

Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Informatics



Diploma Thesis

Proposal and design of network infrastructure...

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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DIPLOMA THESIS ASSIGNMENT

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Thesis title

Proposal and design of network infrastructure for a company

Objectives of thesis

The main objective of this theses is to analyse and design the network infrastructure in a selected organisation.

Partial goals of the thesis are such as following:

- To make literature review of current state of the art and trends in networking technologies.
- To elaborate a case study of design and implementation of network infrastructure.
- To evaluate the proposed solution and to make recommendations.

Methodology

The literature review will be based on the desk research of the latest industry and scholar resources. Practical part is made of the case study including problem statement of the current situation and requirement analysis of the organisation. The design of the network infrastructure will follow the latest industry standards. Feasibility of the proposed solution will be assessed by a set of relevant methods. As for scientific methods, the research will be based on analysis, synthesis, induction and comparison. Based on the results of the case study, final recommendations will be formulated.

The proposed extent of the thesis

60 – 80 pages

Keywords

Computer network, network protocol, connectivity, Local Area Network, wireless network, high availability.

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INIEWSKI, Krzysztof; MCCROSKY, Carl; MINOLI, Daniel. Network infrastructure and architecture: designing high-availability networks. John Wiley & Sons, 2008. ISBN 0470253517

KARRIS, Steven T. Networks: Design and Management. Orchard Publications, 2009. ISBN 978-1-934404-15-7

LEWIS, Geoff. Communications technology handbook. CRC Press, 2013. ISBN 9781136025938

LLAN JOHNSON, A. Days Before Your CCNAExam: A Day-by-Day ReviewGuide for the CCNA 640-802 Exam. Cisco Press, Nov, 31, 9: 2008. ISBN 978-1-58713-197-4

OPPENHEIMER, Priscilla. Top-Down Network Design. Cisco Press, 2011. ISBN 57870-069.

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Declaration

I declare that I have worked on my diploma thesis titled "Proposal and design of network infrastructure" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on by 31.3 2019

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Proposal and design of network infrastructure for a company

Summary

Network infrastructure is a system of interconnected computers for the purpose of sharing digital information. The concept of a network began in 1962 when a server data the Massachusetts Institute of Technology was connected to a server in Santa Monica, California. Since that time the computers and computer networks has increased significantly. One of the most significant challenges to networks is attacks on their resources caused by inadequate network security. Computers and information networks are critical to the success of business, both large and small. The main purpose of this research to case study of design and evaluate small company network infrastructure.

A design of network infrastructure is evolving poor high availability. New infrastructure is designed as extension and improvements. This structure is reliable deliver applications and provides reasonable response times from any host to any host. Therefore, to provide high degree of protection to the network and network user's Firewall need to be used.

Firewall provides a barrier between the user computer and the internet (it prevent unauthorized internet users from accessing private computers and networks connected to the internet.)

Keywords: Computer network, Network protocol, connectivity, Local Area Network, wireless network, high availability.

Návrh a návrh síťové infrastruktury pro společnost

souhrn

Síťová infrastruktura je systém propojených počítačů za účelem sdílení digitálních informací. Koncepce sítě začala v roce 1962, kdy serverová data Massachusetts Institute of Technology byla připojena k serveru v Santa Monice v Kalifornii. Od té doby se významně zvýšil počet počítačů a počítačových sítí. Jednou z nejvýznamnějších výzev pro sítě jsou útoky na jejich zdroje způsobené nedostatečným zabezpečením sítě. Počítače a informační sítě jsou rozhodující pro úspěch podnikání, a to jak velkých, tak malých. Hlavním cílem tohoto výzkumu je případová studie návrhu a vyhodnocení síťové infrastruktury malé firmy. Návrh síťové infrastruktury se vyvíjí špatně vysokou dostupností. Nová infrastruktura je koncipována jako rozšíření a vylepšení. Tato struktura je spolehlivě dodávat aplikace a poskytuje přiměřenou dobu odezvy od libovolného hostitele k libovolnému hostiteli. Pro zajištění vysokého stupně ochrany sítě a síťového uživatele Firewallu je proto nutné použít. Firewall poskytuje bariéru mezi uživatelským počítačem a internetem (brání neoprávněným uživatelům internetu v přístupu k soukromým počítačům a sítím připojeným k internetu).

Klíčová slova: Počítačová síť, síťový protokol, konektivita, lokální síť, bezdrátová síť, vysoká dostupnost.

