Thesis Paper

On

IT Infrastructure for Economic Zone

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Abstract

The simultaneous growth of different businesses has led to some outstanding initiatives such as Economic Zones(EZ). The government and non-government organizations are building such zones in distinct areas to attract different foreign investors to invest and make the economy of the country strong. Bangladesh is a leading developing country with a lower middle income and there is around forty-seven Economic Zones are being developed by both government and private organizations. To attract the Foreign Direct Investment (FDIs), to make the Economic Zone persuasive to different international organization we need to modernize and make the Economic Zone world class. In addition, to make the Economic Zones world class we need a proper IT infrastructure or information system, therefore, we are going to create a blueprint on how to construct a standard Information Technology Infrastructure for EZs. In order to construct the blueprint, we will propose how to design hierarchical switched Local Area Network(LAN) and data center, configuration of wireless connection with appropriate Wide Area Network(WAN) technology, IP surveillance system and proper networking security system.

Declaration

We hereby declare that this report is our own work and effort, which has not been submitted anywhere for any award. All the contents written here is totally based on our labor and findings, dedicated for the completion of our undergraduate thesis. In this paper, we used information from other sources, which have been acknowledged and referred appropriately in the reference section.

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Acronyms and Abbreviations

ASEAN	- Association of South-East Asian Nations
CCTv	- Closed-circuit television
DNS	- Domain Name System
DoS	- Denial-of Service
EZ	- Economic Zone
EU	- European Union
FCoE	- Fibre Channel over Ethernet
FDI	- Foreign Direct Investment
GDP	- Gross Domestic Product
HCMC	- Ho Chi Minh City
HTTP	- Hypertext Transfer Protocol
IMAP	- Internet Messaging Access Protocol
IP	- Internet Protocol
IT	- Information technology
LAN	- Local Area Network
POP3	- Post Office Protocol 3
QoS	- Quality of Service
RMG	- Readymade Garments
SAN	- Storage Area Network
SEZ	- Special Economic Zone
SMTP	- Simple Mail Transfer Protocol

SSH - Secure Shell

STP - Spanning Tree Protocol

UPS - Uninterruptible power supply

VLAN - Virtual Local Area Network

VPN - Virtual Private Network

VSS - Virtual Switching System

WAN - Wide Area Network

WPA - Wi-Fi Protected Access

1 Chapter: Introduction

As developing countries like Bangladesh, Nigeria, Cambodia etc. are trying to build proper business area or district which are known as EZs, to flourish business and attract FDIs. Therefore, these countries need to ensure that they can meet the requirements of proper infrastructure that these growing businesses need. In addition, one of the most important thing they need to make sure that they have a proper Information Technology infrastructure because information and communication are the most important requirement of 21st century. In this paper, we are trying to design an implementable IT infrastructure so that these countries can have a proper reference, when they are building their own infrastructure.

1.1 What is Economic Zone

The number of population is increasing day by day. With this increment, businesses are also expanding and initiating new ideas. Typically, the business organizations and industries are geographically located in different places depending on their production. For example, textiles mills are in different areas, garment factories are in other places, food production factories are in different places, automobile companies are in distinct places along with residential and other organizational areas. But there was no such area which is dedicated only for economic production and business, which is situated in a particular location of the nation and business rules and regulations there are different from the rest of the nation, these kind of business areas are called Economic Zones.

There are five different kinds of EZs and they are: Industrial Park (IP), Special Economic Zone (SEZ), Eco Industrial Park (EIP), Technology Park (TP), and Innovation District (ID). The idea of EZ appeared from late 1950s in industrial countries. The term was introduced as Special Economic Zone(SEZ) then. The Special Economic Zone is an area which is typically located in country's national border and the trade rules or laws are different here from the other parts of the country and the purpose of such zones include increment in trade and investment, job foundation and effective administration.

Being in an economic zone a company gets the benefit of producing and selling products in a lower price and can remain globally competitive. Shenzhen Special Economic Zone was one of the first in china which stimulated the foreign direct investment and caused rapid industrialization in that region. Since then many economic zones have been built in many countries around the world including Vietnam, Myanmar, India, Europe, Indonesia and so on. In Bangladesh, there are some EPZs but Economic Zone is a very new idea here. Bangladesh govt. has decided to build some EZs publicly and also privately to increase facilities of doing business in Bangladesh.

1.2 Problem Definition and Motivation

There are no appropriate research papers on how to build or design IT infrastructure or networking infrastructure for an EZ. However, developed countries like USA, China, Japan, UK etc. have strong networking backbone for their EZS but information about their IT infrastructures are not public or available. There is no EZ how are willing to share information about their infrastructure design and how they implemented them. Together with that, if any country wants to build proper infrastructure for their EZs, they won't find any information to work with and will have to pay some consultancy firm from the very beginning. Therefore, we are trying to design an implementable IT infrastructure for these new EZs so that they can have the initial idea to work with their own infrastructure.

1.3 Methodology

To create the design, we decided to divide our works in small parts, so that, we can finish in time and make every component workable and integrate the whole system together. In order to do that, we first tried to find out the problems and what our solution going to be. To decide those, we had to go through many papers, articles, journals and books. After that, we tried to find out which switches, routers, cables, applications, servers we need according to our requirement and then we designed the LAN design for individual office. In addition, we had to decide how much bandwidth EZs may need and how much they may get. Together with that we designed the LAN design of the data center, cooling and power of data center, how to integrate IP surveillance system, WAN technologies we need. To end with, we have done some analysis based on cost of equipment because one of the most important constraints for setting up IT infrastructure in a developing county is cost.

2 Chapter: Literature Review

When we started, we had very little idea about EZ and we had to know properly what is EZ and how it works. After that, we tried know about the infrastructure that a good EZ require. For that reason, we read about some EZ from Vietnam and China. Though we learned about EZ and how it operates, we could not find any information about their IT infrastructure related information. As we already mentioned that there is no full paper or research on how to design or build IT infrastructure for EZ, we could not find any full structured reference. Therefore, we had to divide our work and search for how to design or implement that particular component. We started searching for solution step by step and to do that we first needed to know about EZ and requirement we need to fulfill.

2.1 Understanding Economic Zone

EZ is an area dedicated for business purpose where business and trade laws differ from the rest of the country. According to the World Bank in 2008, the modern day special economic zone typically includes a "geographically delimited area, usually physically secured (fenced-in); single management/administration; eligibility for benefits based upon physical location within the zone; separate customs area (duty-free benefits) and streamlined procedures." [1] The aim of EZ include increased trade, increased investment, job creation and effective administration. Though the concept of EZ is relatively new in Bangladesh, the idea started since 1950. Almost all develop countries have EZ for special purposes and some of them are dedicated for special businesses. To get the proper idea how an EZ work we studied EZs of Vietnam, China and also the situation of ASEAN community. [19]

2.1.1 Economic Zone in Vietnam

With 90 million people and having average age 30 years Vietnam is likely to improve faster than most other developing country. Vietnam has grown to be a developing country since 1986 when sixth party congress declared "DOI MOI" or "Renovation". From then Vietnam has successfully transformed from a centrally-planned economy with heavy bureaucracy and subsidies to a socialist-oriented market economy characterized by strong dynamism and rapidly growing entrepreneurship. Vietnam chose to internationalize its economy in order to transform its economy in 1986. That decision actually brought them where they are now. [17]

Vietnam now has 313 economic zones altogether and of them 292 are industrial parks, 18 special economic zones (3 of which are referred to as export-processing zones and 15 of which are referred to as economic zones) and 3 technology park. Viet Nam divides economic zones into industrial zones, which comprise industrial parks and Export-Processing Zones, economic zones, which are large Special Economic Zones, and technology parks. Most economic zones in Viet Nam are located in the South-East part of the country near HCMC and the Red River Basin near Hanoi. There are three

technology parks in Viet Nam. They are respectively located in Hanoi, HCMC, and Da Nang. The first technology park was established in 1998 in Hanoi. [19]

The concept of industrial park was widely adopted since 2000 as a strategy for economic development and the first economic zone was built in Ho Chi Minh City in 1991. By 2000, there were 61 industrial zones built or in construction, 293 industrial zones were built or in construction in 2010. There are around 2,500,000 persons working in economic zones in Vietnam and that is 2.5% of its whole workforce. By 2014, they were able to attract 5500 FDIs and a total registered capital of $85.5 billion. The total revenue Economic zones pulled together in 2014 was $118 billion, a 18% increase since 2013. By this date the biggest foreign investors in Vietnam are Samsung, Canon. [18]

Special Economic Zones in Vietnam have these following features:

I. The area has the potential to become an industrial hub.
II. They cover an area of more than 10,000 hectares.
III. They consist of free-tax zone and other functional areas such as: IP, EPZ, port, residential complex, commercial areas.
IV. They enjoy a strategic location (proximity to seaports, airport)
V. They host key projects and investment
VI. They are established under a decision of the Prime Minister.

2.1.2 Economic Zone in China

China is one of the leading country in industrial and technological development. It all started, when China introduced open door policy and since the reform in 1978, China's GDP is growing at an average annual rate more than 9 percent. Back then China started free working zones to attract domestic and foreign investments. At that time, China was not considered as a developed country, however, as of 2015 China is the 3rd largest economy in the world after USA and EU and it did not even take them 35 years to be here. According to Zeng (2010), China's meteoric economic rise over the past three decades is an unprecedented "growth miracle" in human history.

