WOLKITE UNIVERSITY

COLLEGE OF COMPUTING AND INFORMATICS

DEPARTMENT OF INFORMATION TECHNOLOGY

Industrial Project on

Advanced Network Design and Configuration for AGENA Construction and Industrial College

BY

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Advanced Network Design and Configuration for AGENA Construction and Industrial College

SUBMITTED TO DEPARTMENT OF INFORMATION TECHNOLOGY
IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR
THE DEGREE OF BACHLER OF SCIENCE IN INFORMATION TECHNOLOGY

BY

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DECLARATION

This is to declare that this project work which is done under the supervision of **Mr. Korabza Shewarega** and having the title **Advanced Network Design and Configuration for AGENA Construction and Industrial College** is the sole contribution of:

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No part of the project work has been reproduced illegally (copy and paste) which can be considered as Plagiarism. All referenced parts have been used to argue the idea and have been cited properly. We will be responsible and liable for any consequence if the violation of this declaration is proven.

Date: 10/02/2019 G.C.

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Approval Form

This is to confirm that the project report entitled **Advanced Network Design and Configuration for AGENA Construction and Industrial College** submitted to **Wolkite University, College of Computing and Informatics Department of Information Technology** by:

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List of Abbreviations

CAT	Category
CIC	Construction & Industrial College
DHCP	Dynamic Host Control Protocol
DNS	Domain Name Server
E.C	Ethiopian Calendar
ETB	Ethiopian Birr
ETC	Ethiopian Telecommunication
GBPS	Gigabit per second
ICS	Internet Connection Sharing
ICT	Information Communication Technology
ISP	Internet Service Provider
IT.	Information Technology
LAN	Local Area Network
MB	Megabyte
MBPS	Megabyte per Seconds
NAT	Network Address Translation
PC	Personal Computer
SNNPR	South Nation, Nationality and people's Region
TVET	Technical and Vocational Education Training
WAN	Wide Area Network

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CHAPTER ONE

1. INTRODUCTION

The information has become part of Peoples' daily activities. The rapid development of Information technology (such as the use of computers together, process and store information), the growth of knowledge, and the fast pace of the modern world together created extensive awareness of the importance of timely, reliable, and accurate information for every development endeavors.

Nowadays, information essentially is associated with the concept of communication. Accordingly, ICT refers to the communication and sharing of information and other relatively scarce (or expensive) resources. For instance, computers in a given work environment are connected to facilitate fast, accurate and timely information exchange. It also makes all resources, programs, equipment, files sharable and available to every connected computer. This takes us to the issue of networking, which refers to a group of computers interconnected with some communication technology.

One of the most frequently practiced networking types is the so-called Local Area Networking (LAN). It refers to the connection of computers within a small geographical area, usually in a given organizational building(s). LANs are widely used to connect personal computers and workstations in company offices and institutions to share resources (e.g. Internet, Printers) and exchange information. This project focuses on requirement analysis, design and deployment works of an advanced local area networking for AGENA Construction and Industrial College because currently, the college could have Internet of 4 Mbps from Tele but this network is not distributed across the entire college and it used for specific office and covers around five users so, we will design a LAN and make the network distributed and covers more area and give service for many users as much as possible.

1.1. Background of the Organization

Agena construction and industrial college were established at the end of reforming the SNNPR TEVT Agency to the TVET bureau. The year 1995 E.C. was the period when Agena TVET institute and other 12/twelve collages are established as colleges. This college is located on the Region of SNNPR, GURAGE Zone, and AGENA Wereda on 5.8 Hectare land. The area of 3.5 Hectare land is covered by different buildings. Those are 3 Administrative buildings, 1 staff

building, and 4 workshops for Auto, Manufacturing, Electronics, and Furniture, 3 L-shape buildings for classroom and 1 versatile hall.

Vision

To develop from level-1 up to level-5 including a first-degree training program for playing a significant economical & social development role and contribute appositive effects of our country as well as regional and to verify the reduction of poverty of our country by producing competent self-confident citizen.

Mission

To produce self-employed middle level & higher technical competent workforce in quantitatively & qualitatively that are equipped with technological skills and knowledge that plays a significant role in poverty reduction and economic growth of country through demand-driven and outcome-based training by organizing human & material resource and capacitate SMEs by industry extension service and by transferring technologies that save time, effort and cost based on regional institutions training strategies and plan.

Objectives

To deliver training in both formal and informal training by the quality and project-based training and produce a lower and middle level and higher technical competent trainees qualitatively and quantitatively to achieve regional and national growth plans. Capacitate SMEs by industry extension service and by transferring technologies that solve the problems, save time, effort and cost of farmers and other communities.

1.2. Statement of the problem

As we observe the organization many problems exist because no Local Area Network is deployed in the College. So, the college faces many challenges with the manual and semi-automated system. Many kinds of problems confront in manual work is no exception. Most of the problems that are related to Networking is raised in the organization. To recap some of the most distinguishable problems with the networked system are:

- There is no LAN configuration entire the College only Internet for specific office with a limited speed of 4 Mbps,
- There is no information and resource sharing between the staff.
- Too much paperwork on academic and administrative staffs;

- Slow retrieval of data and difficulty of getting aggregated information and report generation;
- Problem to search according to some mechanism, for example (plan, report, feedback, teamwork…etc.);
- There are no network-related services like file sharing, Email service and video conferencing because of the unavailability of a network system inside the college.
- Students and staff members could not get enough internet access.
- No automation project or system is existing inside the college because there is no networked system and data center that consist of different servers.
- The staff members could not get any mechanisms to update the Computers

1.3. The objective of the project

1.3.1. General Objectives

The general objective of this project is to design, configure and simulate an advanced Local Area Network for AGENA Construction and Industrial College.

1.3.2. Specific Objectives

To address the problems mentioned in the problem statement and to achieve the general objective the following specific objectives will be implemented.

- Study and analysis of the existing system and organization.
- Design a Network that considers the current situation and technologies and make it a cost-effective one.
- Configure and Implement a LAN on simulation environment.
- Making unit and integration tests and maintaining network connectivity.

1.4. Functional Requirement and Non-functional requirement

The developed project is expected to provide the following functionalities:

1.4.1. Functional Requirement

The following Functional requirements are necessary to accomplish the objectives of the project:-

- Designing, Configure and simulating a Local Area Network.
- Designing and implementing a centralized file-sharing system.
- The project should allow information and resources (printer, scanner, copy machine, etc.) sharing between staff in the college.

- The project should provide internet access on the campus that use for the Students and the staff.
- Provide enough wireless network connections in the college.
- Configure Vlan and inter Vlan routing.
- Configure a bandwidth management system on the firewall.
- Configure a firewall for security purposes.
- Configure a DHCP and DNS
- Configure inter gateway routing

1.4.2. Non-functional requirement

There are also non-functional requirements expected from the project and the following lists these requirements and those functional requirements are achieved by using a Top-down Network design approach, the hierarchical network design model and router, switch and Firewall configurations.

Security

Security is all about confidentiality, integrity, availability, and non-repudiation. The system should ensure that the network provided by subscribers and other system information is not disclosed to unauthorized processes or sites. The system should maintain the correctness and consistency of the network it provides by configuring different security mechanisms on the firewall, switch, and router.

Performance

Since we use current new technologies, Hardware Devices, and Advanced Configuration mechanisms. So, this gives a high rate of performance for the network it provides.

Scalability

The network should scale gracefully. Scalability is a desirable property of a system or a network, which indicates its ability to either handle growing amounts of work easily. The system can maintain its availability, reliability, and performance as the amount of traffic load increases. This means it should be able to handle more subscribers and increased traffic load by designing a flexible and expandable network.

1.5. Feasibility Study

Feasibility analysis enables the system to determine either or not the project can be developed, evaluates and identifies the newly developed system. Therefore, the feasibility analysis of the proposed system involves the following feasibility:

1.5.1. **Economic feasibility**

The project, we are going to develop is economically feasible than the manual system that the organization is using now. When the team can be analyses the system by comparing the cost with the benefit (the enterprise can get by using the proposed system), surely the benefit out weight the cost. The cost of developing a full system, including software and hardware cost for the class of application being considered should be evaluated.

So, the benefit that obtains by using the proposed system can be categorized as tangible and intangible.

Tangible benefits are:

- Using less manpower than the existing system.
- Increase the speed of activities and competitions.
- Reduce cost.

Intangible benefits are:

- Minimizing data redundancy.
- Better service to the student and staff members.

1.5.2. **Operational feasibility**

The proposed system will solve the business and time problem for the organization. Therefore the college admin staff, Academic Staff, Students, and other users can get effective and efficient service from the network, which satisfies their needs.

The proposed network:

- It offers a greater level of user satisfaction.
- Produces the best results and gives high performance.
- It can be implemented and operate easily.
- It can be solved the existing system problem and challenge.

1.5.3. **Technical Feasibility**

To accomplish our project the project team members have enough knowledge and networking skills. The technology that we are used for design and implement the network is currently available and we can get them easily. So, our project is technically feasible.

1.6. Scope and limitation of the project

1.6.1. **Scope of the project**

The Scope of this project is to analyze the requirements, design and configure a local area network for AGENA Construction and Industrial College and to connect WAN through the internet.

- Design LAN for the TVET college with physical and logical design
- Router and Switch configuration with routing protocols and Vlan
- Security configuration with different security technologies
- Distribute the network across the college
- Wi-Fi or wireless device configuration
- Configure the network on the simulation cisco packet tracer

1.6.2. **Limitations of the Project**

The system has the following limitation:

- There is no integrated network design with other branches or TVET colleges.
- There is no automation projects or systems.
- Our system does not include the physical installation of the network, the configuration of the network is done on the simulation, not on real devices

1.7. Significance of the project

The successful realization of the project will play a significant role in putting a hand on the accomplishment of the mission of the college. Generally speaking, the following are some of the major benefits that could be obtained after the completion of the project:

- Adequate storage mechanisms of data that are specific to the office(textual, audio and video)
- Timely access to relevant and comprehensive information for decision-makers, etc.;
- Reduced wastage of time–through seems petty, the cumulative effect of spending time on the search for information, files, printers, etc. is enormous ;
- Fast data exchange and information communication,
- Reduction on the cost by sharing resources such as internet, printers, scanners, etc.;
- Promote the development of e-learning resources;
- Promote distance education and virtual institutions, particularly in higher education and training;

- Better service and accuracy of the network that gives for the users;
- Provide affordable infrastructure to facilitate dissemination of knowledge and skills through automated platforms;
- Improved communication environment,
- Facilitate the sharing of resources between institutions;
- Integrate IT resources with other regional and national existing resources.
- Ensure that there exists equitable access to ICT resources by students, teachers, and administrators in all regions and educational institutions and offices;
- Better information retrieval,
- Reduction in paperwork,
- Ensure the organized provision of ICT training to students, teachers, and educational administrators;
- Lower operation cost,

1.8. The beneficiary of the project

Some users can directly or indirectly be benefited from this project some of them are the college itself, academic and administrative staff members, students and project team.

This project provides many benefits:

Students: - Allow college students to use internet access for reference, research, and project work.

College: In the manual system, there is a loss of materials like time, paper, a pen which is cost and more manpower, the system reduces the loss of costly materials and manpower. It has great importance for all offices to facilitate their job effectively and efficiently.

1.9. The methodology of the project

1.9.1. **Data collection tools or techniques**

Is the way or mechanism in which we gather information to design the network**.** We have used the following methods:

- Interviewing the dean of the college and the Network Administrator (asking an open and closed question) about the existing system.
- Observing the demography of the college and the Internet that come from Tele.
- Collecting information from different references, projects, and websites
- By discussing and analyzing the problems with the project team.

Practical Observation: we observed physically the currently existing system which has only limited internet access that comes from Tele and not distributed inside the college and most of the works are done manually.

Interview: To get the basic information and background information about the existing system structure, we ask a different question from different persons who are related to the existing system.

