL - license	1200	$ 87.99	$ 105,588.00

Misc. Capital Expenses

Cable Installation	1200	$ 250.00	$ 300,000.00
On site Training Costs/hour $41.00 hour per Trainer x 3 trainers	88	123	$ 10,824.00

Reoccurring Operating Expenses

Level 3 Communications 100 Mbps Internet with EVPL 3 years, 4 sites	36	24000	$ 864,000.00
Electric costs 4.40 cents per kWh Amigo Energy based on 15000 Watts per year operating at 24 hours a day	3	5785.56	$ 17,356.68
Cisco Smart Net Total Care Combined Support Service - extended service agreement (29 cisco devices * 3 years = 87)	87	2365.99	$ 205,841.13
IT Support Staff Sr Engineer/year (1 engineers * 3 years)	3	85,000	$ 255,000.00
IT support Staff Jr Engineer/year (2 Engineers * 3 years)	6	45,000	$ 270,000.00
IT Staff (3 help desk staffs * 3 years)	9	30,000	$ 270,000.00
		Total Budget	**$ 2,998,814.08**

5.3 Summary Project Budget

Year	Hardware	Software	Misc.	Operating Expenses
2016	$ 554,060.73	$ 251,731.54	$ 310,824.00	$ 627,399.27
2017	0	0	0	$ 627,399.27
2018	0	0	0	$ 627,399.27

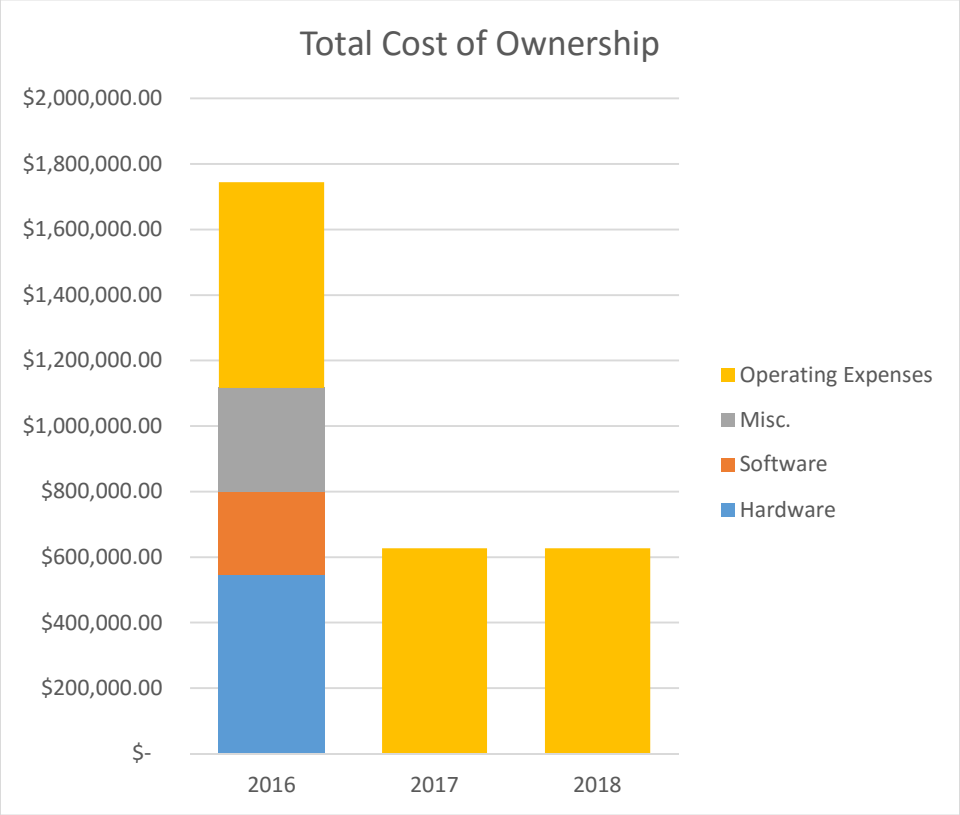


Figure 3 TCO Chart

5.7 Budget Justification

Alpha 490 has chosen a wide range of equipment, vendor solutions and services to ensure that IIS is getting the network in which they deserve. For the backbone of the network, Cisco has been chosen for the routing and switching platforms. Cisco has been the forerunner in computer networks for over 20 years and their products and services offers a reduced total cost of ownership than any other networking Vendor. By utilizing Cisco products, **Alpha 490** can guarantee a 24/7 network operation with near 99.997% uptime and should a major network outage occur, the Cisco Smart net service will allow Mean Time to Repair or replacement of equipment within 4 hours.

In addition to the Cisco equipment offerings, **Alpha 490** has chosen Dell R630 servers to be the core of the internal services hosted by IIS. Dell is an industry recognized hardware vendor which offers a superior product at an affordable price point.

VMWare has been chosen to run on top of the dell R630 servers as the Hypervisor. Configuring VMWare in a cluster set up allows for IIS to be able to deploy virtual servers within a redundant set up with little effort and time. VMWare offers resiliency and redundancy which is perfect for IIS.

For VoIP communication, IIS currently utilizes Avaya as their office PBX system. Integration of Avaya IP Office offers a solution that can easily integrate with their current PBX system and allows for future upgradeability without having to retrain support staff.

For wireless solution, UniFi Enterprise grade wireless access points offers enterprise class Wi-Fi connectivity with small business pricing. This solution is comparable to CISCO unified Wireless connectivity at a fraction of the cost.

Since IIS is a mixed vendor environment, **Alpha 490** has chosen Microsoft Windows Server 2012 R2 and Exchange server 2016 as the solution for DNS, DHCP, File Storage, Active Directory and Remote user support. This solution is cost effective allowing for interoperability between Windows, OSX and UNIX platforms to allow for a single management and access solution.