Developing EZ in china started since 1980 and the journey started with Shenzhen, Zhuhai and Shantou in Guangdong Province and Xiamen in Fujian Province, and designated the entire province of Hainan as a SEZ. At present time, China has 5 SEZ city, One SEZ province and 14 costal development areas. In addition, 15 free-trade zones, 32 state-level economic and technological development zones, and 53 new and high-tech industrial development zones have been established in large and medium-sized cities. Therefore, a multilevel diversified pattern of opening and integrating coastal areas with river, border, and inland areas has been formed in China. [20]

2.1.3 Economic Zone in Bangladesh

Bangladesh government introduced an ACT in 2010 in order to, establish economic zones in all potential areas including backward and underdeveloped regions. The main purpose of this act is to encourage rapid economic development through increase diversification of industry, employment, production and export. There are currently nine EZs being developed in Bangladesh where five of them are owned by government and other three are owned by private companies. One of the private EZ is owned by Abdul Monem Ltd which has a land of 216 acres.

2.1.3.1 Type of Companies in Economic Zone

RMG is one of the prominent industry in Bangladesh and when we are designing an IT infrastructure, we assumed that there will be RMG industries in those Economic Zone. Together with that there will be food processing companies, pharmaceutical company, chemical industries etc. Here, we are trying to design an IT infrastructure that can help businesses of Bangladesh to grow faster. Like other industries mentioned earlier, IT industry in Bangladesh is growing. According to Basis survey (2015), there are over 1500 IT companies in Bangladesh as of 2015. The main constraints of these industries are proper place to do business and proper infrastructure. As we are going to Develop an IT infrastructure, we think this infrastructure will support those IT companies.

2.1.3.2 Employment Opportunity in Economic Zone

In an EZ there can be many companies and when companies grow, job sectors grow with that. There will be more than million new jobs in Bangladesh in next 10 years because of the development of these EZs. When we are designing the IT infrastructure, our main target is to support these business so that new jobs can be created. Together with that there will be jobs for IT specialists because this infrastructure needs to be deployed. Moreover, software engineers, networking engineers, research analyst may get a place here for specific purposes. Therefore, we can say not only the businesses in EZ will create jobs but also for the EZ IT infrastructure there will be new jobs for engineers, technicians and also admin jobs will be created.

2.2 IT Infrastructure Requirement

The phrase “IT Infrastructure” may implicate just hardware and software components. However, there is another important part which is service and creating business value. In order to, develop IT infrastructure we have to fulfill requirement of all these three categories. Moreover, we have to concentrate on seven major areas to develop a full-scale IT infrastructure. [10]

2.2.1 Computer Hardware Platform

The microprocessor is the heart of any computing device no matter how small or large. In addition, this section includes client machines and server machines, as well as modern mainframes produced by IBM. Blade servers are ultrathin servers, intended for a single dedicated application, and are mounted in space-saving racks.

2.2.2 Operating System Platform

Operating systems are software that manage the resources and activities of the computer and act as an interface for the user. To run the computers and servers we need operating system.

2.2.3 Enterprise and Other Software Applications

Integrating applications into seamless processes across the organization is the goal of enterprise software applications. Customer relationship management and supply chain management systems are the two most popular applications in this category.

2.2.4 Data Management and Storage

Accessing to data and saving them is one of the most important part. For managing this data, we need data center with appropriate storage capacity and SAN.

2.2.5 Networking and Telecommunications Platform

This section includes using Windows server operating systems, Novell, Linux, and UNIX. Nearly all LAN and many wide area networks (WANs) use the TCP/IP standards for networking.

2.2.6 Internet Platform

Internet-related infrastructure includes the hardware, software and services to maintain corporate Web sites, intranets, and extranets, including Web hosting services and Web software application development tools.

2.2.7 Consulting and System Integration Services

Systems used in many medium and large-sized IT infrastructure are so complex that most businesses simply can't manage by an organization. Integration services provided by the likes of IBM, HP and Accenture are necessary to simply keep up with changes. [10]

2.3 Local Area Network

LAN (Local Area Network) is the most important backbone of a network infrastructure. It makes sure the interconnectivity within a network. For every corporate building of an EZ there must be a robust, redundant, secured and efficient LAN architecture. While designing the LAN for the Economic Zone IT infrastructure, we

went through so many research papers and resources but hardly any of them were appropriate EZ IT infrastructure.

2.3.1 LAN Design

In any IT infrastructure and businesses, digital communication with data, voice and video is crucial to perform day to day activities. A proper designed LAN is a must for the network infrastructure. While building a switched LAN architecture that satisfies the requirements of business and organizations, hierarchical network design is found to be more successful and cost effective. Since Economic Zone is a vast place and contains numbers of organizations and companies, we will use the hierarchical network design for our network infrastructure. The number of companies investing in an Economic Zone will be different and lot of verities will be there. So, we are going to need a network infrastructure which is scalable, redundant, manageable, maintainable, well performed and secured. Only a hierarchical network infrastructure can provide these features.

2.3.2 Hierarchical Network Design

The design consists of three discrete layers. Each layer provides specific functions that define its role within the network. This separation makes the network modular. The three layers are Access layer, Distribution layer and Core layer. They are described as follows:

Access Layer: The access layer includes routers, switches, bridges, hubs, wireless access points. This layer interfaces with end devices such as printers, IP phones, PCs to provide access to the rest of the network.

Distribution Layer: The distribution layer aggregates the data received from the access layer switches before it is transmitted to the core layer for routing to its final destination. This layer controls the flow of network traffic and performs routing function between VLANs. VLANs allow us to segment network traffic into different sub-networks. Distribution layer needs high performance switches.

Core Layer: This is the high-speed backbone of the internetwork. This layer is critical for interconnecting between distribution layer switches. High availability and

redundancy is a must here. This area can connect to the internet resources. This layer needs large amount of data forwarding rates.

2.3.3 Hierarchical Network Advantages

The hierarchical network model gives us so many advantages which are required for the EZ IT infrastructure. First of all, it comes with the scalability. The hierarchical network is very scalable. It helps us to replicate design elements as the network grows because of the modularity of design. Expansion is very easy to plan and implement since each instance of the module is consistent. For example, if a network model consists of three distribution layer switches for every fifteen access layer switches, addition of access layer switches is possible until it is cross connected to the three distribution layer switches before it is needed to add additional distributional layer switches to the network topology.

Secondly, there is the redundancy. As network grows, availability becomes very important. We can dramatically increase availability through easy redundant implementations with hierarchical networks. Access layer switches are connected to two different distribution layer switches to ensure redundancy. If one of the distribution layer switches fails, the access layer switch can find another distribution layer switch to forward the network packets to the core. Besides, distribution layer switches are connected to two or more core layer switches to ensure path availability if one of the core layers' switches fails. But in the access layer, redundancy is very limited. Typically, end node devices such as PCs, Printers, IP phones do not have the capacity to connect with multiple access layer switches for redundancy.

Thirdly, the performance of the network is increased in a hierarchical network. Communication performance is enhanced by avoiding the transmission of data through performing or intermediary switches. In most cases, data is sent through aggregated switch port links from the access layer to the distribution layer at almost wire speed. The distribution layer switch uses its capability of high forwarding rates to forward

data to the core layer. No contention of network bandwidth occurs due to the core and distribution layer's high performance.

One of the significant benefit of hierarchical network model is it provides necessary security for the network. Access layer switches have the option to be provided various port securities to control which devices are allowed to connect to the network. There is the flexibility to use more upgraded security policies at the distribution layer. We can enforce access control policies that define which communication protocols are applied on the network and where they are permitted to go. For example, if I want to restrict the use of FTP to a specific user community connected at the access layer, I can apply a policy to restrict FTP traffics at the distribution layer.

Manageability is another feature of hierarchical network. Manageability is relatively easier. Each layer of the design performs specific functions that are consistent throughout the layer. Deployment of new switches is simpler and if I want to change the functionality of an access layer switch, I could repeat that change across all the access layer switches in the network. Hierarchical network is modular in nature and it is easily scalable. So, they are very easy to maintain. Maintainability becomes much more complex with other network topological solutions as the network grows. Besides, it becomes expensive too. [8]

2.3.4 Features of Switches for LAN

Switches are the most important components of a LAN. Selecting appropriate switches for the LAN is a challenging job. Different layers of the hierarchical network require different switches with different features.

Access layer switches facilitate the connection of end node devices to the network. For this reason, they need to support features such as port security, VLANs, Fast Ethernet/Gigabit Ethernet, Power over Ethernet (PoE), Link aggregation and Quality of Service (QoS). First of all, port security allows the switch to decide how many specific devices are allowed to connect to the switch. All Cisco switches support layer

security and port security is applied at the access. Secondly, VLANs are used to separate the network logically according to the requirements, although the physical location of the network devices might be the same. Access layer switches allow us to set the VLANs for the end node devices on the network. Thirdly, port speed is also a characteristic we need to consider for access layer switches. Based on the performance requirements we must choose between Fast Ethernet and Gigabit Ethernet switch port. Considering the IT infrastructure of the Economic Zone, analyzing all the switches of Cisco series, we will use Catalyst 3750 switches for the access layer. Link aggregation is another feature that is common to most access layer switches. This allows switch to operate multiple links simultaneously as a logically singular high bandwidth link. Access layer switches take advantage of link aggregation when aggregating bandwidth up to distribution layer switches. Last but not the least, in a converged network supporting voice, video and data network traffic; access layer switch needs to support QoS to maintain the prioritization of traffic. QoS needs to be enabled in access layer switches so that for example, voice traffic gets the priority over the data traffic.