1.9.2. **Network design**

We will be using the hierarchical network design and Top-Down network design approach to design the logical and physical design of the network.

1.9.3. **Performance Testing Methodology**

Measuring network performance has always been a difficult and unclear task, mainly because most engineers and administrators are unsure which approach is best suited for their LAN or WAN network.

A common (and very simple) method of testing network performance is by initiating a simple file transfer from one end (usually workstation) to another (usually server). So, we will be use this type of network performance testing to test the implemented network by unit and integration testing.

1.9.4. **Simulation Tools and Technologies**

- For Simulation: Cisco Packet Tracer
- For Designing: Visio Setup

1.10. Budget and Time Schedule of the project

1.10.1. **The budget of the Project**

We assumed that the following budget is required to complete the project.

Table 1. .Budget of the project

No	Materials Required	Quantity	Price Per Unit (ETB)	Total Cost (ETB)
1	Desktop Computer	1	17000	17000
2	Pen	10	6	60
3	A4 Size Paper	1 Destin	150	150
4	Printing	100	1	100
5	Flash Disk	1(8G)	140	140
6	Firewall	1	500,000	500,000
7	Wireless Access Points	6	5,600	33,600
8	Network Switches	8	75,000	600,000
9	Router	1	120,000	120,000
10	UTP Network Cable	2 roll	6,500	13,000
11	Fiber Optic Cable	300 meter	-	100,000
12	Cable Trunking	140 meter	-	5,000
13	Network Toolkit	-	-	5,000
Total				921,650

1.10.2. **Schedule of the project**

To accomplish our objective we need an effective plan so the project is completed according to the schedule planned that shown in Figure 1.1 below.

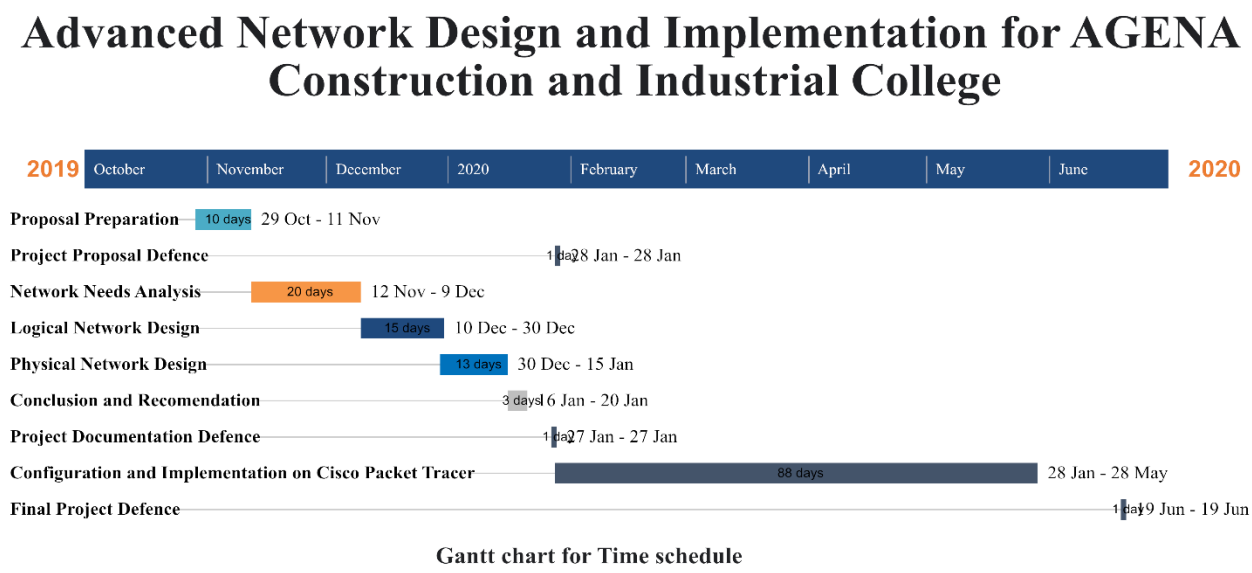

Figure 1. Schedule of the project

1.11. Team Composition

Table 2. Team Composition

Project Team Members	Responsibilities
Abraham Kassie	Study the Existing System and identify the problem by Requirement gathering
Aseba Temesgen	Study the Existing System and identify the problem by Requirement gathering
Besufikad Abebayehu	Design, Configure and Test the Local Area Network
Hiwot Amsal	Design, Configure and Test the Local Area Network

CHAPTER TWO

2. NETWORK NEEDS ANALYSIS

This is focused on analyzing the needs of designing a new computer network infrastructure and modifying the existing one in the organization. AGENA Construction and Industrial College, to the hot pursuit of the pace of the times, development and inter-college, static resource sharing, dynamic information release, distance learning and collaborative work stage, the development of college education modernization, decided to build their college network, strive for early realization of education modernization. After the completion of the college network, which can lead to teaching methods, teaching tools of major reforms. To improve the quality of teaching, and promote the development of Ethiopia`s education modernization plays an immeasurable role. The network also provides an effective way for college dean, administrative staff and teachers to acquire resources and work together. The Proposed college network will improve the management level, work efficiency, and improve the quality of teaching a powerful means, that is, to solve the information age education problem of the basic tools. Through the college information construction professionals to communicate, due to participating in network applications more teachers and students, and contains a large number of multimedia information, so large-capacity, high-speed data transmission is an important requirement for the network. College network development needs are as follows:

- Teaching building, workshop building, main hall and so on, browse the WEB page and visit the Internet.
- The college network security requirements are higher, the college network also has a lot of teaching and file management on the important data, whether it is damaged, lost or stolen, which will bring great losses. The device is required to enable user identification and dynamic binding functions such as identification of users through the dynamic binding of the 'IP + MAC + port' triplet, such as the authentication of the access user, the security of the access computer's computer equipment, The security of the network switch and the control of the server cluster access.
- The college network can achieve the following functions: resource sharing, information exchange, collaborative work, user Web self-service function, the user can Web self-service page, personal information query, password modification, Internet details query.

- The college network requirements for each user's use can be audited afterward, to locate the IP address and the user connected to the port and login user name, limit the use of the accounting port.
- The college network requirements to achieve the dynamic control of user bandwidth.
- The college network to achieve multicast services.
- The college network requirements in the college scale continue to expand, the number of users continues to increase, requiring the network has very good scalability, according to the need to gradually smooth upgrade to 10 Gigabit backbone connection.
- Network management platform to achieve the management of network resources, network security access control. And on the platform can easily develop the required network applications.
- After the completion of the project the network will achieve the following basic functions:
  - ✓ Computer teaching, including multimedia teaching and distance learning;
  - ✓ Network downloads, network chat, etc. .;
  - ✓ E-mail system: mainly with peer exchanges, technical cooperation, academic exchanges, and other activities;
  - ✓ File transfer FTP: the main use of FTP services to obtain important scientific and technical information and technical documents;
  - ✓ Internet service: colleges can set up their home page, the use of external web pages for college publicity, to provide various types of consulting information, the use of internal web pages to manage, such as issuing a notice to collect student opinions.

2.1. **Data Types**

Different data are processed, stored and transferred in the college network infrastructure. The following are data sources for the LAN in the college vicinity:

- Detail college students, academic staff and administrative staff information (i.e. business requirements, the term of agreements, contract letter and others)
- Human resource information of the college
- Inventory information of the college
- Materials that support college students, academic staff and administrative staff information (audio files, textbooks, web files, video files, and other files: - The future automation systems web pages and databases).

2.2. **Data Sources**

The current data source of the college is file based on whether it is manually or/and semi-automated and in the future, the data source of the college will become different databases, web files, and documents.

2.3. **Numbers of Users and Priority Levels**

In the college, the users will be administrators (i.e. College Dean), secretaries, teachers, students, and other workers.

Three priority levels will be supported: administrators (top priority), academic staff (medium priority) and students and other workers (low priority)**.** Note that these designations do not correspond to administrative levels in the school; rather, they are network service levels (i.e. services delivered to the staff and students). Network management processes **(**packages in Simple Network Management Protocol) will receive top priority service; most network processes will receive medium-priority service; a few processes (e.g., e-mail transfers, backup, web access (WWW), FTP, etc.) will be given low-priority service. It should be noted that network management will usually consume a small amount of the available bandwidth; this means that management and user processes will usually enjoy identical support. Background processes will also usually receive more than adequate service, but they will be delayed as needed to maintain support for management and user services.

2.4. Transmission Speed Requirements

The network infrastructure in the college (suppose the college has one thousand students, two hundred staffs both academic and administrative). The college could provide email, video and audio file accesses, web accesses, social network sites accesses, communication, application download, uploads, and accesses the college-specific system and other services.

After the end of the design network, the outcome is to provide applications like mail service, FTP, video conferencing and so on. We are intended to design and agreed with the college that the network will support the following application:

- FTP (for allowed traffic flow): the college allows giving service of file transfer securely with fast speed.
- Web server: that helps to deliver Web content that can be accessed through the Internet.

By considering the number of staff and students of the college and services that are delivered to them, the capacity of the sole internet service provider in the country and budget of the

college. So, the college require a good and high bandwidth, there for we will propose to implement a 1GBPS bandwidth network for the college and its entire community.

2.5. **Load Variation Estimates**

Load balancing is done on the distribution switch, so we will be implementing a load balancing on the distribution layer to minimize the network traffic and user compliant.

Of course, to avoid user complaints, the network will be designed for the average of peak traffic loads and the average throughput requirements of the organization.

2.6. **Storage Requirements**

The storage requirements need to be large enough to store all students, instructors, and other required data (note: student data are data about students, not data generated by students). Also, the university storage requirement can consider for Departments, Faculties, Colleges and Institutes, registrar and other offices in the university.

Nevertheless, the memory requirement cannot only dependent on the current students; but it also considers the future expansion of the college.

So, the college needs one big storage server for multiple purposes by using the concept of virtualization.

2.7. **Reliability Requirements**

Reliability refers to the ability of the computer network's hardware and software component to consistently perform according to its specifications. This project's network will be highly reliable in performance because its components will be a high performance devices. The reliability of security in the network is at a high level. This is because there are many powerful devices used to secure data like the firewall device that is used in filtering data entering into the network. If any issue happens to the data, there is a way of restoring the data from backup servers. Each computer in the network has anti-virus to protect users' data. Also, all router and switches are protected by passwords and encryptions.

The college wants and we will design and implement a network that supports the following network reliability requirement:

- The network should stay up all the time, even in the event of the failed link, equipment failure, and overload conditions.
- The network should be easy to modify to adapt to network growth.

- The network should be secure. It should protect the data that is transmitted over it and data stored on the devices that connect to it.
- Because failure occasionally occurs, troubleshooting should be easy. Finding and fixing a problem should not be time-consuming.
- The network should reliably deliver applications and provides reasonable response times from any host to any host.
- Reliability from the user perspective is a requirement for consistently available services.

2.8. **Security Requirements**

Due to the constant development of software programs that have led to an increase in the theft and the number of cybersecurity attacks, security has become important for all hosts on a network. Network security must protect all information and users supplied by a network. Security involves a pro-active prevention process to avert any danger or attack in a network. A computer administrator must be present to enforce the security of data access in the network. In terms of securing the network, there are three major aspects to consider. These include Infrastructure, Individual Systems/Components, and Individual Hosts.

We will be using a business-grade firewall that supports multiple internal networks (or zones) and performs state full packet inspection.

As the first line of defense against online attackers, the firewall is a critical part of the network security. Configuring a firewall can be an intimidating project, but breaking down the work into simpler tasks can make the work much more manageable.