Section
6

6.0 PROJECT CONDITIONS

EXCLUSIONS / CLARIFICATIONS / ASSUMPTIONS

1. The DeVry Senior Project Team, **Alpha 490** is responsible for completion of this project as detailed in this agreement. All team members listed in section 9.0 share this responsibility regardless of their standing as students.
2. The project must be completed no later than 2/25/2016 for Sr. Project credit, although all students in **Alpha 490** accept the individual responsibility of completing all project details if they remain at that time. Failure to complete the project in a timely manner, or to adhere to the original scope of the project may subject the students to failure of the Senior Project course.

Section 7

7.0 PROJECT CLOSE OUT

GENERAL PROJECT INFORMATION

Commercial Division, IIS also houses a Defense Division in Fairfax, VA. This division does their own Design work, which is completely separate from the Commercial Division. The engineers that work out of this facility team with the Military Security Agency (MSA) and other defense contractors to design and produce highly sophisticated algorithms and models. Recently the Defense Division was awarded an all-inclusive contract with the MSA to integrate IIS's proprietary algorithms and GIS model with MSA's real-time image extraction processes to create an automated threat detection system.

	Description
Project Name	**Alpha 490**
Project Description	A complete overhaul of the current networking infrastructure is crucial. This solution will make use of the data center space already built into the plans of the new 150,000 sq. ft. headquarters. On premise equipment will be managed by a well trained staff capable of resolving any issues in house or through contractors whenever necessary.
Project Manager	Ronald Boestfleisch
Project Sponsor	Nabeel Baig
General Comments	None

	Baseline	Actual	Variance
Start Date	01/04/2016	01/11/2016	[7 days]
Finish Date	02/27/2016	02/20/2016	[7 days]
Hours	[1440 hours]	[480 hours]	[960 hours]
Days	[23 days]	[19 days]	[000 days]
Budget	[$3,000,000.00]	$ 2,998,814.08	[$1,185.92]

MANAGEMENT EFFECTIVENESS

With recognition from the Working Woman Magazine as a Top 10 best place to work and receiving high marks for their support of virtual sales offices in both the U.S and Europe, IIS has taken the time to look to the future. This includes a complete overhaul of their business structure to better meet the needs of their expanding customer base, both in the Commercial and Defense Divisions. IIS looks to consolidate their Dallas offices into one large headquarters, which would house Sales, Engineering/Design, Human Resources, and an IT department. This massive change will look to improve customer relations and the working environment, but it also gives them the time to redesign their network infrastructure and shift to an Enterprise wide telecommunications network shared by all sites globally. The difference in technologies is a primary concern with each location having different standards that need to be met, especially around the topic of security. With a well place security solution, all components of this project will come together to make this project a success.

Alpha 490 effectively provided IIS with;

Training will be scheduled to meet both the teams and clients scheduling limitations. The following training documents will be provided:

- Logical Network Diagram (updated)
- Physical Network Diagram (updated)
- Basic Network User's Manual
- Administrator's Manual/
- IP Address Listing
- Hardware Inventory
    - In Use
    - Available in storage
    - Other

Personnel with the following network documentation upon completion of this project:

- Logical Network Diagram (updated)
- Physical Network Diagram (updated)
- Basic Network User's Manual
- Administrator's Manual/
- IP Address Listing
- Hardware Inventory
    - In Use
    - Available in storage
    - Other

Understanding all the business requirements, is one of the situations that became a problem for the **Alpha 490** since the main purpose is to satisfy IIS technical needs. IIS would like for the design team to consider not only the costs for the initial build-out but for on-going operations and future expansions. It's a requirement that all new equipment be used for the Dallas facility. The current servers are running the Windows 2012/2008 server operating system for the satellite branches. Details on the Wi-Fi is up to your team as you prefer for the Dallas facility.

LESSONS LEARNED

Alpha 490 has examined numerous options that could better serve IIS and their goals, options ranging from convenient to creative thinking. When thinking about the network infrastructure that is already in place it is possible to keep the familiar layout given we choose the best structure. That would provide ease of use and support to an already experienced network. On the other hand, Amazon Web Services (AWS) has a great background with business with its communication and productivity support.

With this project it is only natural that risks come into play here. Each planning solution has a wide range of issues that could turn into large problems if not attended. Risks include delay on equipment and or defective, software, scheduling, enterprise updating, and compatibility issues. These risks could result in a poor

network infrastructure for productiveness and redundancy. To help diminish these risks you will find a plan in the risk assessment section of this document to better understand what we will go through in order to exceed the needs of our client.

With this project the key to the success for **Alpha 490** was the communication which was key with the team members are on different time zones. The project was also an opportunity to see the strengths and weaknesses whether it be the Proposal, WBS, network structure or financing the project as far as equipment or training.

ADMINISTRATIVE CLOSURE

Many of the administrative closures to the project can be referenced in Section 4. In section 4.1.7 there is an idea on the configurations to the servers. Section 4.3 explains the installations details of their sections and when they were installed. Section 4.5 shows all the documentation that was used for the network setup of this project.

CONTRACT CLOSURE

In Section 5.2 and Section 5.3 it shows the material financial layout to the completion of the project along with the budget of the IIS Project. In order to close out the IIS Project the required signatures are required in Section 10, along with the complete review and acceptance of IIS Project.

Appendix A: Project Close-Out Approval

The undersigned acknowledge they have reviewed the **Project Close-Out Form** and agree with the approach it presents. Changes to this **Project Close-Out Form** will be coordinated with and approved by the undersigned or their designated representatives.