Table of contents

1. Introduction.....	11
2. Objective and Methodology.....	12
2.1 Objective.....	13
2.2 Methodology.....	13
3. Literature Review.....	13
3.1 Analysis of business goal.....	13
3.1.1 Analysis of requirements.....	14
3.2 Design process of Network Infrastructure.....	14
3.2.1 Network Basics.....	14
3.2.1.1 Types of Network.....	15
3.2.1.2 Network Components.....	15
3.2.1.3 Network Models	16
3.2.1.4 Network Topology.....	16
3.2.2 Network Protocols.....	17
3.3 High availability.....	18
3.4 Security system.....	24
3.4.1 Networking issues.....	24
3.4.2 Network security resources.....	25
3.5IT security management framework.....	26
4. Practical part.....	27
4.1 Description of the Company.....	27
4.2 Current Network Infrastructure.....	31
4.3 Analysis of business requirements & design of the new network.....	32
4.3.1 Business requirements.....	34
4.3.2 Network Scale requirements.....	34
4.3.1.2 Security requirements.....	35
4.3.1.3 Network service requirements.....	36
4.3.1.4 Network system requirements.....	36
4.4 Design of the new network.....	37
4.4.1 Implementation.....	37
4.4.2 Network cabling.....	39

4.4.2 Financial cost.....	39
5 Result and Discussion.....	43
5.1 3i Infotach company.....	44
5.1.1 Advantage.....	48
5.1.2 Disadvantage.....	48
5.2 Ehenno Solution company.....	49
5.2.1 Advantage.....	52
5.2.2 Disadvantage.....	52
6 Conclusion.....	54
7 References.....	55

List of pictures

Figure 1: Client/Server.....	16
Figure 2: Peer-To-Peer Model.....	16
Figure 3: Server Based Model.....	17
Figure4: Star Topology.....	18
Figure5: Ring Topology.....	18
Figure 6: Bus Topology.....	18
Figure 7: Mesh Topology.....	19
Figure 8: Tree Topology.....	19
Figure 9: Top layer to Bottom Layer.....	22
Figure 10: Load Balancer.....	22
Figure 11: High Availability.....	23
Figure 12: Security Design.....	26
Figure 13: VPN sever.....	27
Figure 14: Map of Fxnet Company.....	29
Figure 15: Structure of company.....	31
Figure 16: Current Network Structure.....	32
Figure 17: Analysis structure.....	33
Figure 18: New Network Design.....	38
Figure 19:SWOT Analysis.....	41
Figure 20: Map of 3i InfoTech Company.....	46
Figure 21: Technical Architecture.....	47
Figure 22: Development Architecture	47
Figure 23: Network structure of 3i InfoTech.....	48
Figure 24: Digital connection.....	49
Figure 25: Network structure of Enehano solution.....	51

List of tables

Table 1: TCP/IP Protocols and their Functions.....	19
Table 2: Address range of LAN Network.....	35
Table 3: Firewall Policy.....	38
Table 4: Hardware cost estimates for the New Network.....	41
Table 5: Total cost estimates for the New Network.....	41

List of Graphs

Graph 1: Forecasting of Internet Users.....	14
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List of abbreviations

- LAN:** Local Area Network
- NIC:** Network interface cards
- IP:** Internet Protocol
- TCP:** Transmission Control Protocol
- DNS:** Domain name system
- VPN:** Virtual Private Network
- ITIL:** Information technology infrastructure library
- IOT:**Internet of things
- ITSM:**Information technology service management
- VOIP:**Voice over internet protocol
- MAU:**Multi-station Access Unites
- DHCP:**Dynamic host configuration protocol
- SPOF:** Single point failure problem

1 Introduction

A network infrastructure is an interconnected group of computer system connected by the various parts of telecommunications architecture. The main purpose of computer network is that shared resources and data between computer networking. In the business, network infrastructure is very important for increasing the productivity. Most of companies' products are ordered to the customer by the digital way. A superior company comes more employees and with more employees comes more network devices. For instance, extra computers and routers are required to handle the traffic for all the new network devices. Unfortunately, the increase of head counts also means a tendency for some unwanted problems. Another problem this growing business will definitely encounter is hardware failure. Hardware failures can happen for many reasons; full memory, old or outdated hardware, tampering, and even computer viruses.

In business, customers are very important. If the customer be purchasing the product but not receiving on time definitely the customer will not be satisfied with the service. It shows the reputation of company and affects the productivity. A significant business, benefits of a network management is that for making the planning of high productivity. One of the greatest benefits of modern networks is that they provide the latest devices, server and network technology to accommodate the needs of the customers.