- **Secure the firewall**: If an attacker can gain administrative access to the firewall it is "game over" for your network security. Therefore, securing the firewall is the first and most important step of this process.
- **Configure access control lists: Extended ACLs:** Introduced in IOS version 8.3, the extended ACLs are more complex and allow filtering of the IP traffic based on a combination of multiple criteria: source IP address, destination IP address, TCP or UDP port, protocol,... In numbered ACLs, the access-list number can be any number from 100 to 199 or 2000 to 2699 (available in IOS versions >12.0.1). Such ACLs can also be named access lists in which the ACL number is replaced by a keyword. This kind of ACL has to be placed near the source as it allows fine-grained control to resources accessed. Placing the ACL near the destination will make the traffic travel through the network before being blocked, resulting in bandwidth waste.

And also, we are going to use the OSPF routing protocol to manage the network properly. Controlling access to network resources is a primary concern. OSPF routing protocols provide techniques that can be used as part of a security strategy. With OSPF routing protocols, you can insert a filter on the routes being advertised so that certain routes are not advertised in some parts of the network.

OSPF routing protocols can authenticate routers that run the same protocol. Authentication mechanisms are protocol specific and generally weak. In spite of this, it is worthwhile to take advantage of the techniques that exist. Authentication can increase network stability by preventing unauthorized routers or hosts from participating in the routing protocol, whether those devices are attempting to participate accidentally or deliberately.

2.9. **Existing Network**

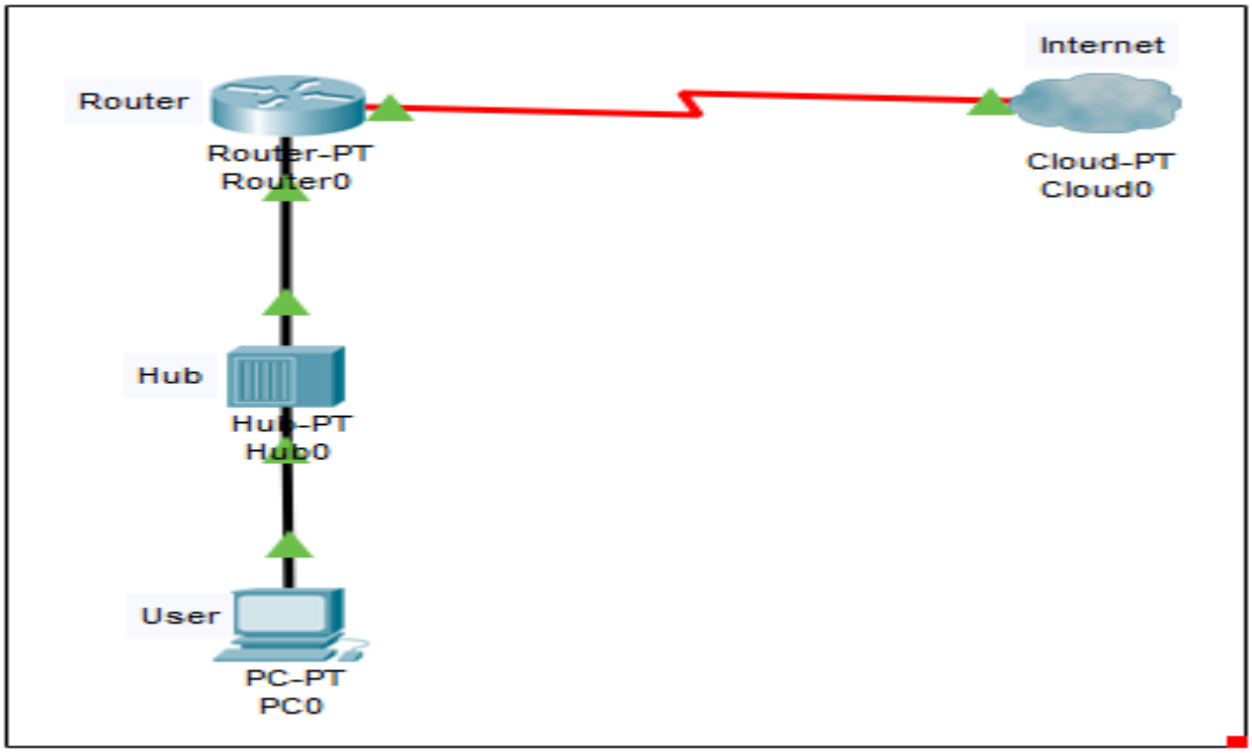

Figure 2. Current Logical Design of Agena CIC

There exists a network infrastructure in the Agena Construction and Industrial College, its bandwidth width is 4 Mbps and it is accessed by small users of the college because the existed network is not configured well in LAN and there is high traffic of network because of the small bandwidth and it does not support many users at a time.

Table 3. Current Quantity and types of devices of Agena CIC

No.	Item Descriptions	Number of the current device	Number of the proposed device
1	Router	1	1
2	Firewall	-	1
4	Access Switch	-	17
5	Server	-	2
6	Patch panel	-	7
7	Rack (12U)	-	1
8	Rack (9U)	1	5
9	Rack (6U)	-	2
10	Rack (42U)	-	1
11	Access Point	1	6
12	UPS for Server	-	2
13	UPS for Access Switch	-	17
14	Router	1	1

CHAPTER THREE

3. LOGICAL NETWORK DESIGN

As the college network started late, and the college funds are not very adequate, cannot be in one step. On the other hand, the level of application of the college is more, some systems even if the installation is not used, therefore, in the construction of the college network process, the system should always implement the application-oriented, pragmatic approach, the principle of economy.

The college network needs to complete, including the book information, college administrative office, and other integrated business information management system for the majority of faculty and students to provide a network environment for teaching and research work of the advanced platform. The college network covers the entire college, and the network design follows the following five basic principles:

- Reliability and high-performance networks must be reliable, including network-level reliability such as routing, switching aggregation, link redundancy, and load balancing. The network must be of sufficient performance to meet the needs of the business.
- Scalability of the system to be scalable, with the business growth and application level, the network of data and information flow will grow exponentially, the need for good network scalability, and can continue to upgrade with the development of technology. Equipment should be used in line with international standards of systems and products to ensure that the system has a long vitality and scalability to meet future requirements of the system upgrade.
- Easy to manage, easy maintenance as the college backbone network system is a large, rich and complex application, the need for network management system has good manageability, network management system with monitoring, fault diagnosis, fault isolation, filtering settings, and other functions to facilitate the management of the system and maintain. At the same time as far as possible to choose a high degree of integration, the module can be a common product for easy management and maintenance. Here we use the equipment is Cisco switches, firewalls.
- Security, the confidentiality of the network system should have good security. As the college backbone network for multiple user intranet to provide interconnection and support a variety of business, requiring flexible and effective security control. In the system design, not only consider the full sharing of information resources but also pay

attention to the protection and isolation of information, so the system should be different for different applications and different network communication environment, take different measures, including system security mechanisms, data access the authority of the control. In the secondary college network erection, it may through subnet and the switch of VLAN to achieve network security.

Through the use of structured, modular design forms with flexibility and comprehensive, to meet the system and different needs from users to adapt to changing requirements. To meet the system goals and functions as the goal, to ensure that the overall program design is reasonable to meet the needs of users while maintaining the use of the system maintenance, as well as the future system of secondary development and transplantation.

3.1. Designing a Network Topology

To develop and implement this college LAN we used a hierarchical model, Top-Down network design approach and hybrid network topology (Star and Mesh Topology).

The 'hierarchical' model is to divide the complex network design into several levels, each of which focuses on certain specific functions, which can make a complex big problem into many simple small problems. The hierarchical model can be applied to both LAN design and WAN design. To understand the importance of hierarchical design more clearly, it is best to understand the OSI (Open Systems Interconnection) reference, model. The OSI model simplifies the communication requirements between computers. Similarly, the use of a hierarchical model to design a network can simplify the requirements of networking.

Hierarchical network design

- **Easy savings**

  In the use of the hierarchical model, the various levels of their duties, no longer in the same platform to consider all the things. Hierarchical model the modular nature of the network to make every layer can make good use of bandwidth, reducing the waste of system resources.
- **Easy to understand**

  The hierarchical design makes the network structure clear, can be implemented at different levels of different difficulty management, reducing management costs.
- **Easy to expand**

In the network design, modularity has the characteristics of network growth so that the complexity of the network can be limited to the subnet, and will not spread to other parts of the network. And if the use of flat and mesh design, any node changes will have a great impact on the entire network.

- **Easy to troubleshoot**

  Hierarchical design can break down the network topology into easy-to-understand subnets, and network managers can easily determine the range of network failures, simplifying the troubleshooting process.

As it has been indicated on the logical design of the LAN as shown in figure 1. Below, this particular network comprises about four switches and at least one server. The server is intended for running networking software such as the Domain Controller, the Back–up DNS, the File sharing, and intended for running bureau specific applications such as Personnel Management Information System, and Education Management Information System. The server is connected to a core switch to which all the server farm access layer switches are also connected to the server.

According to the network environment, we can draw the college network topology. Among them, we use the router to connect with the Internet and choose a hardware firewall to protect the network. The college network topology is shown in Figure 3.1. And Figure 3.2.