Signature:		Date:	2/20/2016
Print Name:	Ronald Boestfleisch		
Title:	Project Leader		
Role:	Project Management		

Signature:		Date:	2/20/2016
Print Name:	Noel Carr		
Title:	Assistant Project Leader		
Role:	Assist in Project Management		

Signature:		Date:	2/20/2016
Print Name:	Alex Ballard		
Title:	Project Team Member		
Role:	Provide additional support to project		

Signature:		Date:	2/20/2016
Print Name:	Miquel Barlow		
Title:	Project Team Member		
Role:	Provide additional support to project		

Section 8

8.0 PROJECT ORGANIZATION

Client:

Intelligent Imaging Systems: *Professor* Bill Baig Executive Grader (CEG)

Direct Phone: (610) 662-9037

E-mail address: billbaig@gmail.com

Team:

Ronald Boestfleisch Project Manager for Team **Alpha 490**

Direct Phone: (845) 401-5883

E-mail address: rboestfleisch@echelon-pc.com

Noel Carr Assistant Project Manager for Team **Alpha 490**

Direct Phone: (555) 555– 2020

E-mail address: ncarr1.nc@gmail.com

Alex Ballard Project Support Representative for **Alpha 490**

Direct Phone: (555) 555– 5555

E-mail address: stillballard898@gmail.com

Miquel Barlow Project Support Representative.

Direct Phone: (555) 555– 5555

E-mail address: mbarlow15@yahoo.com

Section 9

9.0 COMMUNICATION

Businesses often ask their employees to work together on projects to pass around responsibilities to produce high-quality work to get the job done. This project has posed the same effect on **Alpha 490** as this group consisted of members who always looked to stay ahead and eliminate as many problems as possible. Overall the communication behind **Alpha 490** was consistent and efficient towards the project. We did not use the Team Area discussions as much, but we had email threads each week to keep everyone updated on the current week and the upcoming week. Below are the combined Status Reports for Team Accomplishments and Action Items **Alpha 490** worked on throughout the project. We did not encounter any real late tasks or team issues aside from rescheduling a meeting and a member sick. Everyone put their best foot forward to get this project completed.

Team Accomplishments

1. Successfully met and exchanged contact information.
2. Elected Team leader.
3. Successfully communicated team member scheduling, time zone, and meeting times.
4. Successfully reviewed conference call and extrapolated important information in regards to the project.
5. Successful team meeting held on Tuesday January 12, 2016.
6. Assigned business case sections to each team member.
7. Successful communication between team members.
8. Short Team meeting on held on Tuesday 1/19/16.
9. Bidders conference gained helpful insight for the business case.
10. Started first draft of Business Case.
11. Each Member has submitted the initial draft of work.
12. Successful team Meeting on Wednesday, 1/27/15
13. Team Name chosen.
14. Business case draft written up.
15. Business case passed Turnitin Test.
16. Successful completion of Business Case handed in by end of Week 4.

17. Successful Team Meeting held on Tuesday 2/9/16

18. Discussed project proposal and sections to be completed.

Action Items

1. Brainstorming thread started to generate discussion about the needs of IIS based off the initial Conference call.

2. Attending Week 1 Q/A Session on Saturday.

3. Successful team meeting held on Tuesday January 12, 2016.

4. Assigned business case sections to each team member.

5. Successful communication between team members.

6. Finish compiling all team member's sections into business case.

7. Verify all sections are filled out.

8. Discuss cohesiveness of business case.

9. Business case due by end of Week 4.

10. Finish compiling business case

11. Turn in business case by on or before Due Date/Time.

12. Pick Sections for Request for Proposal.

13. Discuss all aspects of RFP.

14. Work on project proposal. Due End of Week 7.

15. Finish Rough draft of proposal by Monday 2/15/16 for Review During team meeting

Section
10

10.0 SIGNATURES

Client:

Bill Baig
Client's Representative Printed Name Here

IIS

2/23/16
Date

Team:

Ronald Boestfleisch
Team Member 1's Printed Name Here

Noell Carr
Team Member 2's Printed Name Here

Alex Ballard
Team Member 3's Printed Name Here

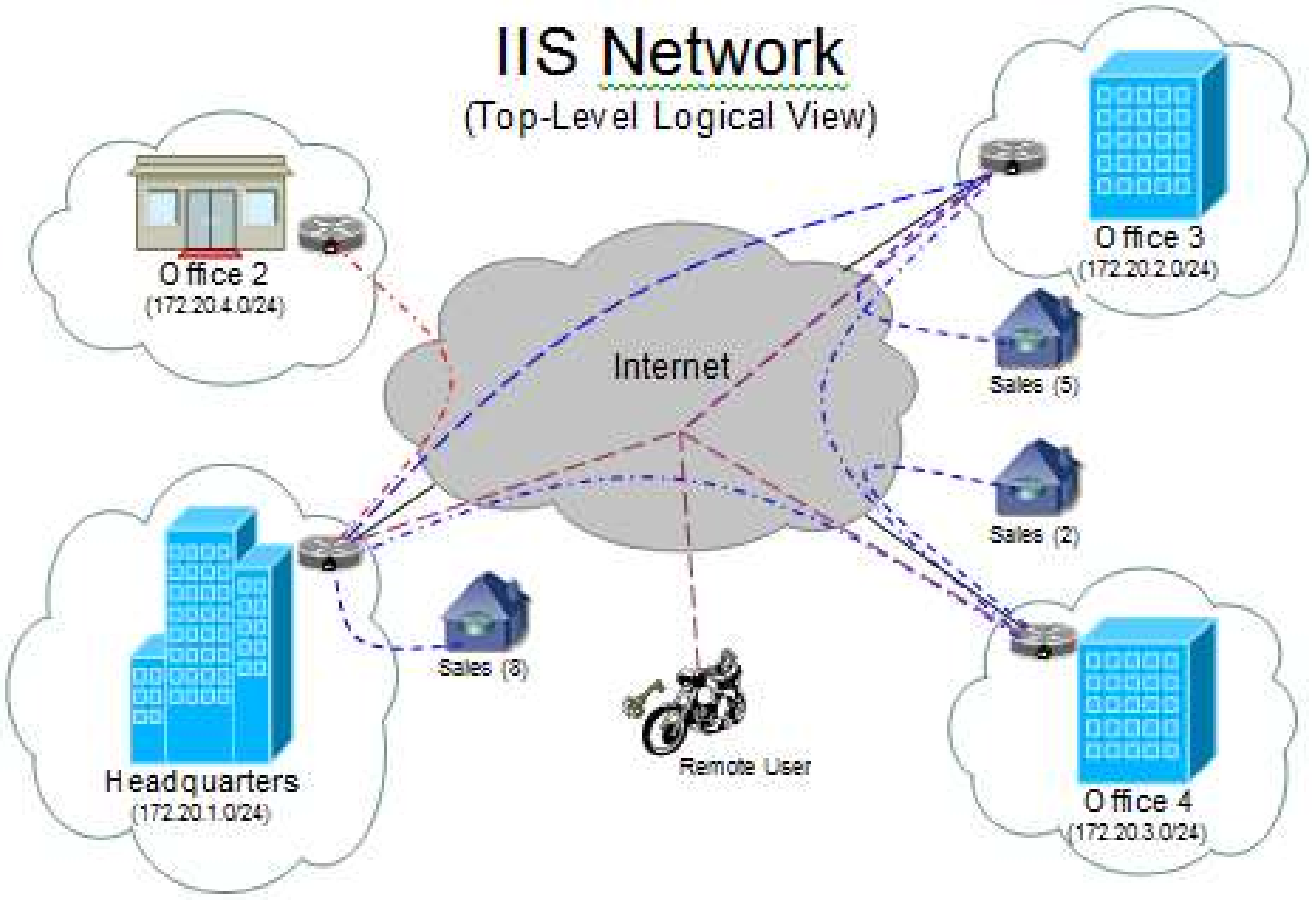
Miquel Barlow
Team Member 4's Printed Name Here