According to time, each company wants to increase the growth in the market because competition is very high in the market. A grate design of network infrastructure is the combination of server and their clients that provides the scalability to the organization for increasing the fast recovery and production. Internet is also more advanced infrastructure that provides email, messaging and information service.

The aim of this study is to "Establish a sustainable, secure, compliant, robust, and reliable IT infrastructure that enables a consistent technology experience for all users". According to the Miniwatts Marketing Group (1), in European Union the population is ' **506,279,458**' is a **6.7 %** of World population but **85.7%** people are using internet. In 2017 all the European countries only Germany is a top side than other countries. The main reason is 50% German people are using social media and **40%** people are educated so they are using internet their own business work. According to research, in India **462, millions** people use to active internet and **43%** are using mobile internet for social media side. The results show that although majority of the users are from European Union and India, the average contribution is higher in India.

This thesis is divided into 7 chapters. In Chapter 2 presents the objectives and the methodology. Comprehensive literature review is included in Chapter 3. Chapter 4 describes the practical tasks carried out according to the set methodology. Results are presented, interpreted and discussed in Chapter 5 & Chapter 6 has the conclusions while proceeding chapters include references and appendices.

2 Objectives and Methodology

2.1 Objectives

The main objective of this thesis is to analyse and design the network infrastructure in a selected organisation Fxnet company in Prague, Czech Republic.

Partial goal of the thesis are such as following:-

Firstly, a literature review of current state of the art and trends in networking technologies small and middle-sized companies will be made.

Secondly, a case study of design and implementation of network infrastructure in the FxnetCompany will be elaborated and proposed.

Finally, the proposed solution will be evaluated, final recommendations and conclusion will be made.

2.2 Methodology

The literature review will be based on the latest industry and scholar resources. Practical part is made of the case study including problem statement of the current situation and requirement analysis of the organisation. The design of the network infrastructure will follow the latest industry standards. Feasibility of the proposed solution will be assessed by a set of relevant methods. Based on the results of the case study, final recommendations will be formulated.

The process of the description of Network Design will be such as following:-

1. Identify the problems.
2. Collect information.
3. Develop solutions.
4. Select an approach.
5. Build a model/Design.
6. Improve the design.

The research will be based on the above process. Therefore, initially the network design will be based on selected organization and solution will be based on the relevance to the research questions identified earlier.

3 Literature Review

3.1 Analysis of business goal

First, we should understand the goal of business. In literature, we can find different methods of business goal. One of the most important authors is Oppenheimer (2) who defined in his book Top-Down network design as follows:

"Business goals include the capability to run network applications to meet corporate business objectives, and the need to work within business constraints, such as budgets, limited networking personal, and tight timeframes.

Another accurate and strong definition simplified by Bider (3), a cofounder and Director of R&D in Sweden? Wrote in his book about the business as follows:

"Business should redesign their process according to customer needs."

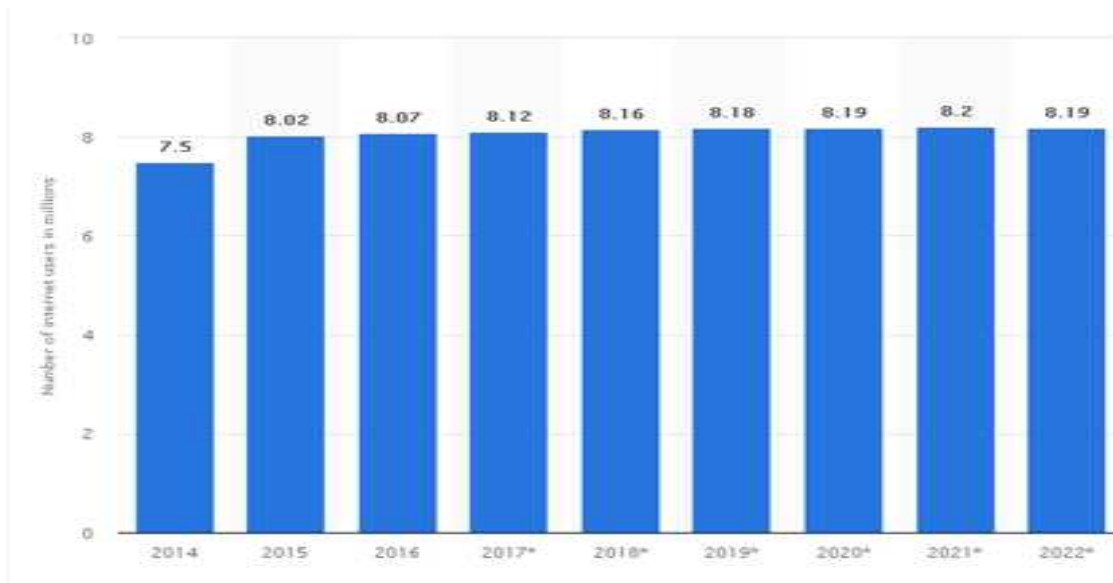
One more important statement about the business given by Blais, (4) in his book 'Business Analysis' (Best practice for success) is defined clearly.