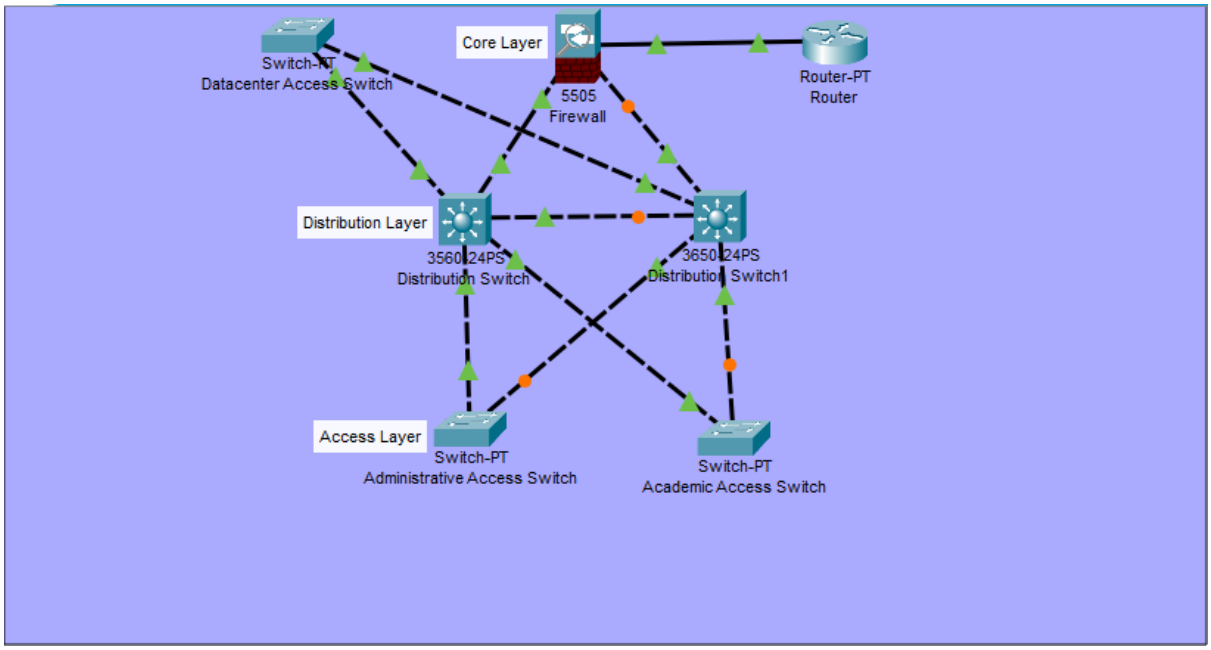

Figure 3. Partial Mesh Network Topology for Agena CIC

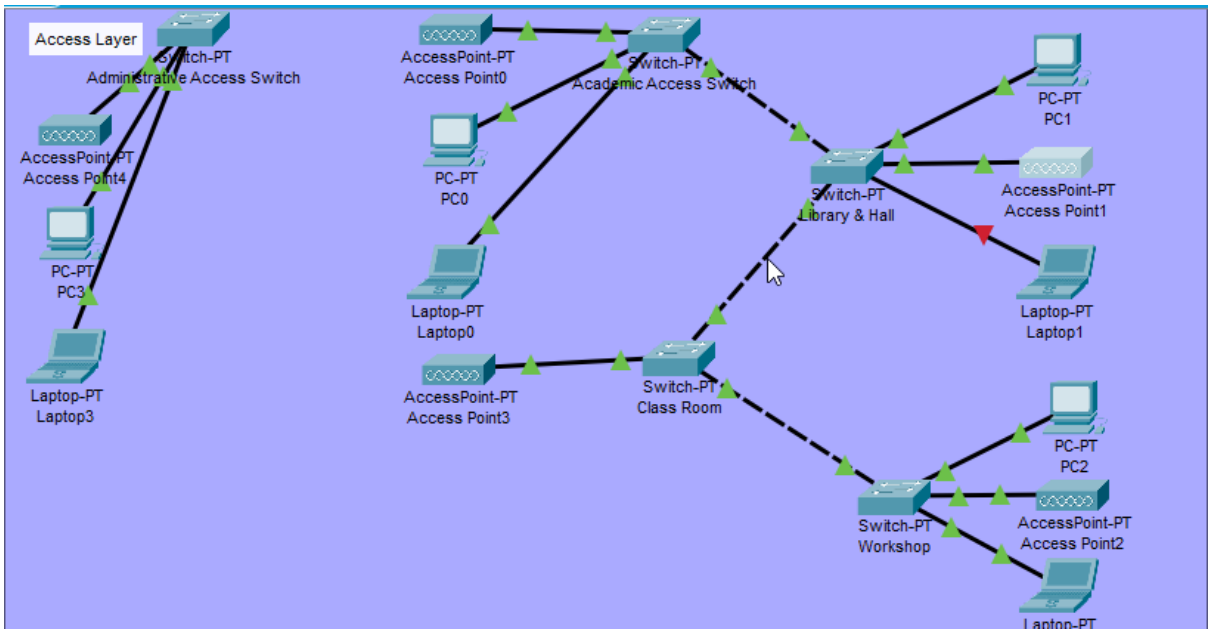

Figure 4. Star Network Topology for Agena CIC

A map is essential for understanding network traffic data. This map should show the location of the main components of the network, such as servers, wide area connections, and major internetworking devices. Wherever possible, indicate the boundaries of workgroups, wide area connections, or secured resources such as Web servers or firewalls.

To support a Traffic Specification, a network map must be accurate; however, it does not need to be 100 percent complete. In fact, certain patterns will be easier to see if you include less detail. For example, if the most important traffic patterns occur between workgroups, it is not necessary to show each desktop within those workgroups. Simply show each workgroup as a "black box" entity, and illustrate the relationships between them. Likewise, if the same problem is occurring within several workgroups, illustrate the problem by mapping one representative workgroup.

3.2. Designing Models for Addressing and Numbering

For the buildings of Academic Staff (100 nodes), Administration building (70 nodes), Main Hall & Library buildings (50 nodes), Automotive workshop building (15 nodes), Production workshop building (15 nodes), Manufacturing workshop building (15 nodes), Construction workshop building (15 nodes) and Datacenter building (15 nodes). So, Agena CIC has around 320 nodes that need an IP address, we assign an IP address based on future network expansion of the organization.

We can have two kinds of IP addresses in a network.

- Private IP address
  - Used for internal communications
  - Not advertised to the public internet
- Public IP address
  - Used for external communications

In the proposed college network, we use private IP address and VLSM to conserve IP addresses and Dynamic IP Address Assignment with DHCP. Our dynamic IP addresses are assigned by an ISP for non-permanent nodes connecting to the internet. Dynamic IP addresses can be assigned automatically using the dynamic host configuration protocol (DHCP). Any node using DHCP first request an IP address assignment from the network,

and automatically configures its network Interface. Some internet providers may allocate private addresses like these instead of public addresses to their customers, although this has a serious disadvantage. Since this address con not be routed over the internet, computers which use them are not really "part" of the internet, and are not directly reachable from it. To allow them to communicate with the internet, their private address must be translated to public addresses this translation process is known as network address translation (NAT), and normally performed at the gateway between the private network and the internet and it also will configured at Firewall or Router.

Table 4. Table of selection of IP address Assignment

	Static Address Assignment	**Dynamic Address Assignment with DHCP**
Number of hosts	UP to 30 hosts	More than 30 hosts
Renumbering	Require manual reconfiguration of all hosts	Only DHCP server reconfiguration is needed
Address tracking	Easy address tacking	Require additional DHCP server reconfiguration is needed
Additional parameters	Require manual reconfiguration of all hosts	Only DHCP server needs to be configured
High availability	IP addresses are available at any time	Redundant DHCP server is needed
Security	Minor security risk	Any device gets IP address

We will be use the classless private IP addressing which address is 192.168.1.0-192.168.3.128

Table 5. Table of selection of IP addresses

Vlan	**Vlan Name**	**Network IP**	**Default gateway**	**Host range**	**Broadcast IP**
Vlan10	datacenter	192.168.2.160/28	192.168.2.161/27	32	192.168.2.191/27
Vlan20	admin	192.168.2.0/26	192.168.2.1/26	64	192.168.2.63/26
Vlan30	academic	192.168.1.0/25	192.168.1.1/25	128	192.168.1.127/25
Vlan40	library	192.168.1.128/25	192.168.1.129/25	128	192.168.1.255/25
Vlan50	class	192.168.2.128/27	192.168.2.129/27	32	192.168.2.159/27
Vlan60	workshop	192.168.2.64/26	192.168.2.65/26	64	192.168.2.127/26
Vlan70	connection	192.168.2.192/27	192.168.2.193/27	32	192.168.2.223/27
Vlan80	admin_Wifi	192.168.2.224/27	192.168.2.225/27	32	192.168.2.255/27
Vlan90	academic_Wifi	192.168.3.0/27	192.168.3.1/27	32	192.168.3.31/27
Vlan100	library_Wifi	192.168.3.32/27	192.168.3.33/27	32	192.168.3.63/27
Vlan110	hall_Wifi	192.168.3.64/27	192.168.3.65/27	32	192.168.3.95/27
Vlan120	class_Wifi	192.168.3.96/27	192.168.3.97/27	32	192.168.3.127/27
Vlan130	workshop_Wifi	192.168.3.224/27	192.168.3.128/27	32	192.168.3.159/27

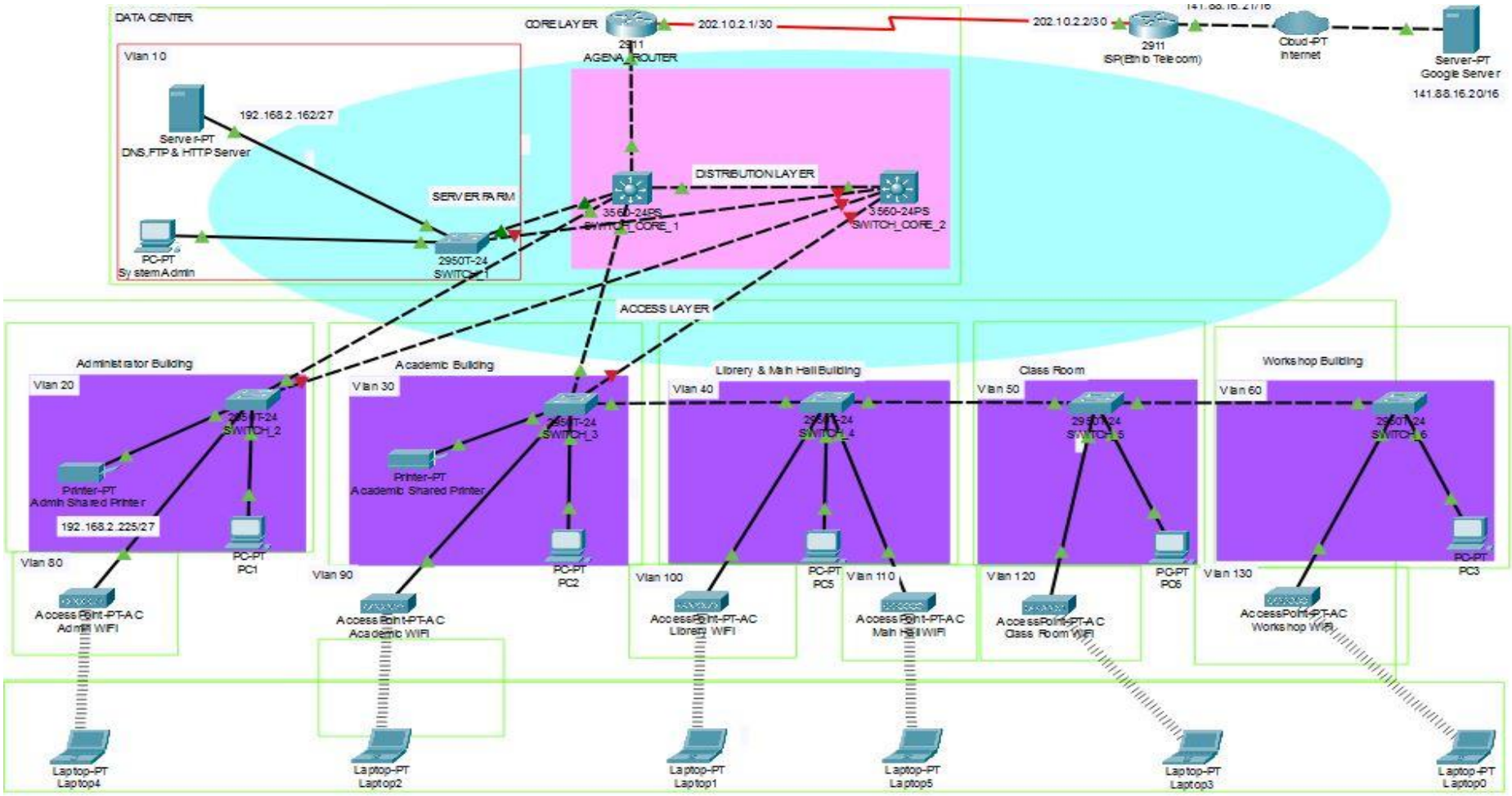

Figure 5. Proposed Logical Network Design for Agena CIC

3.3. Selecting Switching and Routing Protocols

Let see the following decision table for routing algorithms and organization objectives.

Table 6. Decision table for routing algorithms or protocols

Routing Protocols	Adaptability	Must scale to a large size	Industry standard	Not create a lot of traffic	Run-on inexpensive routers	Easy to Configure And manage	Distance vector	Link-state	Automatic route summarization	Manual route summarization	Proprietary	Convergence time
OSPF	✓	✓	✓	✓	✓	✓		✓		✓		Fast
IS-IS	✓	✓	✓	✓	✓	✓		✓		✓		Fast
IGRP	✓	✓					✓		✓	✓	✓	slow
EIGRP	✓	✓					✓		✓		✓	Very Fast
RIP	✓						✓		✓			Fast

Based on the above decision table we select the OSPF routing algorithm or Protocol. Open Shortest Path First (OSPF) was designed as an interior gateway protocol (IGP), for use in an autonomous system such as a local area network (LAN). It implements Dijkstra's algorithm, also known as the shortest path first (SPF) algorithm. As a link-state routing protocol it was based on the link-state algorithm.