Members of **Alpha 490**

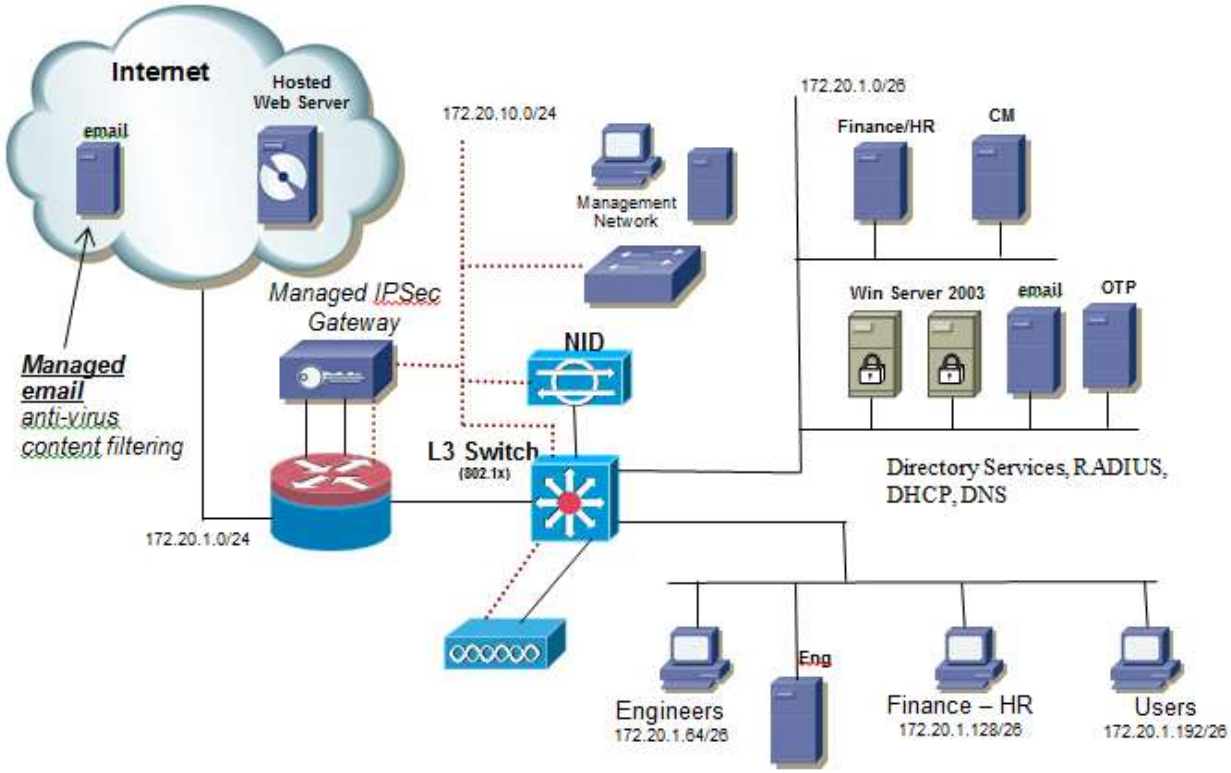
2/23/16
Date

Section
11 11.0 APPENDIX

11.1 Existing System – Diagrams

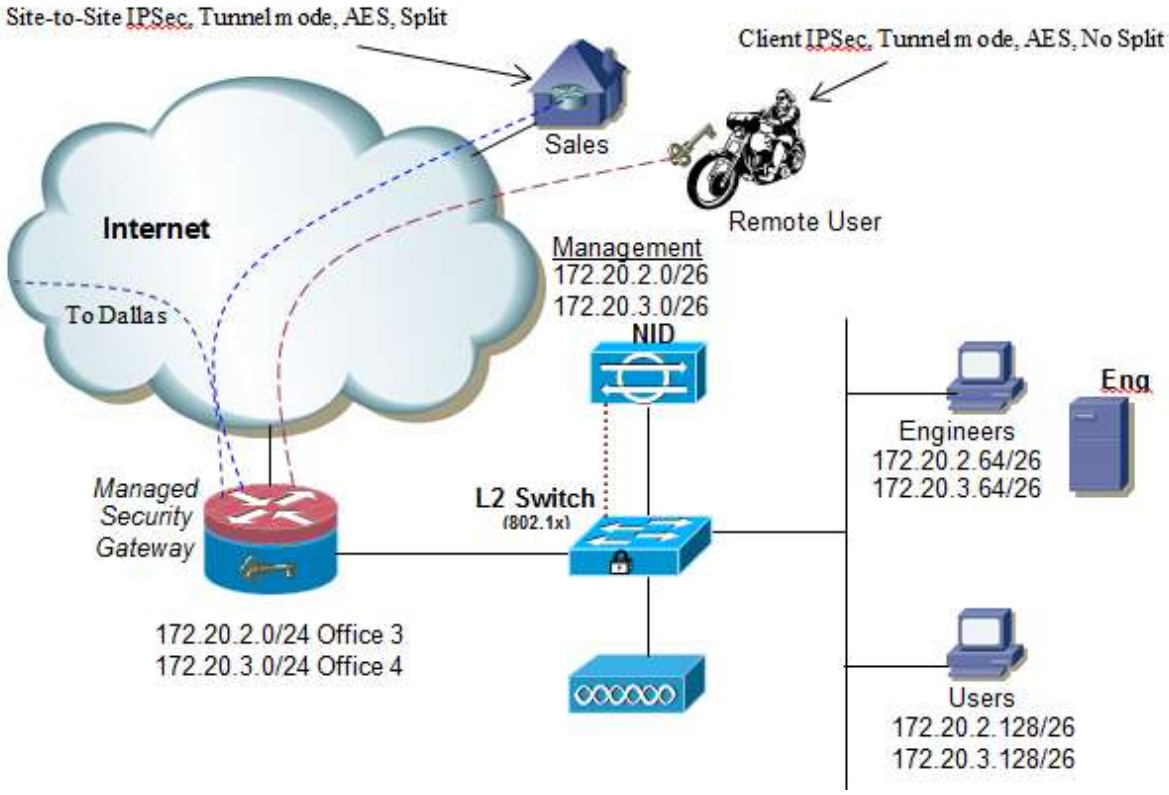


Headquarters

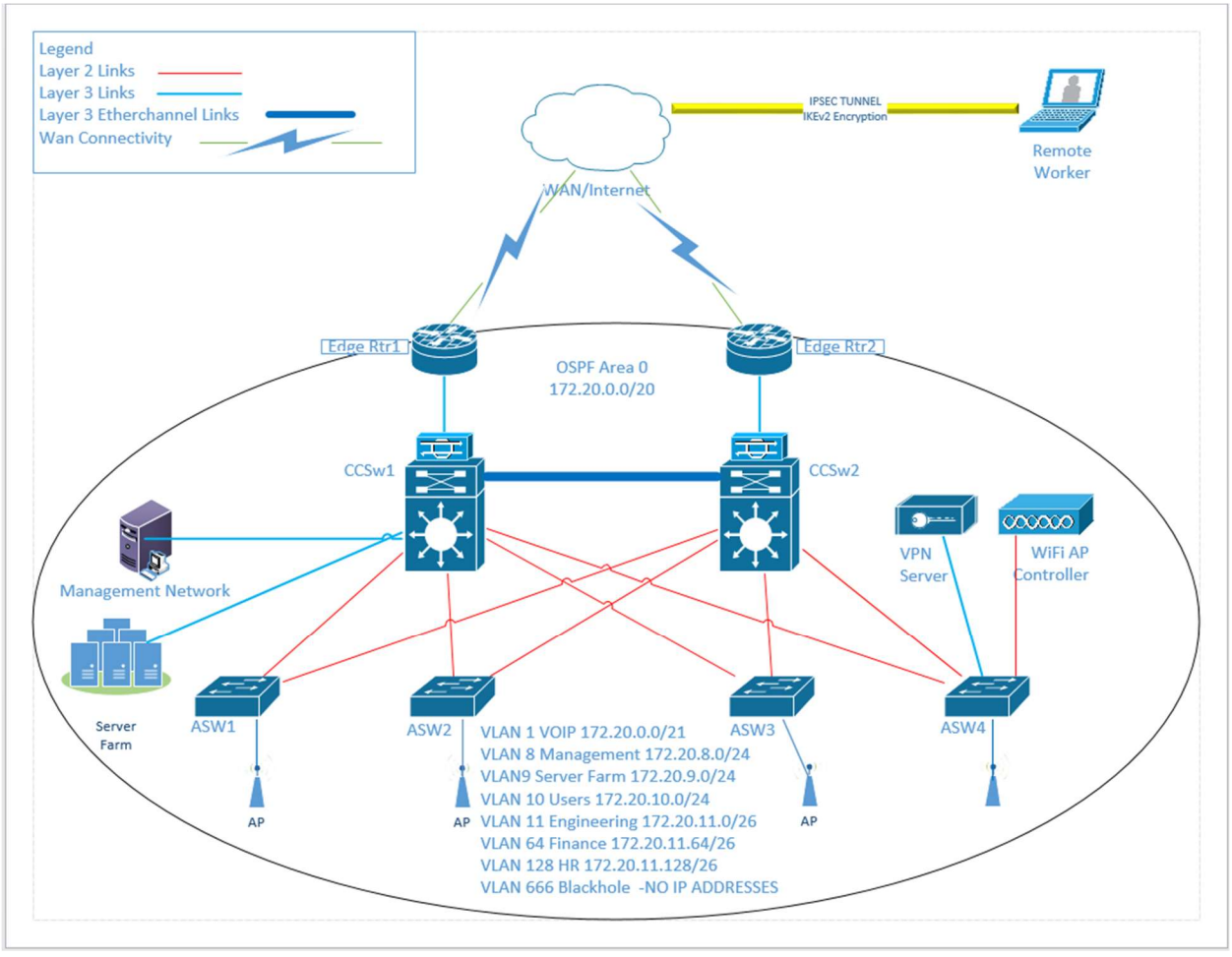


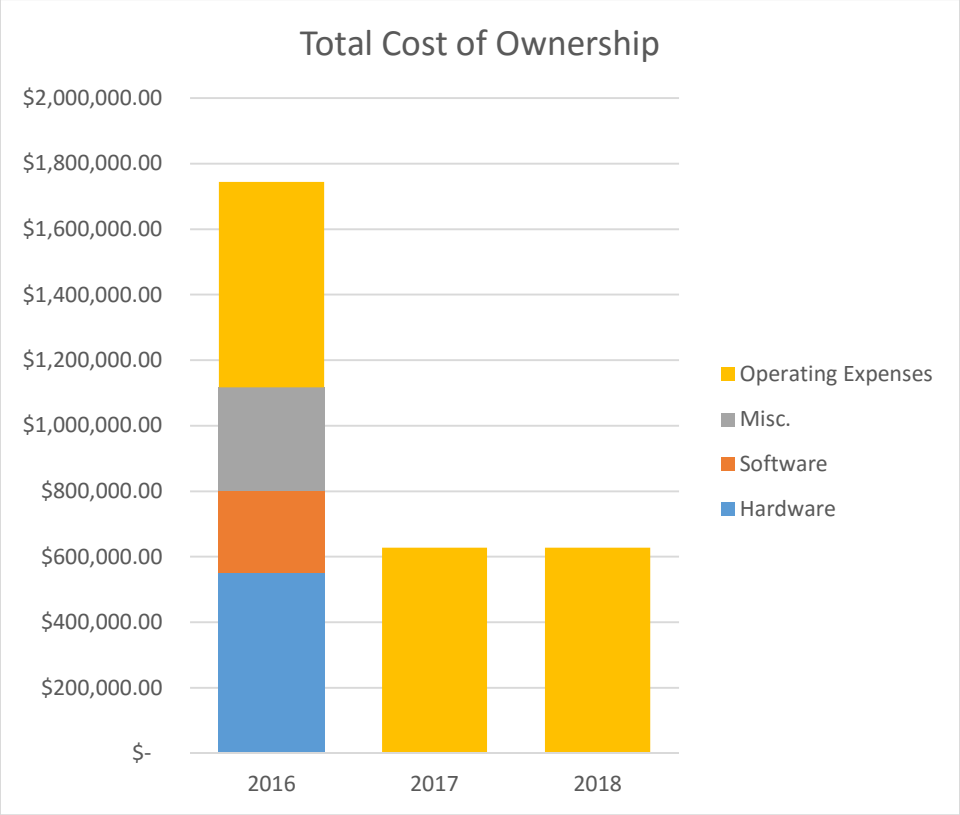
Branch Offices

Office 3 & Office 4



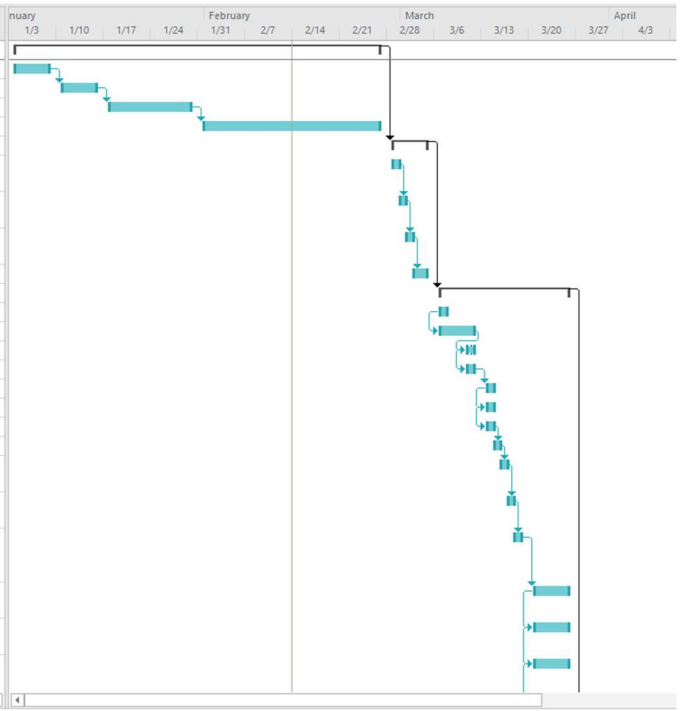
11.2 Proposed System – Diagrams



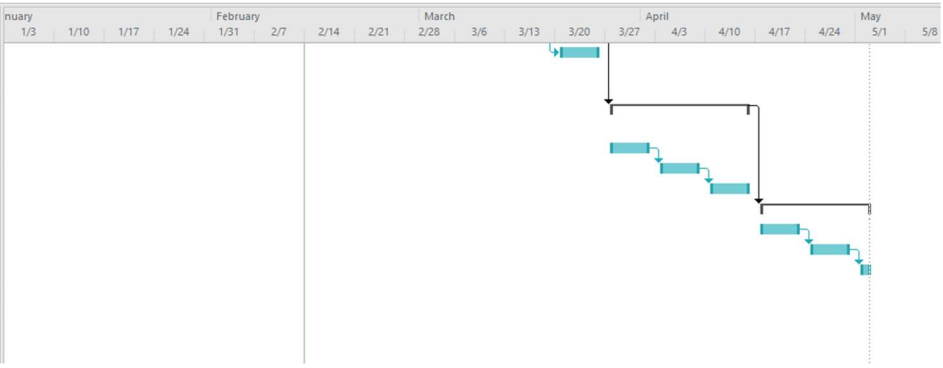


11.3 Project Schedule in Gantt Chart Format

Task Mode	Task Name	Duration	Start	Finish	Predecessor	Resource Names
	Planning Phase	**40 days**	**Mon 1/4/16**	**Fri 2/26/16**		
	Conference Call	5 days	Mon 1/4/16	Fri 1/8/16		
	Bidders Conference	5 days	Mon 1/11/16	Fri 1/15/16	2	
	Network Design	10 days	Mon 1/18/16	Fri 1/29/16	3	
	RFP	20 days	Mon 2/1/16	Fri 2/26/16	4	
	Prepare Phase	**5 days**	**Mon 2/29/16**	**Fri 3/4/16**	**1**	
	Current Network Benchmark Location1	1 day	Mon 2/29/16	Mon 2/29/16		
	Current Network Benchmark Location 2	1 day	Tue 3/1/16	Tue 3/1/16	7	
	Current Benchmark Location 3	1 day	Wed 3/2/16	Wed 3/2/16	8	
	Equipment Inventory	2 days	Thu 3/3/16	Fri 3/4/16	9	