"Business analysis is all about changes such as changes in business process, changes in the information technology system supporting business process and change in the way the organization does business."

Each author given the definition of business analysis in different way but it is related to each other. By these statements we can easily understand connection between the business goals and information technologies that must support them.

After analysis found how many companies, students, adults will be use internet 2015 to 2022 in future for daily schedule. In the introduction part mention the current value Czech Republic population they are using internet but this graph will describe the answer of this question:-

Forecast of internet user numbers in the Czech Republic from 2015 to 2022 (in million users)



Graph 1: Forecasting internet users (5)

3.1.1Analysis of requirements

In the requirements analysis, network analysts technically understand the business problems and the technical goal for increasing the growth of organization. In this task, the analyst can include logical and physical topology and transmission media. Oppenheimer, (2) wrote that in this phase is to analyze current and future network traffic, including traffic flow and load, protocol behaviour and quality of service(QOS) requirements.

The requirements of high availability of network infrastructure are Redland devices, switches, routers, network connections, Wi-Fi and internet is also important in the organization. The network should stay up all the time, even in the event of failed links, equipments failure and overloaded conditions and 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 and finding and fixing a problem should not be too time-consuming.

3.2Design process of Network infrastructure

3.2.1Network Basics

By Allan Johnson given the statement in his book "31 Days before your CCNA Exam" (6) simple and accurate lines about the network basics as follows: "In network basics can include network devices, components, diagrams, model, application and data flow."

Network architecture is the combination of hardware and software resources. It is the interconnection of multiple devices, generally termed as Hosts connected using multiple paths for the purpose of sending/receiving data or media.

3.2.1.1 Types of network

- **Local area network(LAN)** - LAN is the fraction of network that is connected to small area(50 to 100 KM). It is mostly used in geographical area such as school, small offices or one building. Krzysztof Iniewski, Carl McCrosky, Daniel Minoli wrote the simple and interesting definition about the LAN in their book (7), Typically, a local area network is connected to the public network using a firewall. The firewall provides data and security protection for a business. Firewalls also provide a convenient demarcation point between LAN, MAN and WAN infrastructure.
- **Metropolitan area network(MAN)**- It's coverage area is large rather than local area network. MAN network is useful for city into a single larger network. Karris, By Steven T, described the views in his book "Network Design and Management" as follows (8), A metropolitan area network is a high speed network that can carry voice, data and images at up to 200 mbps over distance of up to 75 km.
- **Wide area network(WAN)** - WAN is a telecommunication network that covered large distance. Krzysztof Iniewski, Carl McCrosky, Daniel Minoli (7), defined what is required to build a wide area network? A network should be flexible, which can be accomplished by providing a large number of interchanges to offload traffic at various points in the network.

3.2.1.2 Network Components

Network infrastructure consists of several components. These are basic components used in high availability architecture.

- **Network interface cards (NIC)** - In a network, each computer requires a network interface card. NIC allows the station on the network to communicate with each other.
- **Transmission medium** - one good statement about the transmission medium described by Elahi, Ata in his words (9), the transmission medium connects the computer together and provides the communication between

computers. Types of transmission are twisted pair, coaxial cable, optical fibre and wireless communication.

- **Network operating systems - NOS run on the server and allow** the service to the client such as login, password, and print file and file sharing.

3.2.1.3 Network Models

Network models are useful in computer network. Ata Elahi defined the network model in his book (9), types of network models as given:

Three types of network models are used based on type of network operation needed. These are:

Client/server In the client/server model, a client submits the task to the server; the servers then execute the client's request and return the results to the requesting client station. This process of information sharing is called client/server model.