3.4. Developing Network Security Strategies

Also, the security design document is including the following security parameters:

- An access policy that defines access rights and privileges of users in the network. The access policy should provide guidelines for connecting external networks, connecting devices to a network, and adding new software to systems. An access policy might also address how data is categorized (for example, confidential, internal, and top-secret).
- An accountability policy that defines the responsibilities of users, operations staff, and management. The accountability policy should specify an audit capability and provide incident-handling guidelines that specify what to do and whom to contact if a possible intrusion is detected.
- An authentication policy that establishes trust through an effective password policy and sets up guidelines for remote-location authentication.
- A privacy policy that defines reasonable expectations of privacy regarding the monitoring of electronic mail, logging of keystrokes, and access to users‟ files.
- Computer-technology purchasing guidelines that specify the requirements for acquiring, configuring, and auditing computer systems and networks for compliance with the policy.

Security experts promote the security defense in depth principle. This principle states that network security should be multilayered, with many different techniques used to protect the network. Because there is, a security mechanism can be guaranteed to withstand every attack. Therefore, each mechanism should have a backup mechanism[5].As part of implementing security defense-in-depth, security design should be modular just like the network design. Multiple security methods should be designed and applied to different parts of the network, whether it is the internet connection, the wireless infrastructure, server farms, user services or the remote-access component.

3.5. Developing Network Management Strategies

Network management is one of the most important aspects of logical network design. A good network management design can help an organization achieve availability, performance, and security goals. Effective network management processes can help an organization measure how well design goals are being met in the working environment and adjust network parameters if these goals are not being met. .

Network management also facilitates meeting scalability goals because it can help an organization analyze current network behavior, apply upgrades appropriately, and troubleshoot any problems with upgrades.

Most clients need to develop network management processes (it also true for the team network project) that can help them manage the implementation and operation of the network, diagnose and fix problems, optimize performance, and plan enhancements. The International Organization for Standardization (ISO) defines five types of network management processes, which are often referred to with the FCAPS acronym:

- **Fault management**: refers to detecting, isolating, diagnosing, and correcting problems. It also includes processes for reporting problems to end-users and managers, and tracking trends related to problems. In some cases, fault management means developing workarounds until a problem can be fixed. Monitoring tools are often based on the Simple Network Management Protocol (SNMP) and Remote Monitoring (RMON) standards.
- **Configuration management**: helps a network manager keep track of network devices and maintain information on how devices are configured. With configuration management, a network manager can define and save a default configuration for similar devices, modify the default configuration for specific devices, and load the configuration on devices. It also lets a manager maintain an inventory of network assets and do version logging. So, we will document every configuration that is implemented on the network and prepare a configuration manual and guideline for the proposed network.
- **Accounting management**: facilitates usage-based billing, whereby individual departments or projects are charged for network services. Even in cases in which there is no money exchange, accounting of network usage can be useful to catch departments or individuals who "abuse" the network. The abuse could be intentional or unintentional.
- **Performance management**: allows the measurement of network behavior and effectiveness. It includes examining network application and protocol behavior, analyzing reachability, measuring response time, and recording network route changes. It facilitates optimizing a network, meets service-level agreements (SLA), and planning for expansion.

- **Security management**: lets a network manager maintain and distribute passwords and other authentication and authorization information. It includes processes for generating, distributing, and storing encryption keys. It can also include tools and reports to analyze a group of router and switch configurations for compliance with site security standards. It is a process for collecting, storing, and examining security audit logs. Network management tools should provide an intuitive user interface that can react quickly to user input. In many cases, having both a browser interface and a command-line interface (CLI) is beneficial.

CHAPTER FOUR

4. PHYSICAL NETWORK DESIGN

The college has ground plus three buildings and four independent blocks and a total of sixty-one rooms. Taking into consideration the current user environment of each room and the future expansion plan, the design team has calculated:

- The maximum number of nodes and their location for each room.
- The cable path for backbone and horizontal cabling.
- The location and the total number of devices used and types of access switches, servers and required communication media.
- The physical topology of an internetwork is described by the complete set of routers and the networks that connect them. Networks also have a logical topology.
- Different routing protocols establish logical topology in different ways.

The college has multiple interconnected buildings academic building, laboratory (workshop building), library and Main Hall, data center and administration; that will be networked to each other. In academic building needs around 100 nodes, for laboratory 70 nodes, administration building 70 nodes, library 50 nodes, and in data center also needs 15 nodes. Totally the college needs around 325 nodes containing computers, servers, printers, iPhone etc.

PHYSICAL DESIGN DESCRIPTION

Infrastructure works of Agena CIC, consisting of UTP, Fiber optic cable and the following details. Connecting the data center to the different buildings (blocks) using fiber optic & UTP cable. The blocks are the following:

1. B1 Data center Building
2. B2 Administration Building
3. B3 Academic staff Building
4. B4 Workshop Building
5. B5 Library & Versatile Hall Buildings and,
6. Class Room Buildings

Data center description

The college needs to have different kinds of servers for different utilities. These are File Server or archive server, DNS server, Web server and DHCP server at the Server Room.

The server pool at the server room will require a centralized server UPS when it becomes functional and Redundant UPS for the core switch and also UPS for each Access switch and PC's are needed. The college requires to have a sufficient number of centralized Diesel Generator for the future. From the standpoint of internetworking devices, dual power systems can prevent otherwise debilitating failures.

Some backbone-in-a-box routers can address this requirement by providing redundant power systems. In addition, many sites connect one power system to the local power grid and the other to an uninterruptable power supply. If router power fails, the router can continue to provide connectivity to each connected network.

General power outages are usually more common than failures in a router's power system. Consider the effect of a site-wide power failure on the redundant star and meshed topologies. If the power fails in the corporate office, the organization might be seriously inconvenienced. Key network applications are likely to be placed at a centralized, corporate location. The organization could easily lose revenue for every minute its network is down. The meshed network configuration is superior in this case because links between the remote offices would still be able to communicate with each other.

In data center room, air conditioner will be instaled and non interruted power will be ensured through UPS and stand by advanced generator. All the servers and many core layer switches will be placed in this room. Thus the data center room may contain, Core switches all necessary Smart UPSs, Distribution switch etc.

- College and department servers:-delivers file, print and DNS services to workstations in the building module.
- Core switches: -provides layer 3 services to the servers and inspects data crossing the server module with NIDS.
- Distribution Switch
- Access Switch
- All necessary Smart UPSs
- All necessary patch panels and fiber termination boxes
- Two medium size air conditioner (cooler) outside to the IT room as well as in the room.

- Wall-mounted rack, 9 U and Cabinets
- Multi-mode Fiber optic backbone coverage for administrator building

How the college design a data center will have a direct impact on two major performance metrics, downtime and energy consumption. These both features impact the long term viability of a data center. The situation, service providers must guarantee system uptime of 100 percent to remain competitive in today's business.

In terms of energy usage, efficiency is the primary goal. Since power contributes most to overall operating costs, power campus must design a data center with the lowest possible energy consumption. Efficient use of not only lowest costs, but helps achieve the green initiatives of the data center operator. The data center will also be better positioned to comply with any future energy regulation. Ways of data center designing to meet these two vital systems are 4 methods.

1. **Forming the team**: - assemble a multi-disciplined team of architects, technical consultants, mechanical engineers and electrical engineers to design a data center. The design team must be able to handle the complete project scope including the permitting process.
2. **Planning the design**:- The campus has greatest potential to affect the data center performance levels. The design must integrate complex components such as power, cooling, security, monitoring, fire suppression, mechanical and electrical systems, equipment specifications' and more.
3. **Selecting the site:-** is a crucial decision during data center design.

Server farm

Server farms are typically located in computer rooms and data center. Managing and securing numerous distributed servers at various locations within a business network is difficult. Recommended practice centralizes servers in server farms.

We use centralized server farm. Because it has the following benefit:

- Network traffic enters and leaves the server farm at a defined point. This arrangement makes it easier to secure, filter, and prioritize traffic.
- Load balancing and failover can be provided between servers and between networking devices.
- The number of high-capacity switches and security devices is reduced, helping to lower the cost of providing services.

Administrative Building

- Horizontal cabling includes Cat 7 UTP cable to 70 nodes

- 48-port Access switches
- 48-port switch patch panels
- Fiber termination box
- Wall-mounted rack, 9 U
- 1KVA Smart UPS
- Multi-mode Fiber optic backbone coverage for administrator building,

Academic building

The Academic building has multipurpose building interconnected blocks and almost all the staff member of the college are within this building. This building is constructed with having down steep class for many useful purposes.

So the requirements of switches, cables, and other related IT equipment's to this building are the following:

- Multi-mode Fiber optic backbone coverage from other 2 building,
- Horizontal cabling includes Cat 7 UTP cable to 100 nodes.
- Cat 7 UTP and Multi-mode fiber optic cables.
- 100 outlets for 70 end user and 30 outlets for the next converged network or growing future of the users.
- Racks, jacks, panels, and others there in this building in proportion to our users.
- Electrical power cable.
- 48-port patch panels and Fiber termination box
- Smart UPS 7 which are used on ground floor

Workshop Building

This building is the campus students' lab class which has all 4 classes are reserved for computer laboratory and internet service.

The requirements of laboratory building consist of the following.

- Horizontal cabling includes Cat 7 UTP cable to 50 nodes
- switches (two - 48 port switches)
- 48-port switch patch panels,
- Fiber termination box
- 4 U rack
- 1KVA Smart UPS
- Multi-mode Fiber optic backbone coverage from Class Room building

- Wireless Access point

Library & Versatile Hall Building

The main purpose of the library building is to give booking service for student, so it may not have many computers except for master's students and librarian in the underground.

- Multi-mode Fiber optic backbone coverage from administrator building,
- Horizontal cabling includes Cat 7 UTP cable to 50 nodes
- 48 port Access switches
- 48-port patch panels.
- Fiber termination box
- Wall-mounted rack, 3U
- Smart UPS
- Wireless Access point