Distribution layer switch features include, High Forwarding rate, Gigabit Ethernet/10 Gigabit Ethernet, Redundant Components, Layer 3 support, Link aggregation, QoS and Security Policies/Access Control Lists (ACLs). First of all, distribution layer switch needs high forwarding rates because it has to forward all the network traffic of access layer of different networks to the core layer. Secondly, layer 3 functionalities are needed in distribution layer switches because of the advanced security policies that can be applied to the network traffic. Access control lists filter the network traffic inside and outside of the network. An access control list prevents certain network traffics and permits others. It is very important that the distribution layer switches support redundancy for adequate availability. Loss of connection in distribution layer can have significant impact on the rest of the network, since all access layer data pass through the distribution layer switch. Besides, distribution layer switches have to support link aggregation since access layer switches use multiple links to connect to a distribution layer switch to ensure adequate bandwidth to accommodate the traffic generated on the access layer and provide fault tolerance in case a link is lost. Lastly, the distribution

layer switches have to support QoS to prioritize the traffic coming from the access layer switches. Priority policies ensure that the traffic which had been given priority, get the adequate bandwidth.

Core layer switches need to be featured with Layer 2 Support, Very High Forwarding Rate, Gigabit Ethernet/10 Gigabit Ethernet, Redundant Components, Link Aggregation and QoS. Since, core layer switches are responsible for handling the majority of data on a switched LAN. First of all, the core layer of a hierarchical topology is the high-speed backbone of the network because all the data of different distribution layer come to the core layer to be forwarded to the rest of the networks. So, redundancy is the another most important features in the core layer, that is if one link fails to forward data it should find another link to be forwarded to the other networks and to the internet. Link aggregation and Quality of service are other two important features while designing the network for the core layer.

2.4 Data Center Design and Requirements

A data center is a facility used to house computer system and associated components, such as telecommunications and storage. The purpose of a data center is to provide operational, network, sever, computing and storage infrastructure for IT services, with sufficient, scalable capacity to operate these services, using converged network technology (Ethernet, Fiber Channel, Fiber Channel over Ethernet), virtualization of servers, and shared physical infrastructures. Data center often requires extensive redundant or backup power supply systems, cooling systems, redundant networking connections and policy-based security systems for running the enterprise's core applications. Data center security involves ensuring the reliability of both the connections to the data center as well as the mission-critical information contained within the data center's storage. To build a large-scale data center, it may need as much as electricity as a small town. Data center is one of the most important parts of building a large-scale IT infrastructure. While designing an IT infrastructure for an Economic Zone, we need to think how design a Data center for it. There is some existing design for data centers by some big companies. [16]

2.4.1 Storage Infrastructure

Almost all the organizations have to face difficulties solving the problem of growing amount of data storage of the organization and a Storage networking is the key to solve this problem. Centralized storage reduces the amount of disk space trapped on individual server platforms and eases the job of providing backup to avoid data loss. The Cisco CVD- Data Center Design uses Cisco Nexus 5500UP series switches in the core layer of the hierarchical data center network. Universal port (UP) capabilities is the significance of this model switch. A UP is capable of supporting Ethernet, Fiber Channel and Fiber Channel over Ethernet on any port allowing the data center core to support multiple storage networking technologies on a single platform type. It reduces cost and minimizes complexity in data center hosting environments. [13]

2.4.2 Data Center Foundation and Services

The primary building block of a data center is foundation layer. Whether it is a server room Ethernet LAN or a formal data center, it is a must for the foundation layer to be resilient, scalable and flexible for supporting data center services to add performance and reliability, as data center services are the next layer in the hierarchy. It might be needed large open spaces for a manufacturing floor or high solid walls with controlled access for a secure environment. Data center services may include intrusion detection systems, firewalls, virtual switching and so on. [16]

2.4.3 Ethernet Infrastructure

The Ethernet infrastructure forms the foundation of resilient layer 2 and layer 3 communications in data center. This layer serves the ability to migrate from original server farm to an architecture featured with Fast Ethernet, Gigabit Ethernet and 10-Gigabit Ethernet connectivity. Virtual Port Channel technology which is featured in the Cisco Nexus 5500UP series, can apply a loop free approach to build the data center in which any VLAN can appear on any port without blocking links. Core layer switches are redundant with sub-second failover. [16]

2.5 WAN Technologies in the Infrastructure

AN known as wide area network is a computer network covering multiple distance areas, which may spread anywhere. The term WAN refers not to the internet but exclusively to the enterprise WAN services such as Frame Relay, ATM or MPLS. Enterprise WAN services were designed mainly to connect a branch offices and data center while the internet provides connectivity to huge range of resources.

The modern WAN started in 1969 with the deployment of the ARPANET which was the precursor to today's internet. The technology used to build the internet began to be commercialized in the early 1970s with the development of X2.5 based packet switching networks. In the mid to late 1980s, it became common for enterprise IT organizations to deploy integrated TDM-based WANs to carry both voice and data traffic. In 1990s, organizations began to deploy Frame Relay-based WANs and later parts in 1990s, organizations replaced Frame Relay-based technology with ATM technology. In 2000s, it began the trend to use MLPS WAN technology in the organizations. Cost saving was the main moto of revolution of WAN technologies.

Organizations currently make relatively little use of WAN services other than MLPS and the internet. The concerns regarding WAN services are cost, uptime, latency, lead time to implement new circuits, security, lead time to increase capacity on existing circuits, packet loss, jitter and the concerns regarding the internet are also the same.

2.6 Security

Network security is very important when it comes to protect resources, to have a smooth transition and the main purpose of security is to protect assets. In order to have secure infrastructure we have to make sure the information that we are saving is correct and protected against data corruption as well as willful alterations, only the intended people are able to see information and lastly, people can access desired data at any time without exception. Moreover, network security is critical to protecting IT infrastructure from various threats, such as viruses, worms and denial-of-service(Dos). Therefore, we have to make the LANs, Data center, WANs secure enough so that people can rely on the IT infrastructure of the EZ. [3]

3 Chapter: Design and Implementation

In any IT infrastructure and businesses, digital communication with data, voice and video is crucial to perform day to day activities. As we already mentioned in chapter 2 what do we need and what are the requirement we have to fulfill. For designing the whole system, we divided the work into step by step process. At first, job is to find out which switches, routers, cable, applications, servers, technologies we need and then design individual LAN for every office, factory and resident building. In addition, we have to decide how much bandwidth we are offering for different places. Together with that, we need to design the LAN for data center, cooling and power supply of data center, cctv integration, WAN technologies that a EZ should use. Lastly, we are going to do a cost analysis, as cost is one of the most vital issue for a developing country.

3.1 Overview of EZ IT Infrastructure

As we already mentioned, one of the EZ being developed in Bangladesh is AMEZ and it has an area of 216 acres. We are considering that much land as standard area and assuming that there will be about 100 companies. Firstly, in EZ there will be different kind of companies and their IT need will not be the same. Such as a Tech company might need access to data ten times more than a RMG company; it also might be same for Bandwidth, number of computers, routers, cables etc. Therefore, we analyzed some of the companies' IT infrastructure in Bangladesh and based on that we designed how much hardware and software components we might need, which companies need how much bandwidth, where we need router and how we should connect the LAN.

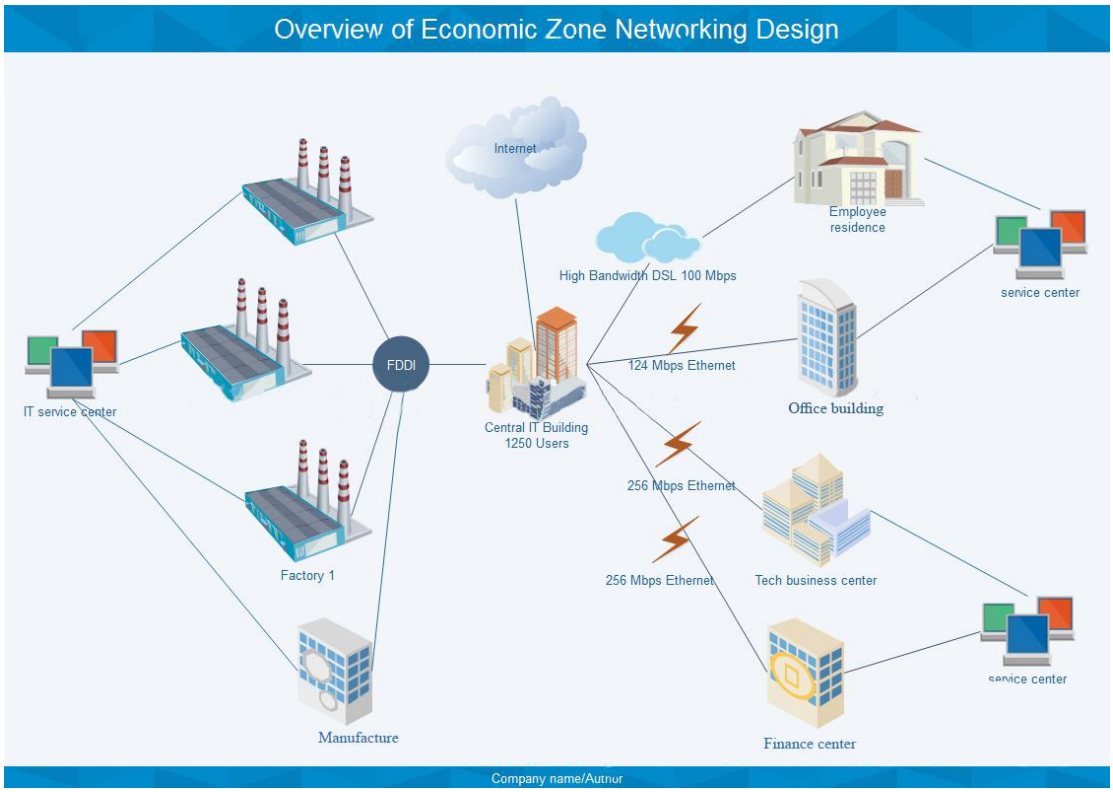

Figure 3.1: Sample Overview of EZ IT infrastructure

In the above figure 3.1 we showed a sample overview of an EZ IT infrastructure and as it showed there, we will have a centralized IT infrastructure including centralized

data center, server room etc. However, depending on the area there might be some service centers.