	Implementation Phase	**15 days**	**Mon 3/7/16**	**Fri 3/25/16**	**6**	
	Equipment Ordering	1 day	Mon 3/7/16	Mon 3/7/16		
	HQ Wiring Install	5 days	Mon 3/7/16	Fri 3/11/16	12SS	
	City Inspections	1 day	Fri 3/11/16	Fri 3/11/16	13	
	Cable Certication	1 day	Fri 3/11/16	Fri 3/11/16	14SS	
	Equipment Delivery	1 day	Mon 3/14/16	Mon 3/14/16	15	
	Equipment Installation	1 day	Mon 3/14/16	Mon 3/14/16	16SS	
	WAN Install	1 day	Mon 3/14/16	Mon 3/14/16	17SS	
	Router Configuration	1 day	Tue 3/15/16	Tue 3/15/16	18	
	Collapsed Core Switch Configuration	1 day	Wed 3/16/16	Wed 3/16/16	19	
	Access Switch Configuration	1 day	Thu 3/17/16	Thu 3/17/16	20	
	Dell Power Edge Server Installation/ Configuration	1 day	Fri 3/18/16	Fri 3/18/16	21	
	Windows Server Installation/Configurat	5 days	Mon 3/21/16	Fri 3/25/16	22	
	Unix Server Installation/configurati	5 days	Mon 3/21/16	Fri 3/25/16	23SS	
	Network Management System	5 days	Mon 3/21/16	Fri 3/25/16	24SS	



Task Mode	Task Name	Duration	Start	Finish	Predecessor	Resource Names
	Unified Communications system	5 days	Mon 3/21/16	Fri 3/25/16	25SS	
	Operation and Optimization Phase	**15 days**	**Mon 3/28/16**	**Fri 4/15/16**	**11**	