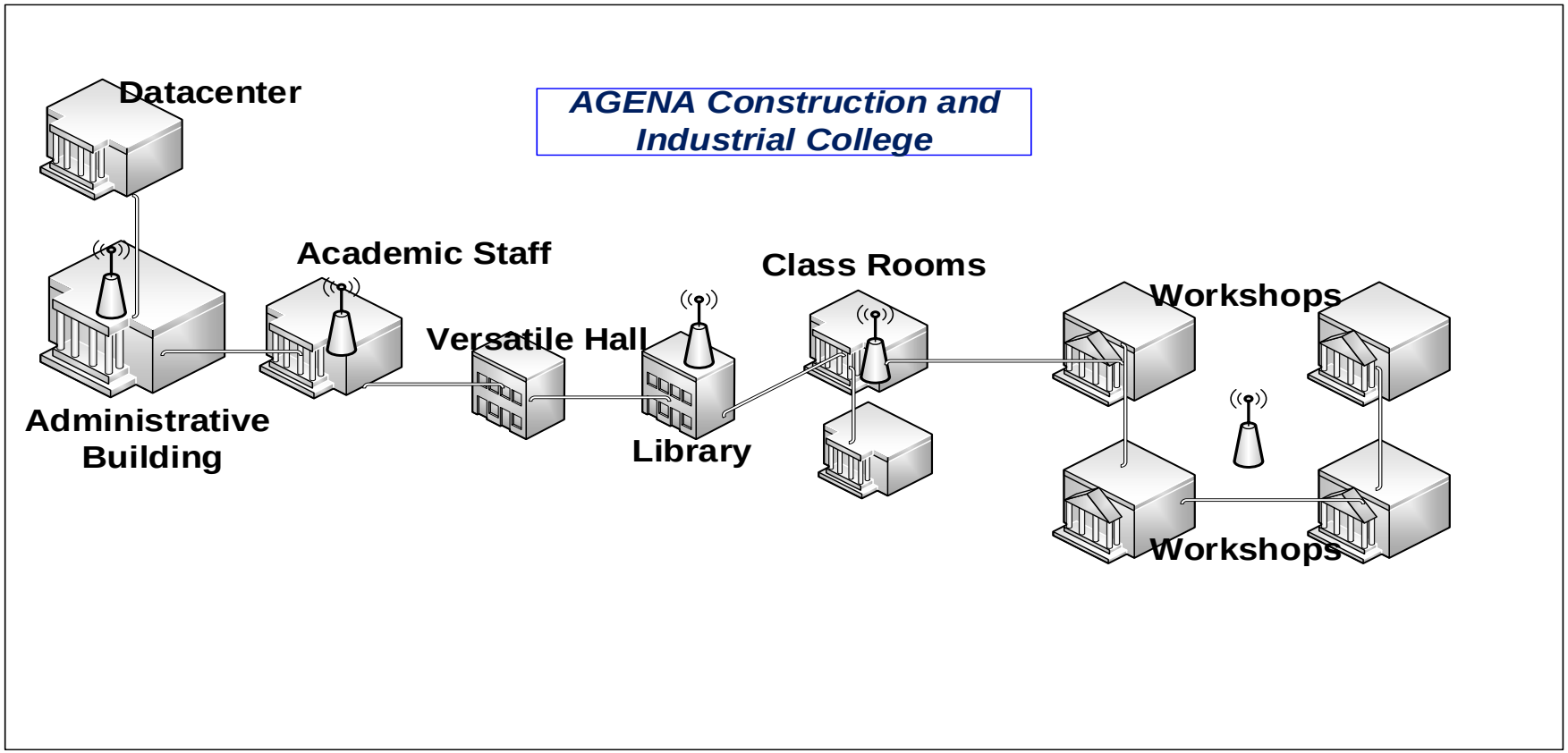

Figure 6. General Building Architecture of the Agena CIC

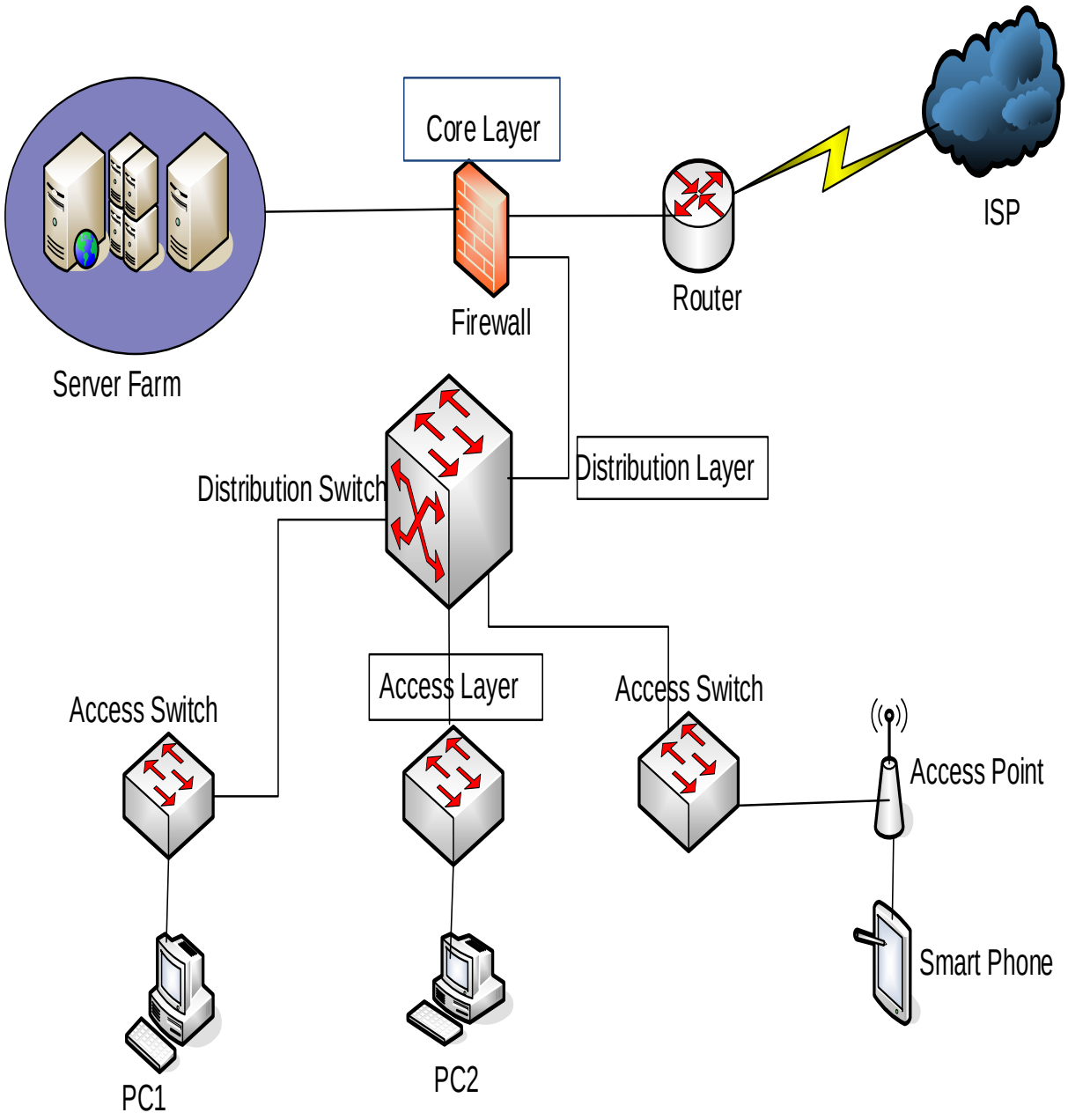

Figure 7. Conceptual Physical Network Design for Agena CIC

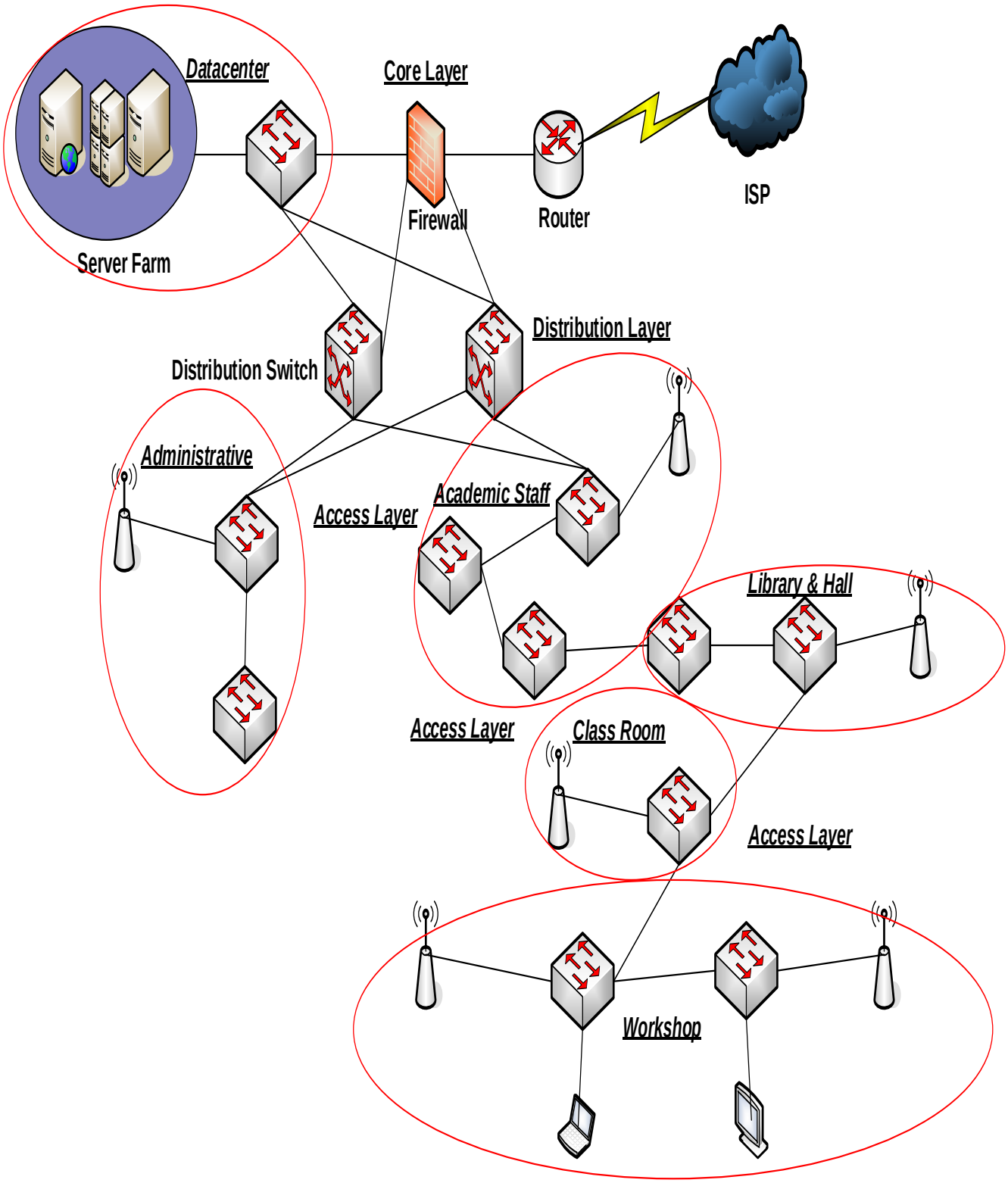

Figure 8. Detail Physical Network Design for Agena CIC

The explicit topology in a hierarchical scheme takes precedence over the topology created through addressing. If a hierarchical routing protocol is used, the addressing topology should be assigned to reflect the hierarchy. If a flat routing protocol is used, the addressing implicitly creates the topology. There are two recommended ways to assign addresses in a hierarchical network. The simplest way is to give each area (including the backbone) a unique network address. An alternative is to assign address ranges to each area.

CORE LAYER: - provides a fabric for high-speed packet switching between multiple aggregation devices. It serves as the gateway where all other modules meet, such as the WAN edge. Core layer devices have the following features:

- Layer 3 support
- very high forwarding rate
- Gigabit Ethernet
- Redundant components
- link aggregation
- quality of service

DISTRIBUTION LAYER: -Many times the distribution layer is doing inter- Vlan routing for the access switches with Layer 3 connection to the core. It really can depend on the design. Distribution layer devices have the following features:

- Layer 3 support
- High forwarding rate
- Gigabit Ethernet/1 Gigabit Ethernet
- Security policies /access control list
- Link aggregation
- Quality of services (QoS)
- Load balancing
- Network Management policies
- Network distribution
- Connect the core and the access layers
- Bandwidth management
- Redundant components
- Support Redundancy

ACCESS LAYER: - access Layer switches facilitates the connection of end node devices to the network. This layer includes switches. This layer is also called the desktop layer because it focuses on connecting client nodes, such as workstations to the network. This layer ensures that packets are delivered to end user computers.

Access layer Switch has the following features:

- Port security
- VLANs
- Gigabit Ethernet

Power over Ethernet:

- Link aggregation
- Quality of service

4.1. LAN Cabling Plant Design

When installing or servicing structured cabling, our team checks conduit bends, pull boxes and joints to verify that the bend radius is optimal. Structured cabling pulls through tightly bent elbow fixtures are always back-fed. Where raceway or rack transitions expose cable, flexible conduit is recommended for protection.

At the physical layer, the design team recommends CAT 7 full copper UTP cable to be used since every node is within no more than 75–meter radius and the TIA/EIA-568B/568A standard for straight-through layout and connection of wiring schemes.

Infrastructure works of Agena CIC, consisting of UTP, Fiber optic cable and the following details. Connecting the data center to the different buildings (blocks) using fiber optic & UTP cable.

In the network design and implementation project, one of the main network equipment is cable and so we give a special focus in cable installation and design.

Cable Construction:

The college has 10 buildings and four blocks of which the four blocks 300-350 meters from the Datacenter office and it has within the different LAN structures. The future requirement has been made according to the proposed plan situated at the college. All buildings and blocks would be connected to the server room with single-mode fiber optics or cat 5e full copper cable.