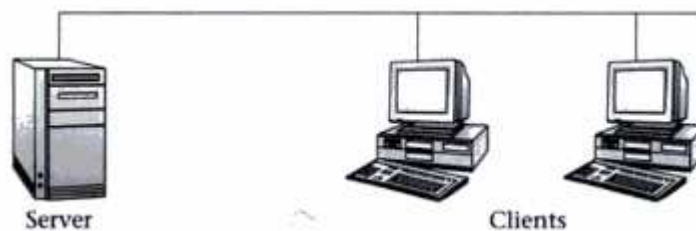


Figure 1: Client/Server (9)

Peer to peer Edwards, James Bramante, and Richard wrote lines in their book "Networking Self-Teaching Guide" about peer to peer networking simple way (10), A peer-to-peer network relationship that: are equals and they share resources that are necessary to be shared.

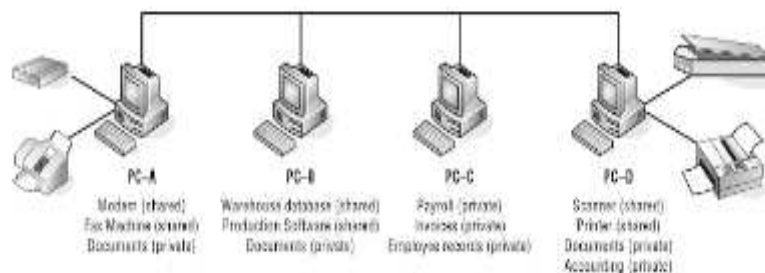


Figure 2: Peer-To-Peer Model (10)

Server Based model server based model, cover all the computers sharing files and network applications such as network database, service requests, operating system and manage operations of whole network.

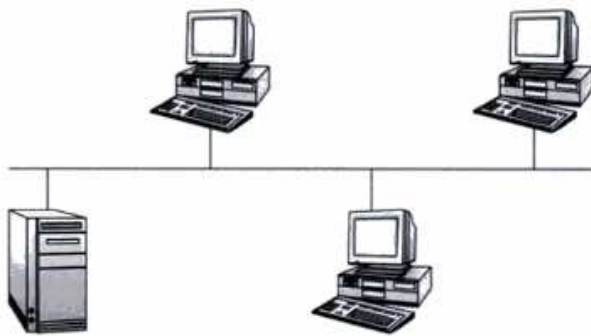


Figure 3: Server Based Model(9)

3.2.1.4 Network Topology

In this part of the chapter, will be introduce the most common topologies for small companies and explain their advantage. There are several kind of network topologies that are popular in the small companies network but mostly used five important topologies in small/medium companies.

Two types of network topologies are generally used physical topology and logical topology. Under the "**physical topology**", network devices are connected to cables and wires, but "**logical topology**" refers to how the devices, cables and wires appear to be connected regardless of the physical connections.

- **Star topology** -Star topology is a physical topology. In this topology, each computer is connected to a central hub like router or switch by the point-to-point connection. Local area network use star topology in small area.
- **Ring topology** -Krzysztof Iniewski, Carl McCrosky, Daniel Minoli defined the advantage of ring topology in their book as follows (7), The main advantage of the ring topology is its survivability: If a fibre cable is cut, the nodes have the intelligence to send the affected services via an alternative path.
- **Bus topology** - In the bus topology, each node is connected to a single cable by the help of interface connectors. Elahi, Ata. Cengage Learning(9) gave the

advantage and disadvantage of bus topology in his book "Network communication Technology" as follows:

"The advantages of bus topology are simplicity, low cost and easy expansion of the network and the disadvantage of the bus topology is that a breakdown in the bus cable brings the entire network down."

- **Mesh topology** - Mesh topology is a network topology in which devices are connected with many redundant interconnections between network nodes. In a true mesh topology every node has a connection to every other node in the network. There are two types of mesh topology full mesh and partial mesh.

In a full mesh topology, every computer in the network has a connection to each of the other computers in that network. The number of connections in this network can be calculated using the following formula (N is the number of computers in the network) $N(N-1)/2$.

In a partially connected mesh topology, at least two of the computers in the network have connections to multiple other computers in that network. It is an inexpensive way to implement redundancy in a network. In this topology if one of the primary computers or connections in the network fails, the rest of the network continues to operate normally.

- **Tree topology** - A **tree topology** is a special type of structure in which many connected elements are arranged like the branches of a tree. For example, tree topologies are frequently used to organize the computers in a corporate network.

In a tree topology, there can be only one connection between any two connected nodes. Because any two nodes can have only one mutual connection, tree topologies form a natural parent-child hierarchy.