	Network Stability Test	5 days	Mon 3/28/16	Fri 4/1/16		
	Network Baseline	5 days	Mon 4/4/16	Fri 4/8/16	28	
	NMS Audit and Invento	5 days	Mon 4/11/16	Fri 4/15/16	29	
	Training	**11 days**	**Mon 4/18/16**	**Mon 5/2/16**	**27**	
	Basic Training	5 days	Mon 4/18/16	Fri 4/22/16		
	Advanced Training	5 days	Mon 4/25/16	Fri 4/29/16	32	
	Moves Adds Changes	1 day	Mon 5/2/16	Mon 5/2/16	33	



References

Avaya. (2016). *Avaya IP Office*. Retrieved from Avaya.com: http://www.avaya.com/usa/product/ip-office/

Avaya. (n.d.). *Avaya IP Office Select.* Retrieved from Avaya.com:

https://www.avaya.com/usa/documents/ip_office_select_sme7648.pdf

CDE. (n.d.). *Microsoft Windows Server 2012 R2 Standard License 2 Processors.* Retrieved from CDW.com: https://www.cdw.com/shop/products/Microsoft-Windows-Server-2012-R2-Standard-License-2-Processors/3178215.aspx?RecommendedForEDC=3847581&RecoType=RP&cm_sp=Product-_-Session&ProgramIdentifier=3

CDW. (n.d.). *AVAYA IP OFFICE R9+ SELECT IPO SL9*. Retrieved from CDW.com: https://www.cdw.com/shop/products/AVAYA-IP-OFFICE-R9-SELECT-IPO-SL9/3731406.aspx?pfm=srh