3.2 LAN Design for the Economic Zone

In EZs, business growth is very simultaneous and rapid. Hardware component's requirements increase is very frequent. So, while designing the LAN design of the network infrastructure requires a robust architecture. For our design of the LAN, we will be using Hierarchical Network Topologies over Flat LAN Topologies since hierarchical network topology ensures Scalability, Redundancy, Security, Manageability, Maintainability and performance. There is been a vast discussion on the benefit of using the hierarchical network model in chapter two. [8]

3.2.1 Hierarchical LAN of the EZ

We used three distinct switch types in the core, distribution and access layer of the hierarchical network topologies. While designing the LAN, we had to keep in mind that the implementation of the design should be cost effective and robust as well. The end node devices such PCs, Printers, Hubs etc. are connected to the access layer switch. Two or more access layer switch is connected with more than one distribution layer switches and the distribution layer switches are connected with more than one core layer switches. In every layer, there will be interconnection and cross connection with Ethernet cable among the switches. For example, there will be cross connection among every switch in the access, distribution and core layer. In chapter four there will be the specific number of components to design.

In the figure 3.2.1 the hierarchical LAN design is showed.

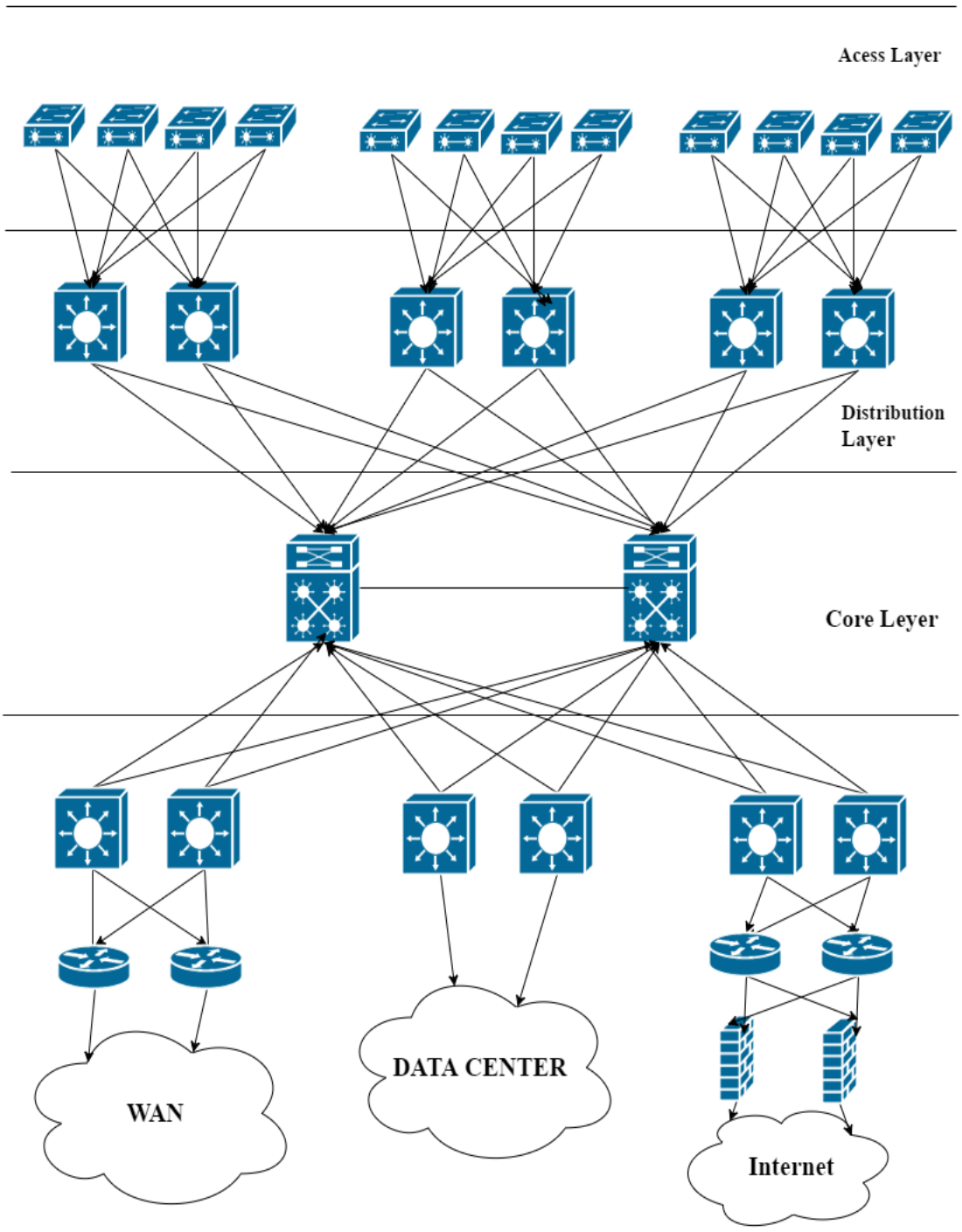

Figure 3.2.1: Hierarchical LAN Design

3.2.2 Partial-Mesh Topology versus Full-Mesh Topology

While connecting devices with full-mesh topology, it ensures the maximum redundancy and reliability but maintaining the full-mesh topology is very complex and toilsome. On the other hand, we can ensure redundancy and reliability using partial-mesh topology too but it is not maximized. It is simpler than full-mesh topology to maintain and manage. Therefore, we used partial-mesh topology for connectivity. We ensured two to three backup paths for every route in every LAN design. [8]

3.2.3 Hardware components

Hardware components of the LAN design includes switches, routers, different servers, PCs, Printers, IP phones, Ethernet cable, Fiber optics etc. We used three different types of switches in different layers. For, the access layer we used Cisco 3750 series switches after analyzing different cisco series switches. The reasons behind choosing this switch after analyzing are this switch offers forwarding rates from 32 Gbps to 128 Gbps and it supports cisco stack wise technology. This switch series support Fast Ethernet and Gigabit Ethernet connectivity, up to 48 10/100/1000 ports, plus four SFP ports. Besides, there is the optional integrated Power over Ethernet (PoE) up to 24 ports with 15.4 watts or 48 ports with 7.3 watts. This switch meets all the requirements of access layer switches as we stated in chapter two. Besides, cost is very much effective and within the range of developing countries.

For distribution layer, we used Cisco 3560 series switch as it has the features including PoE, QoS (Quality of Service), advanced security features such as ACLs (access control lists). Besides, it supports Fast Ethernet and Gigabit Ethernet connectivity with up to 48 10/100/1000 ports, plus four small form-factor pluggable ports and optional 10 Gigabit Ethernet connectivity. These features are the best fit for the distribution layer of the hierarchical network design.

In the core layer of the hierarchical network topology, we integrated Cisco 6500 series switch which is the upgraded modular switch widely used in different medium and large sized business. This series switch supports data forwarding rates up to 720 Gbps.

It has modularity and LAN/WAN service modules, up to 1152 10/100 ports and Gigabit Ethernet ports. Besides, it supports dual, hot-swappable internal AC or DC supplies and advanced hardware assisted IP routing capabilities. These were the analyzed output of using Cisco series 6500 switches in the core layer.

3.2.4 Design of a single Building Network

To fulfill all the requirements, we have divided the IT infrastructure into small modules such as a detailed IT blueprint for a single factory/home having the following features. Connectivity in every room: A both wired and wireless connection. The number of wired ports ranging from two to twelve ports per room. Re-configurability: All ports can be configured for different purposes, be it for IP connectivity, power over Ethernet, phone line, IP TV, alarm, sensors or some other special purpose. Redundant Internet Connections: to ensure that connectivity is always available. Private and public networks to ensure that both visitors and members get the services. Centralized network services.

Environmental sensor networks inside and outside the building: used for monitoring building health and to track exceptional situations for safety reasons. Integration to social media and messaging system: For instance, the environmental monitoring system is capable of raising alarms and can provide information in Facebook. In addition, an SMS interface. Services such as door opening indication, toaster on indication, humidity alarm, fire alarm, miss configured ventilation system alarm and so on. A fire and burglary alarm system and a video surveillance system with footage archival storage.

The figure 3.2.4 shows the home network layout.