CAT 7: works like Cat5 and Cat6 but include an upgrade that reduces crosstalk (bleeding of signals due to induction, slowing network transfer speeds) and can support gigabit Ethernet (1GBASE-T) - networks running at 1Gbps - rated at 350Mhz, making it well suited for networks planning to upgrade to gigabit Ethernet.

The installed cable must be manufactured to meet or exceed the following specifications:

4.2. Cabling Topologies

When choosing a Topology, consider the Network you'll need:

- **Cable type:** twister pairs, coaxial or optical fiber cables each carry different levels of IT and telecom data.
- **Length of cable needed:** physical impediments and type of cable impact the length of the run.
- **Scalability**: if you think you'll need to upscale your network, you'll want to choose an infrastructure that allows you to add nodes (points of entry and integration) with minimal disruption. You may want to explore the upside of conducting a Site Survey.

4.3. LAN Technologies

We will be used Gigabit Ethernet Star & Mesh (Hybrid) topology.

Star Topology | in this network configuration, every device is directly connected to the central point/server (responsible for managing data and transmission) and indirectly connected to every other point in the network. Network connections are made using a coaxial cable, twisted pair, or optical fiber cable.

Mesh Topology| in this network configuration, every device is directly connected to each other in a redundant link. So, it is a big favorite for failure management and reduction. But, it needs need a high cable consumption and it need a high cost when we compare it with Star Topology.

Mesh Topology will implement on the distribution layer and it connect the distribution switch each other by a redundant link and also it connect this layer with core layer devices, datacenter access switch, academic and administrative access switches in a redundant link. So, fully supports the redundancy of cable links, network devices and the Network itself.

The Star Topology is a big favorite for its cable conservation, and the fact that workstations can go down or be updated without having to take the whole network offline. While relatively safe from failure, server (or central node) health must be managed for reliability; adding tech cost to your bottom line. But, when weighing the cost of downtime to system-maintenance-costs, the benefits of utilizing a Star Topology often outweigh its financial burden for enterprise businesses.

4.4. Ethernet Technology Choices

We will be used Gigabit Ethernet Star and mesh topology:

- 1 GBPS bandwidth
- Uses same CSMA/CD media access protocol and packet format as in Ethernet
- 1GBaseTX (UTP) and 1GBaseFX(Fiber) standards
- Physical media:-
    - 1GBaseTX: UTP Cat 7
    - 1GBaseFX: Multimode Fiber
- Full Duplex/Half Duplex operations

Wireless Access Point (Device) and Technologies choices

A wireless access point is comprised of one 4-pair Category 7 twisted pair data cable (violet). The location will typically be located above the drop ceiling when possible and terminated in a typical surface or flush mounted jack. The cable will be terminated, tested. The locations for these cables and access point shall be determined by us. So we identify the location for deploying an access point.

These access point locations have been selected on the basis of coverage, WLAN bandwidth, channel reuse, cell-to-cell overlap, security, aesthetics, and deployment feasibility. Based on the above criteria the following location selected:

- Class room: for instructors and students.
- Library: for laptop user student.
- Main Hall building: for users.
- Workshop Building
- Administrative Building
- Academic Staff Building

Wireless Network Connectivity:

- It Shall be secure in accordance with Statewide Standard P800-S830, Network Security; use encryption technologies; be protected using Virtual Private Network (VPN) and firewalls, as necessary; and be compliant with IEEE 802.11x (Wireless Local Area Network (WLAN)), Statewide Standard P800-S830, Network Security, describes minimum requirements for providing secure and seamless interconnection of communication networks and systems.
- Statewide Standard P800-S850, Encryption Technologies, describes minimum requirements for ensuring the authenticity, integrity, confidentiality, and reliability of digital information.
- Security is being addressed in the transmission layer with the IEEE 802.11i standard and at the IP applications layer with standards- and policy-based authentication and access control. The Wired Equivalent Privacy (WEP) algorithm, which is part of the 802.11x standard, is susceptible to compromise; therefore, improved security methods should be considered. The Wi-Fi Protected Access (WPA) standard and Protected Extensible Authentication Protocol (PEAP) with the IEEE 802.11x Network Port Authentication standard provides interim, improved security until approval and widespread adoption of 802.11i.

4.5. Selecting Internetworking Devices for College Network Design

The college needs to have a multi-service router at the Server Room for WAN connectivity. This multi-service router will be connected to the MPLS cloud through a Fiber link and secondary wireless link to provide wired and wireless connectivity respectively. It is also connected to server farm switch through the firewall and the server farm switch is directly connected to the servers. The core switch will be connected to the Ethernet port of the router through the firewall.

Table 7. Selected Internetworking Devices and Bill of Quantity

AGENA CIC Internetworking Devices and Bill of Quantity																	
Block	**No of Nodes**	**No of RJ-45**	**No of Cable(Roll)**	**No of Rack**	**No of Access Switch**	**No of Server**	**No of Core switch**	**No of wall outlet**	**No of Patch Panel**	**Cable manager**	**Trunk(60x40)**	**Server UPS**	**UPS for Access Switch**	**Router**	**Firewall**	**Wireless Access point**	**Air conditioner**
Academic	100	-	-	**3**	**5**	-	-	-	**3**	**3**	-	1	**3**	-	-	**1**	-
Library&	70	-	-	**1**	**3**	-	-	-	**1**	**1**	-	-	**1**	-	-	**1**	-
Administrative	50	-	-	**1**	**3**	-	-	-	**1**	**1**	-	1	**1**	-	-	-	-
Workshop	50	-	-	**1**	**3**	-	-	-	**1**	**1**	-	-	**1**	-	-	**1**	-
Class room	30	-	-	**1**	**2**	-	-	-	**1**	**1**	-	-	**1**	-	-	-	-
Datacenter	15	-	-	**1**	**1**	**2**	**2**	-	**1**	**1**	-	**1**	**1**	**1**	**1**	-	**2**
Total	**315**	**1260**	**20**	**8**	**17**	**2**	**2**	**300**	**8**	**8**	**500**	**4**	**8**	**1**	**1**	**3**	**2**

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Agena Construction and Industrial College is one of the TVET college that has a limited network infrastructure and which is done some works and activities manually. By considering the problems of the manual system and limited network infrastructure, our team found solution which reduces the problems of the existing system. With the contribution of each member of the team, and advisor in developing the new system from starting of data (requirement) analysis to the implementation & configuration, we reached to the final result. During the implementation this project, team face some challenges, but by the cooperation's of all team members reach to their goal and come with this new project.

On this project, we design and configure an advanced local area networking for AGENA Construction and make the network distributed and covers more area and give service for many users as much as possible.

Generally, based on the existing network problems the team will find a proposed solution which solves some problems of the existing network. Like it decreases time consumption, energy consumption, resource loses during processing browse internet and doing internal and external activities in manual system and available network.

5.2. Recommendation

Due to shortage of time and some other condition like resources we do not include some services and network configurations to the Simulated LAN. The team wants to recommend those who wants further work on our project like adding Voice over IP, Video conferencing, Email service…etc. The other things we recommend to be added to in this project are automation systems that are run on the proposed network infrastructure.

References

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[3] P. K. Patil, P. Gaikar, S. Adke, and R. Bhawar, "College Campus Network Design and Security," pp. 1374–1378, 2018.