CDW. (n.d.). *Cisco 48-Port 1 Gigabit Copper Ethernet Module with DFC4 - expansion Module*. Retrieved from CDW.com: https://www.cdw.com/shop/products/Cisco-48-Port-1-Gigabit-Copper-Ethernet-Module-with-DFC4-expansion-module/2457330.aspx

CDW. (n.d.). *Cisco ASR 1002 VPN Bundle - router - desktop, rack-mountable - with Cisco A*. Retrieved from CDW.com: https://www.cdw.com/shop/products/Cisco-ASR-1002-VPN-Bundle-router-desktop-rack-mountable-with-Cisco-A/3954273.aspx?pfm=srh

CDW. (n.d.). *Cisco Catalyst 3650-48ps-1 switch*. Retrieved from CDW.com: https://www.cdw.com/shop/products/Cisco-Catalyst-3650-48PS-L-switch-48-ports-managed-desktop-rack-mo/3225180.aspx?pfm=srh

CDW. (n.d.). *Cisco Catalyst 6500 Series Supervisor Engine 2T - control processor*. Retrieved from CDW.com: https://www.cdw.com/shop/products/Cisco-Catalyst-6500-Series-Supervisor-Engine-2T-control-processor/2448389.aspx?RecommendedForEDC=2457330&RecoType=RP&cm_sp=Product-_-Session&ProgramIdentifier=3

CDW. (n.d.). *Cisco Catalyst 6513-E - switch - 2 ports - rack-mountable - with Cisco Cata*. Retrieved from CDW.com: https://www.cdw.com/shop/products/Cisco-Catalyst-6513-E-switch-2-ports-rack-mountable-with-Cisco-Cata/2556683.aspx#PO

CDW. (n.d.). *Cisco Gigabit Ethernet Transceiver Module*. Retrieved from CDW.com: https://www.cdw.com/shop/products/Cisco-Gigabit-Ethernet-Transceiver-Module/2558100.aspx

CDW. (n.d.). *https://www.cdw.com/shop/products/Cisco-Smart-Net-Total-Care-Combined-Support-Service-extended-service-agre/3600707.aspx?pfm=srh#PO.* Retrieved from CDW.com: https://www.cdw.com/shop/products/Cisco-Smart-Net-Total-Care-Combined-Support-Service-extended-service-agre/3600707.aspx?pfm=srh#PO

CDW. (n.d.). *Microsoft Exchange Server 2016 Standard - license.* Retrieved from CDW.com: https://www.cdw.com/shop/products/Microsoft-Exchange-Server-2016-Standard-license/3847579.aspx?RecommendedForEDC=3446565&RecoType=RP&cm_sp=Product-_-Session&ProgramIdentifier=3

CDW. (n.d.). *Microsoft Exchange Server 2016 Standard CAL - license.* Retrieved from CDW.com: https://www.cdw.com/shop/products/Microsoft-Exchange-Server-2016-Standard-CAL-license/3847581.aspx?pfm=srh

CDW.com. (n.d.). *Avaya DL3609g8 Server Ent*. Retrieved from CDW.com: https://www.cdw.com/shop/products/AVAYA-DL360PG8-SERVER-ENT/3732673.aspx?pfm=srh

Cisco. (2006, May 25). *Hot Standby Router Protocol*. Retrieved from Cisco.com: http://www.cisco.com/c/en/us/support/docs/ip/hot-standby-router-protocol-hsrp/9234-hsrpguidetoc.html#background

Cisco Global Learning Network. (2003). *Scalable Network Design*. Retrieved from Cisco: http://www.cisco.com/web/learning/netacad/demos/CCNP1v30/ch1/1_1_1/index.html

Communication, L. (n.d.). *Level 3 MPLS/IP VPN Service.* Retrieved from Level3.com: http://www.level3.com/~/media/files/brochures/en_vpn_br_ip_vpn_service.pdf

Level3 Communications. (2015). *Level 3 Virtual Private Lan Services (VPLS)*. Retrieved from Level 3: http://www.level3.com/en/products/virtual-private-lan-service/

Microsoft. (2016). *Windows Server 2016*. Retrieved from Micosoft.com: https://www.microsoft.com/en-us/server-cloud/products/windows-server-2016/

Newegg Business. (n.d.). *APC SMT3000R2X180 SMART-UPS 3000VA RM 120V LCD 2U WITH NMC INSTALLED*. Retrieved from Newegg Business: http://www.neweggbusiness.com/product/product.aspx?item=9b-1hu-0052-00014

Newegg Business. (n.d.). *http://www.neweggbusiness.com/product/product.aspx?item=9b-99-996-331*. Retrieved from Newegg Business: http://www.neweggbusiness.com/product/product.aspx?item=9b-99-996-331

Newegg Business. (n.d.). *LADDER RACK RUNWAY- 5 FT*. Retrieved from Newegg Busienss: http://www.neweggbusiness.com/product/product.aspx?item=9b-050-00d8-00070

Newegg Business. (n.d.). *StarTech.com 42U Adjustable Depth Open Frame 4 Post Server Rack Cabinet - Flat Pack w/ Casters, Levelers and Cable Management Hooks*. Retrieved from Newegg Business: http://www.neweggbusiness.com/product/product.aspx?item=9b-16-129-115

Newegg Business. (n.d.). *Ubiquiti UniFi AP-AC 3-pack, UAP-AC 3 pack Dual Band Access Point AC 3x3 PoE+*. Retrieved from Newegg Business : http://www.neweggbusiness.com/product/product.aspx?item=9b-0ed-0005-000e1

Ubiquiti Networks. (2016). *UniFi AC*. Retrieved from Ubiquiti Networks : https://www.ubnt.com/unifi/unifi-ac/

Table of Figures