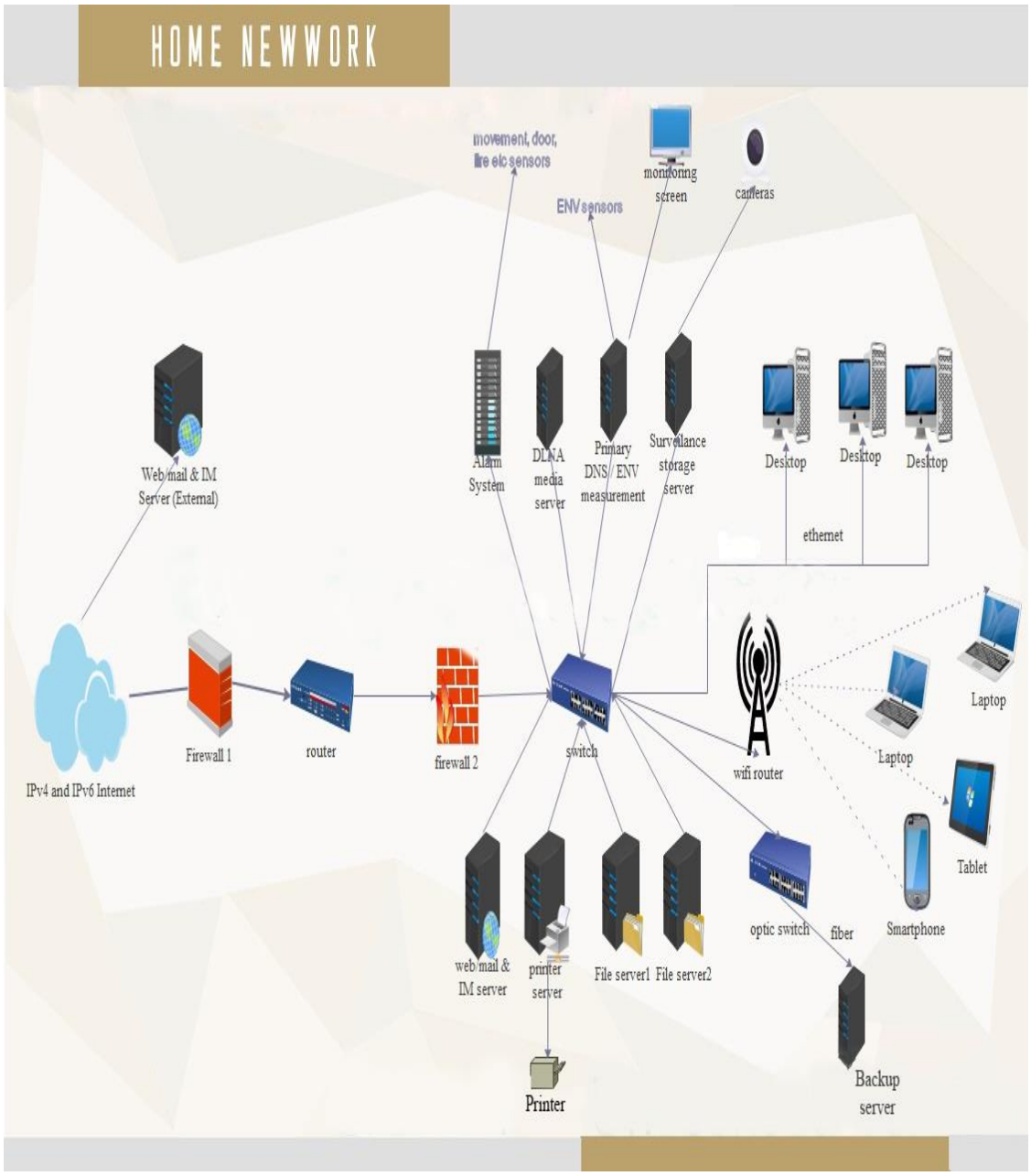

Figure 3.2.4: Single Building Networking Infrastructure Layout

3.3 Data center

In Chapter 2 we already mentioned how important the data center is for our IT infrastructure. As we reviewed some of the data center solution from companies, we found out what we need in EZ data center. In the figure below shows the basic design overview of Data center.

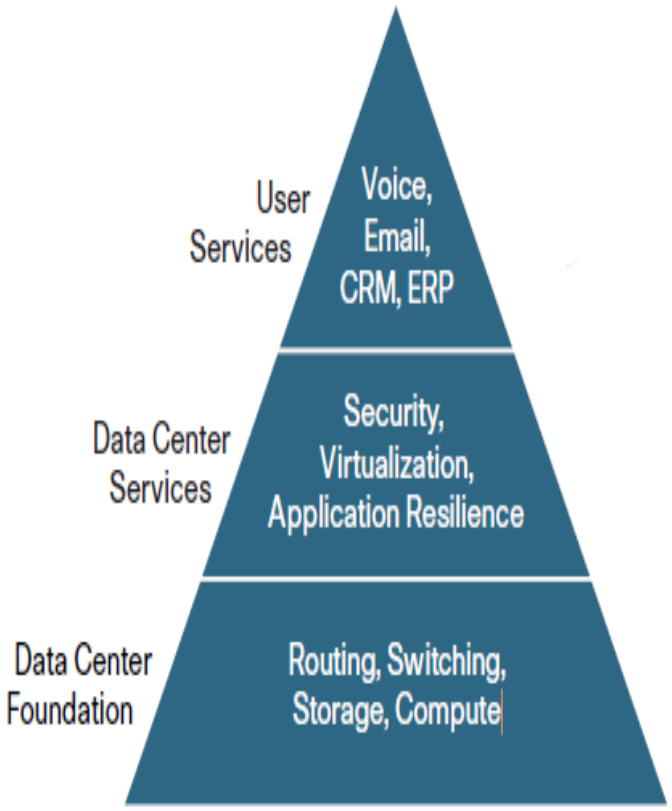

Figure 3.3: Data Center Design Overview

3.3.1 Data Center foundation

We need a foundation for data center where all the services can rely on and this foundation provides the computing necessary to support the application that process information and transport between servers, storage and the end users who access the

application. The foundation has to be resilient, scalable and flexible in order to support data center services. The data center foundation includes routing, switching, computing, storage and other important networking infrastructure. [16]

3.3.2 Data Center Services

After foundation services are the next layer in a data center. Data center services allow us to customize the environment to a greater degree and enhance operation. Therefore, this layer includes firewalls and intrusion prevention in order to enhance security of the data and applications. [16]

3.3.3 User Services

User services are those applications that allow users to do their job and ultimately gain productivity for an organization. User services in a data center include email, order processing, file sharing, ERP and other applications that rely on the data center foundation and services like database applications, transaction processing etc. [16]

3.3.4 Ethernet Infrastructure

The Ethernet Infrastructure forms the foundation between layer 2 and layer 3 in data center. The connection between all the switches are connected with Ethernet cable. Core connection of data center is built with Nexus 5000 series switches. To connect them we are considering Gigabit Ethernet connectivity. [11]

3.3.5 Server infrastructure

In a data center one of the most important part is the servers. We need a backbone to support the servers in data center and therefore, we need to build the server infrastructure. It will include computer server systems with disk capacity and physical administration of the system. The number of servers we need depends on how many people are going to access to servers. We are going to Integrate DNS, web server with HTTP, email server with SMTP, POP3, IMAP, video server etc. [11]

3.3.6 Storage Infrastructure

For storage, we are going to use disk storage to store data. We have to build a storage infrastructure so that it can solve the growing amount of data storage that the organization always struggle with. In addition, storage infrastructure ensures uninterrupted and redundant connection between the disk storage and servers. [11]

3.3.7 Cooling

As data center contains a lot of electrical components and those components especially processors generate heat when in operation. With increasing heat efficiency of processors decrease and in extreme cases, all the components could fail. Therefore, cooling a data center is essential. Servers are installed in racks, which basically resemble specially standardized shelves. They laid out so that two rows of racks face each other, thereby creating an aisle are covered above and closed off at the ends by doors. Cool air set to a normal temperature and blown through holes in the floor, flows through the racks, and dissipates the heat emitted by the servers. This process is known as raised floor with underfloor cooling. At high temperature, the air conditioning systems are cooled with water, made possible by turbo-cooling units. In addition, heat exchangers on the data center's roof, which release hot air into the environment. [12]

3.3.8 Power Supply

The electrical power supply and distribution system design is crucial to data center reliability and operational efficiency. In a data center interrupt of power may cause a lot of damage and applications, server may fail. For that reason, we have to make sure that we have enough power supply to maintain the facilities and also implement UPS to prevent power interruption. During a power interruption, the UPS will switch over the current load to a set of internal or external batteries. Some UPSs are online, which means the power is filtered through the batteries all the time; others are switchable, meaning they use batteries only during power loss. Most UPSs provide for remote monitoring and the ability to trigger a graceful server shutdown for critical servers if the UPS is going to run out of battery. [12]

3.3.9 Data Center Solution Topology

The figure 3.3.9 is a Cisco tested solution. At a high-level hierarchical design, the following four functional areas are addressed in this design by the physical devices:

- Core layer.
- Aggregation layer.
- Services layer.
- Access layer.