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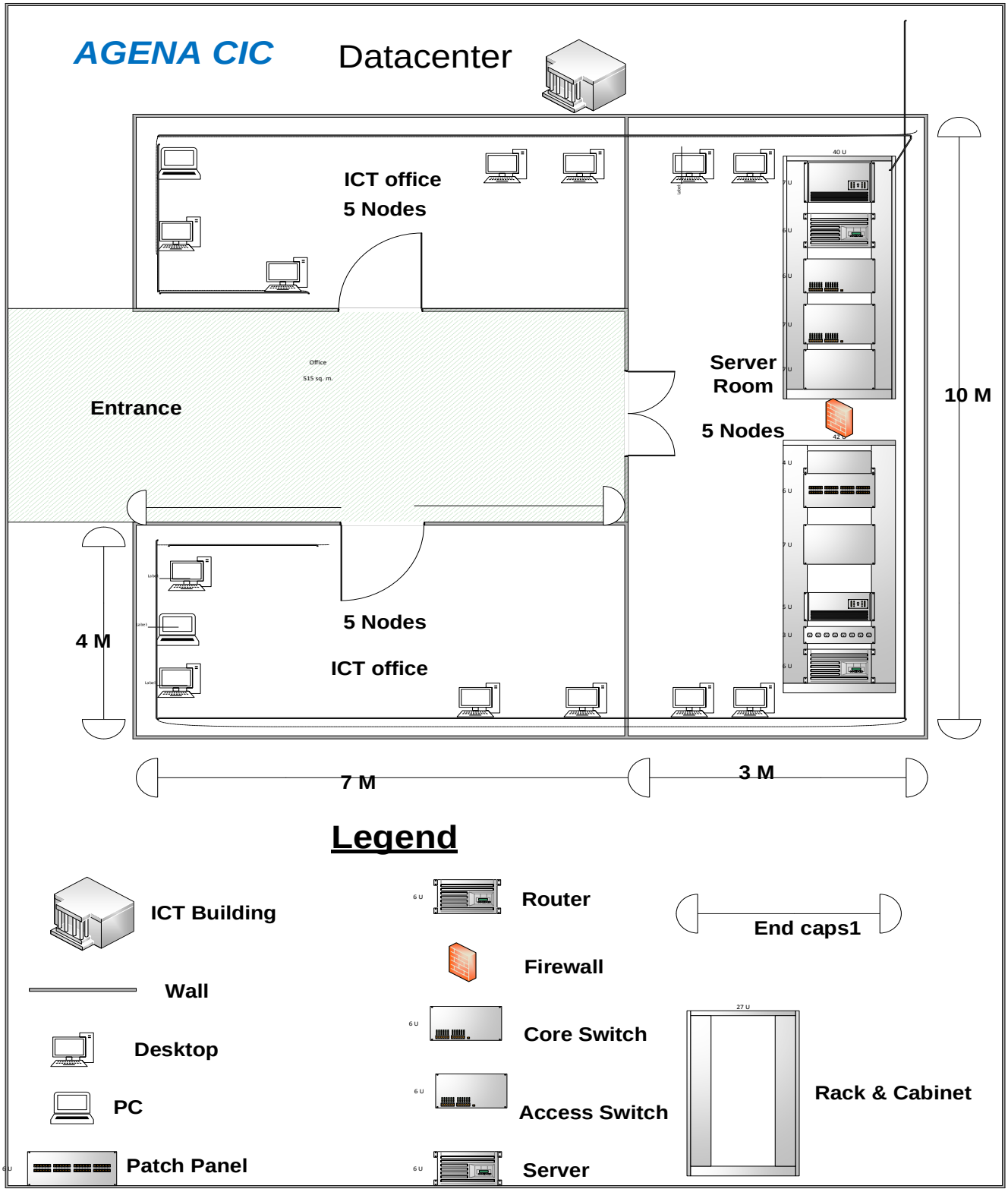
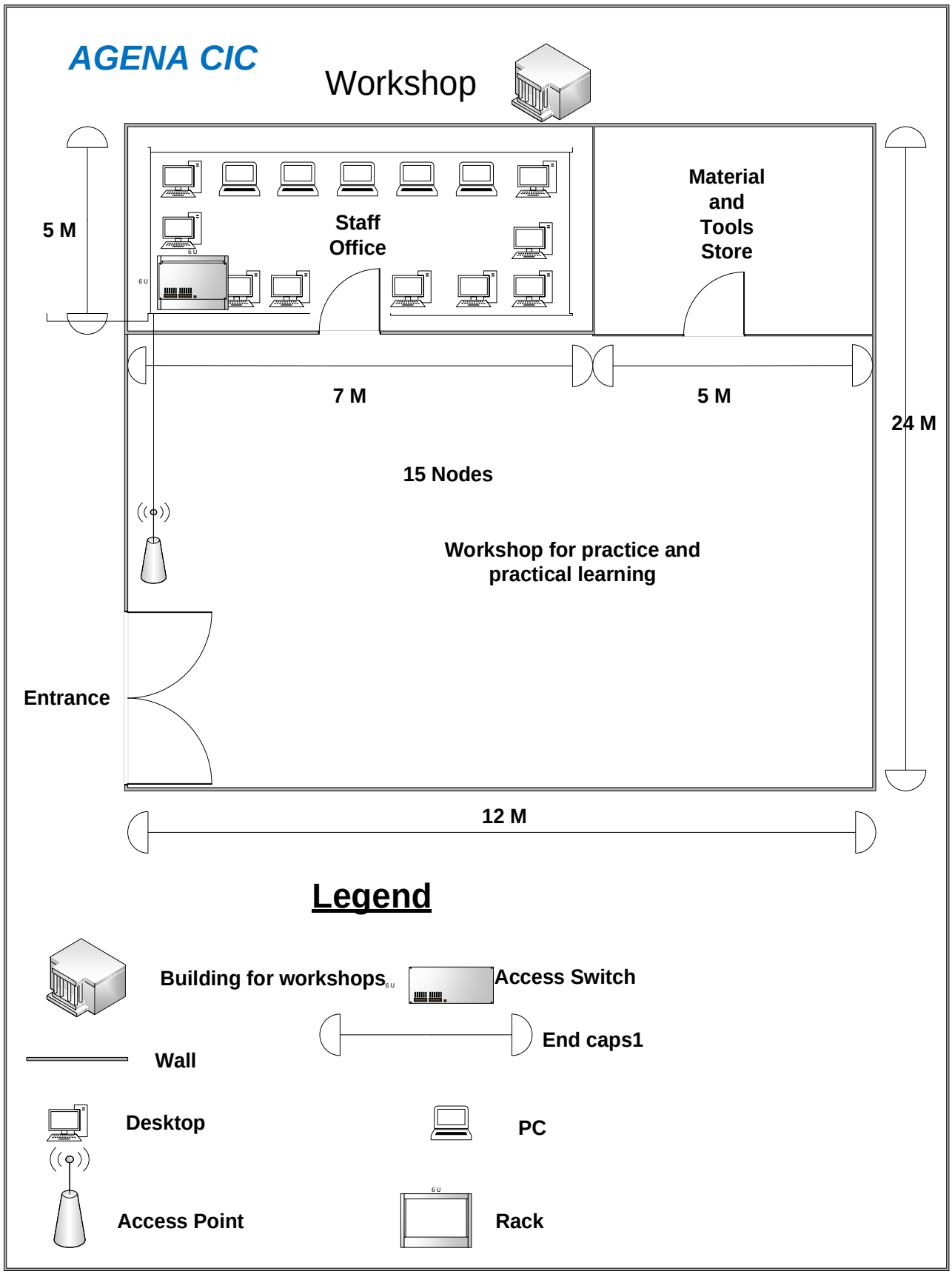
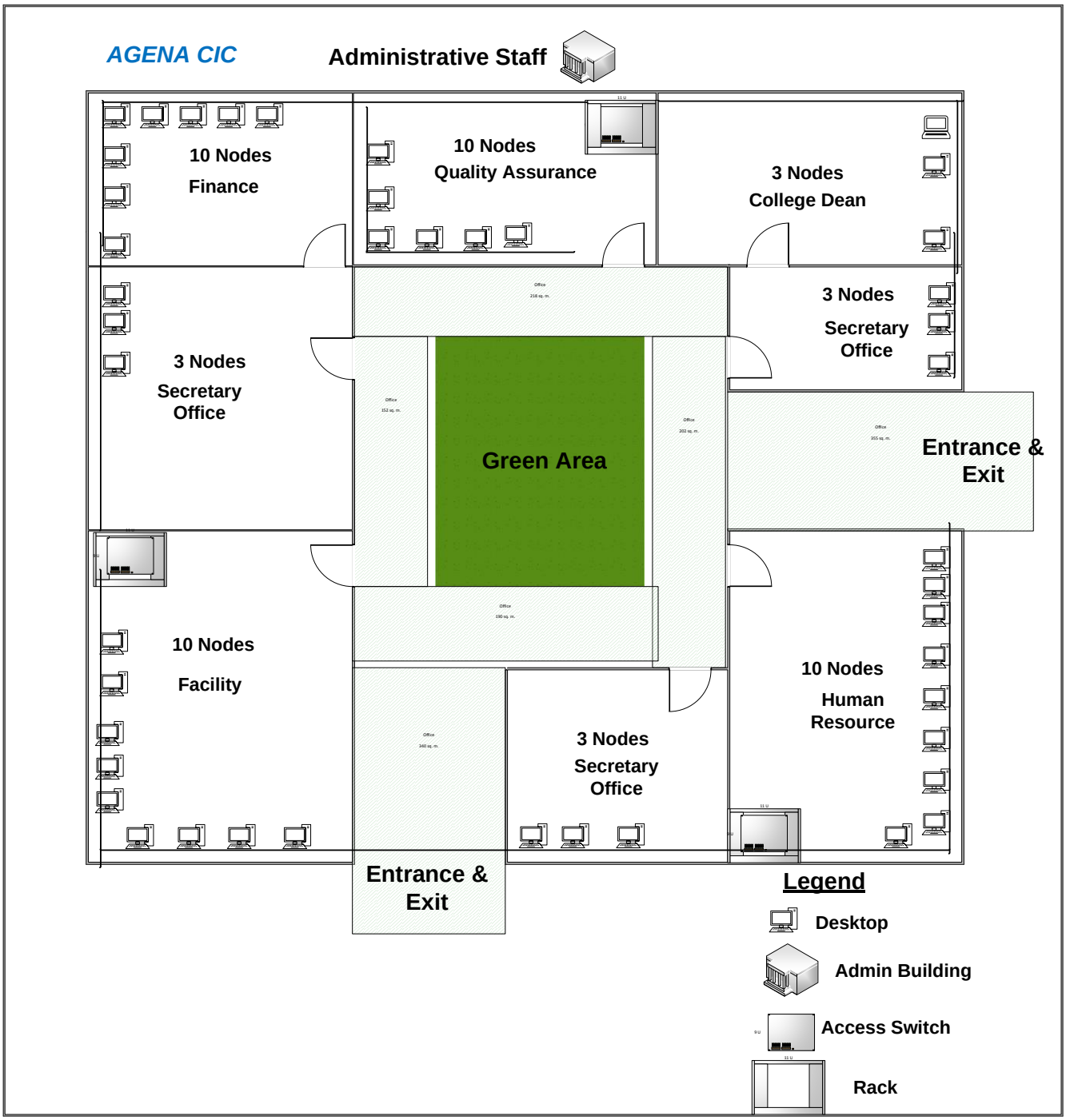
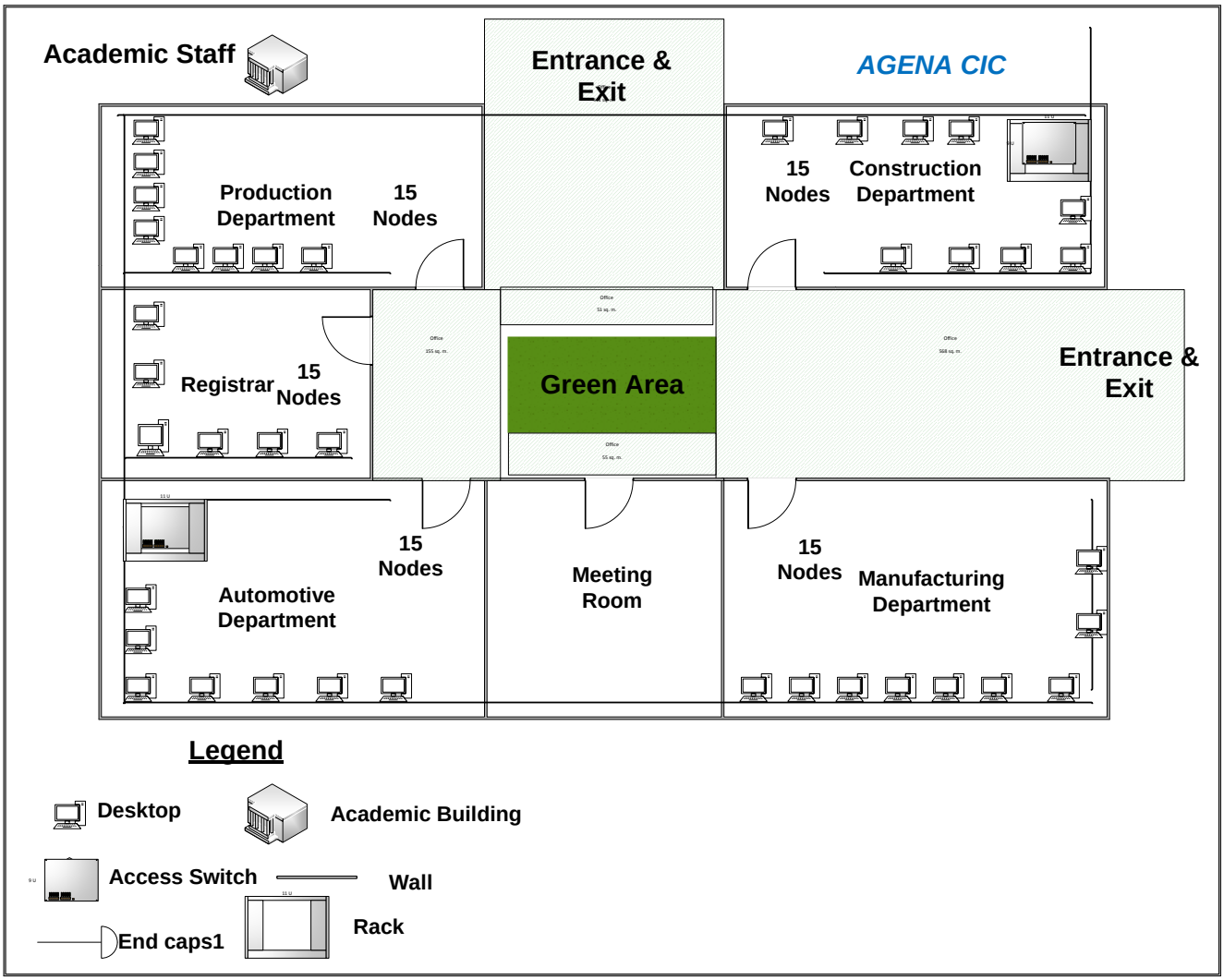
Appendix A: Physical Design Layout of the Agena CIC LAN




AGENA CIC
Workshop
5 M
Staff
Office
Material
and
Tools
Store
7 M
5 M
24 M
15 Nodes
Workshop for practice and
practical learning
Entrance
12 M
Legend
Building for workshops
Access Switch
End caps1
Wall
Desktop
PC
Access Point
Rack


AGENA CIC
Administrative Staff
10 Nodes
Finance
10 Nodes
Quality Assurance
3 Nodes
College Dean
3 Nodes
Secretary
Office
3 Nodes
Secretary
Office
Green Area
Entrance &
Exit
10 Nodes
Facility
10 Nodes
Human
Resource
3 Nodes
Secretary
Office
Entrance &
Exit
Legend
Desktop
Admin Building
Access Switch
Rack


Academic Staff
Entrance & Exit
AGENA CIC
Production Department
15 Nodes
15 Nodes
Construction Department
Registrar
15 Nodes
Green Area
Entrance & Exit
15 Nodes
Automotive Department
Meeting Room
15 Nodes
Manufacturing Department
Legend
Desktop
Academic Building
Access Switch
Wall
End caps1
Rack