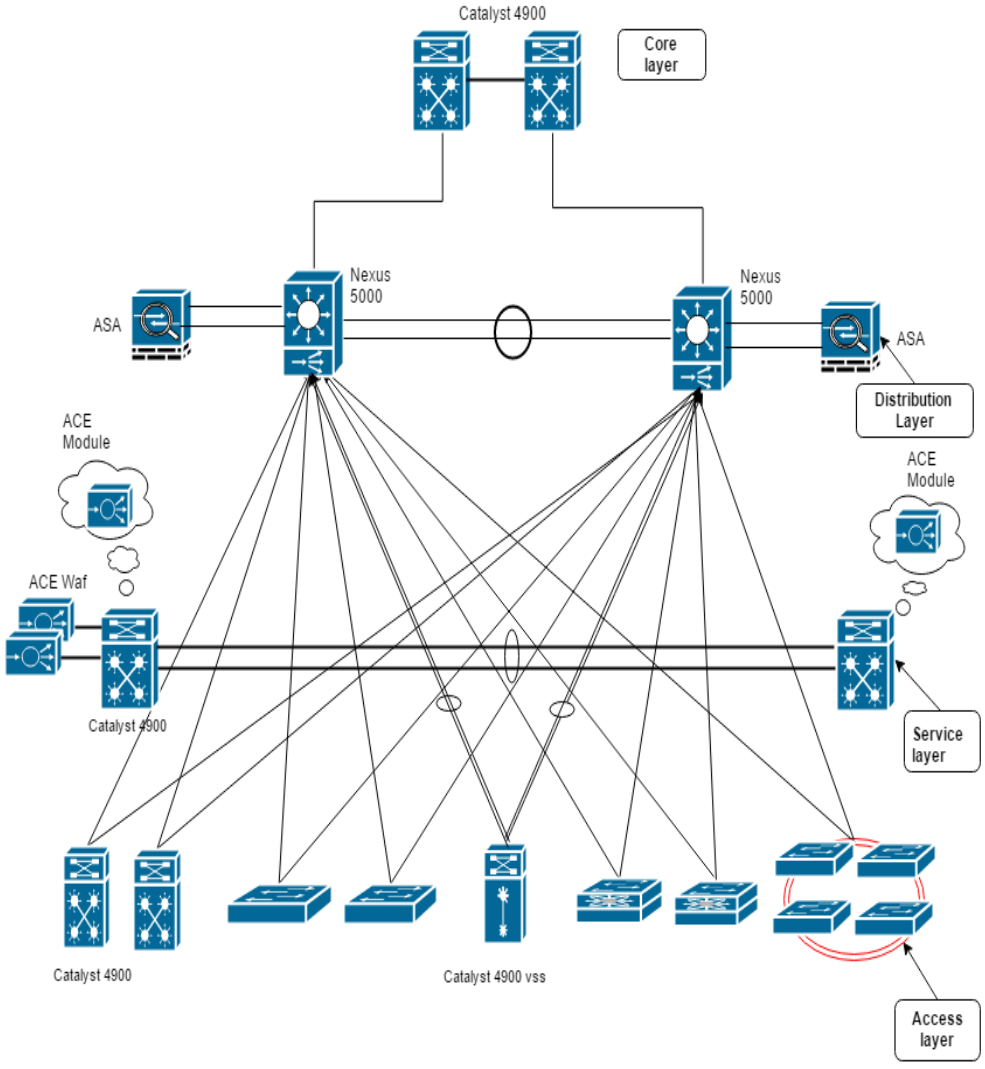

Figure 3.3.9: Data Center Design Topology

3.3.9.1 Core Layer

The core of data center is a high-speed layer 3 fabric. It is consisted of CISCO Catalyst 4900s devices. The core layer appears as highly traditional in its deployment model; however, Virtual device contexts(VDC) allows engineers to logically partition or virtualize the Nexus 5000 connection into Catalyst 4900 core devices.

3.3.9.2 Aggregation Layer

The devices used in this layer are the Nexus 5000 series switches. From a physical perspective, the Nexus 5000 provides more than enough slot and port density to support the surrounding core, services, and the access layer devices within the topology. In addition, the Nexus devices offer rich set of layer 2, layer 3 and virtualization features permitting a new level of segmentation and control within a single aggregation device in the data center.

3.3.9.3 Service Layer

This layer consists of Catalyst 4900 series switches using service modules and dedicated appliance platforms. The appliance services may attach directly to the Nexus 5000 aggregation layer or use the port density available on the services chassis themselves. The services layer design used for this solution is based upon previous efforts surrounding services chassis design but expands upon this foundation of load balancing and firewalling to include intrusion detection, intrusion prevention, and web-application firewall services. In addition, techniques to monitor data center traffic, including virtual machine are introduced.

3.3.9.4 Access Layer

This layer is the point of connectivity for data center endpoints that provides entry to the greater network. This is a layer-2 domain requiring network administrators to concern themselves with loop mitigation, oversubscription requirements, and physical port availability for server connectivity. There are many solutions

available to the network administrator to address and eliminate these issues including Virtual Switching System (VSS) 1440 and Virtual Blade Switch (VBS) technologies. Each of these technologies simplifies the network by creating a single virtual instance of a switch, simultaneously removing the complexities of spanning tree and allowing server endpoints to achieve greater performance levels through NIC teaming. [14]

3.3.10 Data Center Configuration Steps

As we are using CISCO solution topology and the switches in the data center are also from CISCO, we are going to configure them using CISCO manual.

Process 1:

In this process, we have to configure Ethernet Infrastructure.

Step 1: Configure Ethernet Out-Of-Brand Management

- Configure Switch Universal Setting.
- Apply the switch global configuration.
- Configure switch access ports
- Configure switch links to the Layer 3 core

Step 2: Configure Data center core setup and layer 2 Ethernet

- Establish physical connectivity
- Perform initial device configuration
- Configure QoS policies
- Configure virtual port channel
- Configure data center core global settings
- Configure Spanning tree

Step 3: Configuring the Data Center Core IP Routing

- Configure the IP routing protocol
- Configure IP routing for VLANs

- Configure IP Multicast routing
- Configure connectivity to the LAN core
- Configure management switch connection
- Configure vPC object tracking

Step 4: Configuring Fabric Extender Connectivity.

- Configure Fabric Extender connections
- Configure end node ports

Process 2:

In this process, we have to configure Storage Infrastructure.

Step1: Configuring Fibre Channel SAN on Cisco Nexus 5500UP

- Configure Fibre Channel operation
- Configure VSANs
- Configure Fibre Channel ports
- Configure device aliases
- Configure zoning
- Verify the configuration

Step 2: Configuring Cisco MDS 9148 Switch SAN Expansion

- Perform initial setup for Cisco MDS
- Configure VSANs
- Configure the trunk for SAN interconnect

Step 3: Configuring FCoE Host Connectivity

- Configure FCoE QoS
- Configure host-facing FCoE ports
- Verify FCoE connectivity

Process 3:

In this process, we have to configure Network Security.

Step 1: Configuring Cisco ASA Firewall Connectivity

- Configure firewall VLANs on Nexus 5500s
- Configure port channels on core switches

Step 2: Configuring the Data Center Firewall

- Configure initial Cisco ASA settings
- Configure firewall connectivity
- Configure firewall static route to the core
- Configure user authentication
- Configure time synchronization and logging
- Configure device management protocols
- Disable proxy ARP

Step 3: Configuring Firewall High Availability

- Configure the primary appliance for HA
- Configure the secondary Cisco ASA for HA

3.4 IP Surveillance (CCTV Integration)

In an EZ it is very important to have proper security system. To monitor the whole EZ, the authority may have security team. However, that is not enough and that is why we have to set up camera around the EZ to monitor the whole EZ. In this section, we are showing what kind of surveillance system we are designing.

3.4.1 Choosing a network camera

Includes cameras that can be par/tilt/zoom, vandal-proof, weather resistant or fixed dome products. Each type of camera can be blended into an IP surveillance system to create a local package that solves security needs.

3.4.2 Compression

Selecting the right compression is vital, and includes choices between proprietary or industry standard modes such as Motion JPEG or MPEG-4.

3.4.3 Video management

Video management tools are dependent on the application and many factors have to be configured. Considerations of available bandwidth, storage capabilities, scalability, frame rate control and integration capabilities.

3.4.4 Storage

Considerations when determining storage requirement include frame rate, the amount of time the video needs to be stored, the required redundancy and which type of storage that fits best.

3.4.5 Incorporating analog cameras

The analog camera is simply connected to a video server, which digitizes, compresses and transmits video over the network.

3.4.6 Wireless networking

It could be useful in historic buildings, where the installation of cables would damage the interior or within facilities where there is a need to move cameras to new location on a regular basis. The technology can also be used to bridge sites without expensive ground cabling.

3.4.7 Designing the network

It is important to consider IP addressing and transport protocols along with transmission methods, bandwidth, scalability and network security.

3.4.8 Security

Choosing the right security option such as firewalls, virtual private networks (VPNs) and password protection will eliminate concerns that an IP surveillance system is open to the public.

3.4.9 Hot Technologies

Advanced network cameras can have built-in motion detection and event handling. In addition, more intelligent algorithms such as number (license) plate recognition, people counting are being integrated.

3.4.10 Best practices

Camera placement and lighting conditions working-with IT departments and technicians to determine issues such as the pic times for network usage.

3.5 WAN Infrastructure Design and Implementation

Proper WAN infrastructure is very important while designing an IT infrastructure. There are many WAN technologies available to deploy. The consideration while designing the WAN infrastructure are deploying considerations, guaranteed bandwidth and best effort bandwidth.

WAN links should be made redundant to provide higher levels of fault tolerance, voice and data should remain converged at the WAN, just as they are converged at the LAN. QoS provisioning and queuing mechanisms should be available there, maintaining separate links or devices makes troubleshooting and management difficult at best, when deploying voice in WAN environment using lower-bandwidth G.729 is recommended. For guaranteed bandwidth, the WAN technologies available such as Leased Lines, Frame Relay, Asynchronous Transfer Mode (ATM), ATM to Frame Relay Service Interworking, Multiprotocol Label switching (MPLS) etc. options are available. For our WAN infrastructure of the IT infrastructure of Economic Zone we are using MPLS

WAN technology since it is very cost effective and modern technology comparing to other WAN technologies available.

Modernizing WAN Infrastructure: Since the technology growth is very rapid so, we need to modernize the WAN infrastructure. To modernize the WAN infrastructure there are four distinct and important steps to be followed. They are stated above:

- Migration to hybrid WAN: A transport-independent architecture that enables the business to connect multiple access networks, internet, third and fourth generation with a single overlay for operational simplicity to be built.
- Protect and optimize application performance: An application policy based model that maximizes usages and the application experience.
- Enable a secure, scalable, and resilient infrastructure: Evaluating and redesigning WAN architecture to maximize security at branch offices and direct internet access, promote infrastructure that can resize the business frequently.
- Promote greater automation and orchestration: Using software based controller model to overcome with the network complexity.

3.6 Network System Security

In this section, we are going to describe how we are designing network security for the IT infrastructure we are proposing. In our network security system, we tried to cover infrastructure protection, policy enforcement, threat detection and mitigation and secure connectivity. Each and every security area is integrated into appropriate device within the network. The figure below is showing all the area and what service they providing.

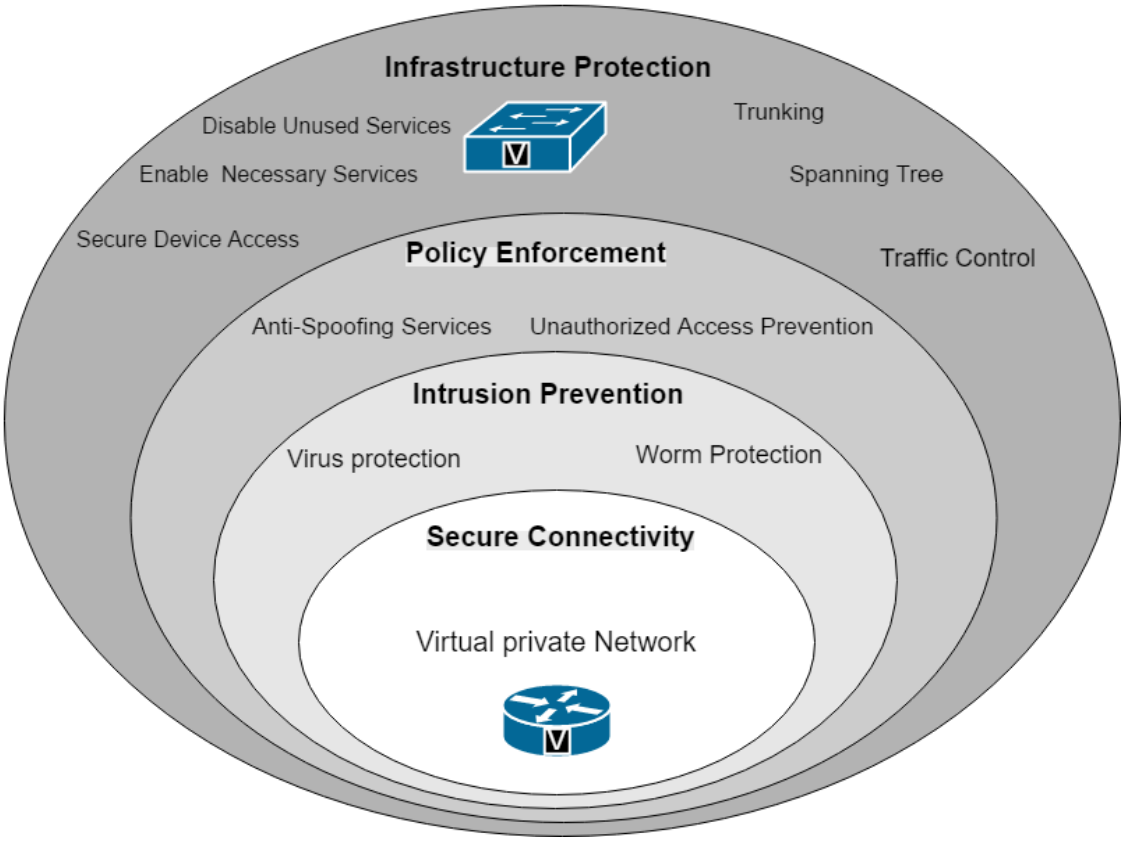

Figure 3.6: Network Security Deployment.

3.6.1 Infrastructure Protection

In order to ensure the smooth transition of the network, it is very important to implement the security tools to protect each network components and the infrastructure as a whole. In this design, every router is configured with infrastructure protection services using the Security Audit feature within the Cisco router and Security Device manager. This ensures:

- Unused services, such as IP source routing is disabled.
- Necessary services, such as password encryption and logging, are enabled.
- Secure device access for console, Telnet, SSH and HTTP.
- Trunk 802.1 used for VLAN and also Spanning Tree Protocol(STP) is used in layer 2.

3.6.2 Policy Enforcement

This section defines the acceptable and the unacceptable use of the network resources and other devices attached to the network. In the design, a basic firewall is deployed within the router to uphold policy enforcement. The firewall is configured not to permit any external traffic into the network unless the traffic is a reply to a session that was originally sourced from the internal network.

3.6.3 Threat Detection and Mitigation

The ability of a network device to monitor and inspect traffic as it traverses a network, to detect activity, and respond by mitigating the treat before network security can be compromised are the goals of threat detection and mitigation. Some files containing list of signature and their definitions that are used to match suspicious traffic. These services are deployed in the router with intrusion prevention services (IPS). IPS is configured in the LAN and WAN interfaces of the router.

The following actions a device perform:

- Drop the packet
- Reset connection
- Deny traffic from the IP address of the attacker and on the connection the signature was seen.

3.6.4 Secure Connectivity

Secure connectivity refers to the protection against the interception and alteration of information being transported within un trusted environment. VPN can be used to provide secure connectivity and for encrypting the information protocols such as Digital Encryption Standard or Advanced Encryption Standard, are employed. In addition, for authentication on each side of VPN mechanisms such as RSA or pre-shared keys and authentication for data set algorithms such as MD5 and SHA, are used. [3]

4 Chapter: Result and Analysis

As we already mentioned that we are designing an IT infrastructure for EZ with an area of more than 200 acres, it is not possible for us to show physical implementation result. Therefore, we are going to show that our proposed infrastructure is cost effective because cost is the main constraint for building an IT infrastructure in a developing country. Together with that we are going to do a prototype LAN design simulation in this chapter.

4.1 Required Hardware and Software Components

The components we need are already mentioned in the previous chapter. Here in this section we are going to give an estimation of required number component being used in the infrastructure we are designing. There are few assumptions of data based on the information provided by Economic Zone holders and other experts of different organization. They are provided below:

- Estimated area of the Economic Zone is 200 acres.
- Assumed number of Companies would be 100 and there will be 100 office buildings.
- Estimated number of people working in the Zone is 20000 assuming 200 people per company.
- Estimated user of the internet at a time is 2000 and another 2000 via mobile devices.

Based on the above information we have analyzed and specified the number of hardware required for the Economic Zone IT infrastructure. The specifications are given in the table below:

Serial No.	Router	Description	Amount	Switches	Description	Amount
1	Cisco 2800 Series	For mobile devices in each floor	1	Cisco Catalyst 3750	Access Layer Switch	700-710 24-Ports
2	Cisco 2800 Series	Connecting one LAN to another	3-4	Cisco Catalyst 3560	Distribution Layer Switch	190-200 24-Ports
3	Cisco 2800 Series	Connecting one network to another	3-4	Cisco Catalyst 6500	Core Layer Switch	11-13 24-Ports

The above data is for the LAN architecture of the IT infrastructure of the Economic Zone. The hardware requirements for the data center is quite different form the LAN architecture environment. The data center requires more powerful, efficient and secure networking devices so that the data center is efficient and resilient. Besides, we have to always keep in mind that the design has to be cost effective as it is mainly focused for the developing countries. Required hardware for data center is given below:

- Cisco Catalyst 4900 series switch for the core layer of the data center.
- Nexus 5000 series switch in the distribution layer.
- Cisco ASA firewalls.
- ACE Modules.
- ACE Waf.
- Catalyst 4900 series switch in the service layer.
- Servers.

Beside the hardware components, there are some software requirements for a complete Information Technology infrastructure. The list of software components required is given below:

- Microsoft Windows and Linux as the Operating System.
- Microsoft .Net/IIS for the internet platform.
- SQL server for Data Management and Storage.
- Consultant and System Integrator would be IBM.
- BMS software for controlling a building [10]

4.2 Prototype LAN Simulation

As a part of the network, we simulated the prototype LAN design of the IT infrastructure of the Economic Zone using Cisco Packet Tracer Activity to check if the hierarchical LAN works perfectly or not. We designed the LAN prototype using two separate hierarchical LAN and connecting those two LANs using Cisco routers. Since, in the packet tracer activity the appropriate devices for the network infrastructure are

not available which we mentioned earlier, we had to use some other representative devices to simulate the LAN. After designing the LANs and connecting them with the routers we assigned some sample IP addresses and necessary commands to the devices. After configuring the whole network, we observed that the hierarchical LAN design works perfectly. The screenshot of the LAN simulation is given below.

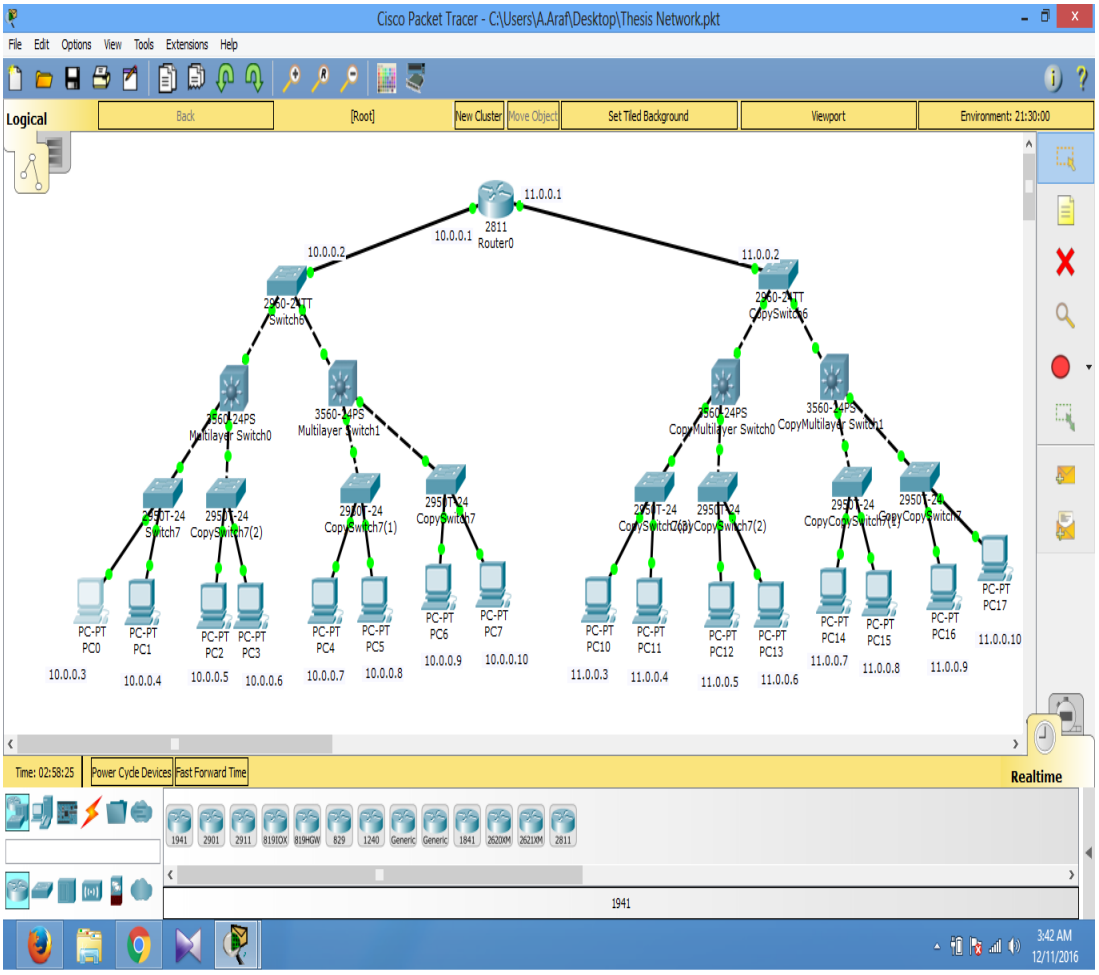

Figure 4.2: Prototype LAN Simulation in Packet Tracer

The two-different hierarchical LAN work perfectly. We performed a ping command to the PCs of other network and the command gave positive results. Switches used for prototype LAN are Cisco 2950 series in the access layer, Cisco 3560 series in the distribution layer and Cisco 2960 series in the distribution layer. Router used to connect the two networks. The IP used to configure the two switches are 10.0.0.2 and 11.0.0.2

accordingly. IP of the router's port connected to the two switches are 10.0.0.1 and 11.0.0.1 accordingly. In each LAN, total eight PCs are connected to the access layer of the hierarchy. The IP addresses of the PC's of the first LAN are 10.0.0.3 to 10.0.0.10 and for the second LAN the IP addresses of the PC's are from 11.0.0.3 to 11.0.0.10. All the devices were configured with appropriate commands and IP addresses to make the network work. Finally, the design and configurations worked properly and we could ping to PCs of other network and got positive results.

4.3 Cost Estimation and Analysis

The equipment and devices cover the most of the cost to build the IT infrastructure of the Economic Zone. To build an efficient, robust, scalable, redundant and secure IT infrastructure for such a big zone requires a high cost. But while designing the infrastructure our primary focus was cost minimization and efficiency. We would not say that our infrastructure is the best regarding the cost effectiveness but it is within the budget of the EZ holders of the developing countries. Besides, this infrastructure ensures efficiency and scalability.

4.3.1 Cost of Equipment

Cost comparison helps to demonstrate which specifications would be best fit for your infrastructure regarding your budget and performance of the IT infrastructure. In this section, we provide the cost comparison category-wise to demonstrate a full understanding of the cost model regarding the current prices of the equipment. The prices we use here are based on vendors provided data on their website and other online markets available now-a-days.

- Cisco 3750 series switch costs $350 each (approximately).
- Cisco 3560 series switch costs $930 each (approximately).
- Cisco Catalyst 6500 series switch costs $5000 each (approximately).
- Nexus 5000 (N5K-C5010P-BF) series switch costs $5000 (approximately).
- Cisco Catalyst 4900 series switch costs $3500 each (approximately).
- Price of server rack $30-$40 each (approximately).

- $10 for intra-rack and $50 for inter-rack cabling cost (approximately).
- Cost of Cisco ASA firewall is $1600 (approximately).
- Cisco 2800 series router costs $270 (approximately).

4.3.2 Cost Model Analysis

Analyzing the cost model of different data center solution models can demonstrate a proper understanding of the data center types and costs. In the cost model, we provide the demonstration of types of data centers known as SW-FatTree, HY-BCube, HY-deBruijn and SRV-deBruijn. To understand those in a few words we can say, one is switch only data center, one is server only and other two are a combination of both switch and servers. We are using the HY-BCube model since it provides us the most cost efficiency meeting with the requirements of the data center of the IT infrastructure. This model is a hybrid model of data center and it is a combination of 60 percent switch and 40 percent servers in the data center. [15]

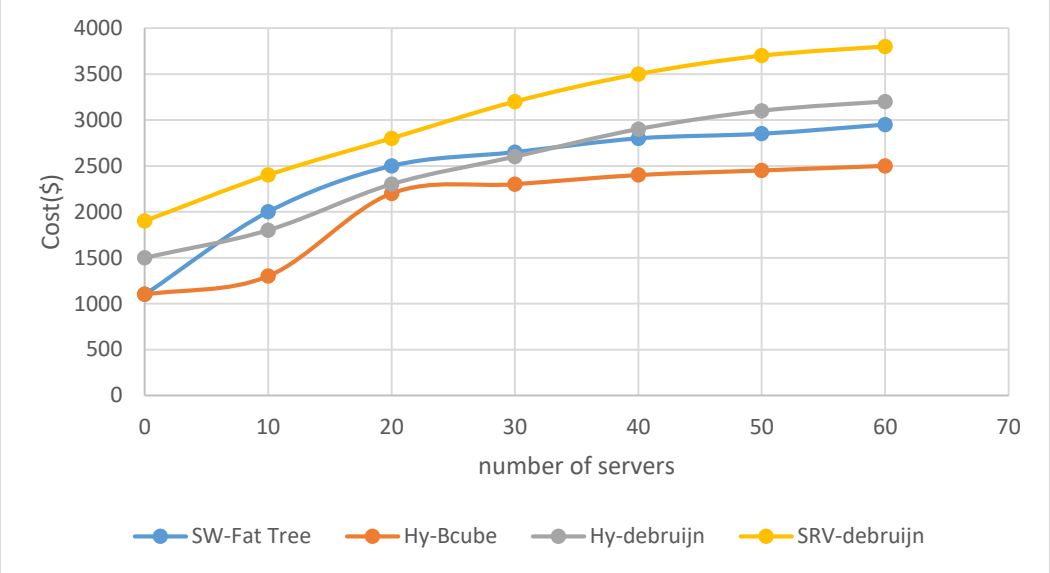

Figure 4.3.2a: Data center server cost

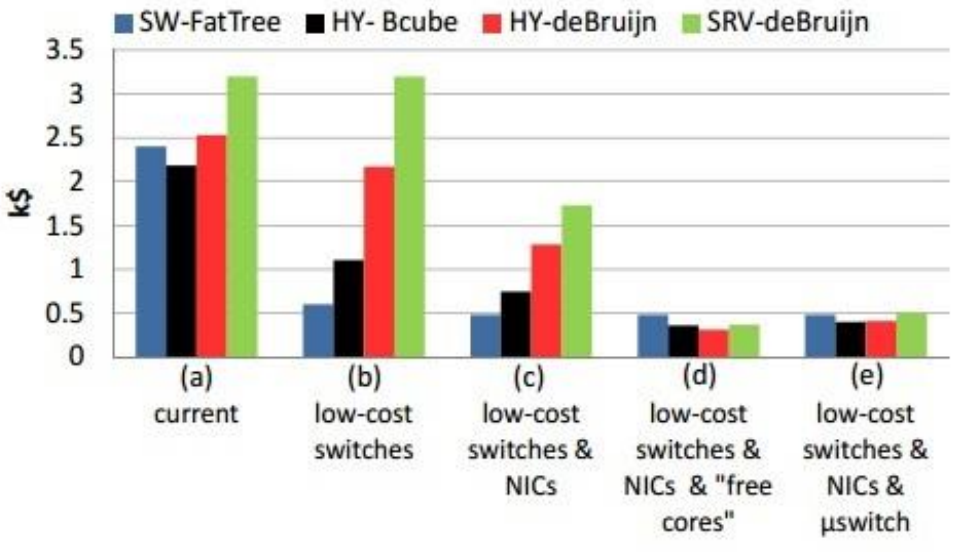

Figure 4.3.2b: Cost of different models future scenarios

5 Chapter: Future Works and Discussion

As we already discussed that we are designing an EZ IT infrastructure for developing country such as Bangladesh, we could not use many up to date components because of cost and also the availability of components in those countries. We had some limitations such as we could not show the whole infrastructure in a single picture and also it was not possible for us to show physical implementation. In addition, we could not add waste water treatment facility to our infrastructure and also could not show a road map as Bangladesh currently do not have any EZ which is in operation. For the same reason, we could not specify the companies that will be in EZ. Therefore, we had to make some assumptions to design the infrastructure. However, we already discussed that our model will be will cost effective for a developing country and we hierarchical LAN design is implementable. Though there might be some constraints, we already discussed every part of the infrastructure and with proper consultant our model will be implementable. In spite of that there might some changes need based on the need of a specified EZ. In future, we will try to work on our limitations and make it more efficient.

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