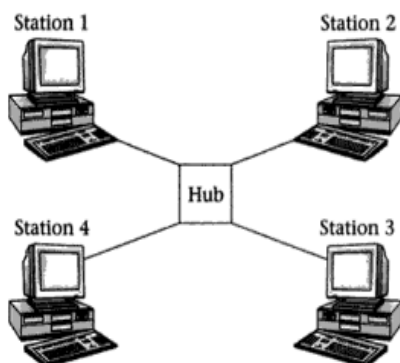


Figure4: Star Topology (9)

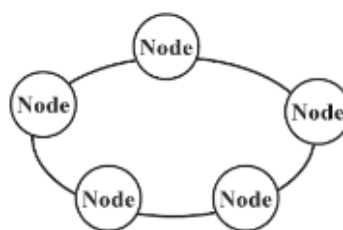


Figure5: Ring Topology (7)



Figure 6: Bus Topology (9)

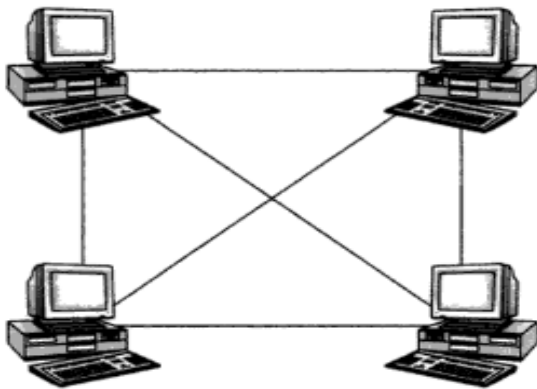


Figure 7: Mesh Topology (9)

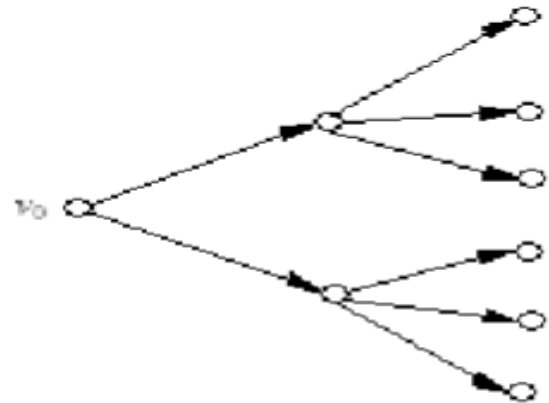


Figure 8: Tree Topology (10)

3.2.2 Network Protocol

Network protocols are necessary for network communication. Types of protocols are Transmission control protocol (TCP), User datagram protocol (UDP), Internet protocol (IP).

Elahi, Ata (9) represent the Transmission control protocol (TDP)/Internet protocol (IP), As is shown on the following Diagram:-

Transmission control protocol (TCP)/internet Protocol(IP):-

<i>Protocol</i>	<i>Service</i>
Internet protocol IP	Provides packed delivery between networks
Internet Control Message Protocol ICMP	Controls transmission errors and controls message between hosts and gateways
Address Resolution Protocol ARP	Request physical address from source
Reverse Address Resolution Protocol RARP	Response to the ARP
User Datagram Protocol UDP	Provides unreliable service between hosts
Transmission Control Protocol TCP	Provides reliable service between hosts
Simple Network Management Protocol SNMP	Used for diagnostics purposes between hosts

Table 1: TCP/IP Protocols and Their functions (9)

User Datagram Protocol(UDP):James Edwards, Richard Bramante defined the use of UDP in Network communication in their book briefly (10), UDP is preferred in situation where you need data to be transmitted quickly. UDP (User Datagram Protocol) is an alternative communications protocol to Transmission Control Protocol (TCP) used primarily for establishing low-latency and loss tolerating connections between applications on the Internet.

Routing protocol: -Firstly focus on the routing protocol's definition and protocols that are widely used nowadays in different kind of environments. Routing is a process of finding a way from the starting point to the destination- like a path. Routing consists of finding all the possible paths and choosing the shortest path. Therefore, a routing protocol does these things for the data that is flowing between the hosts. Amounting protocol makes a routing table for the hosts in the network.

The border Gateway protocol or BGP routes data between or within autonomous systems.

RIP stands for Routing information Protocol. This is probably one of the oldest routing protocol.

It utilizes user Datagram protocol packets when exchanging the routing information..

3.3 High availability

In this guide, firstly we will discuss what exactly high availability means and how it can improve the infrastructure's reliability.

Recently, the growth of the internet and the use of computing system to run business day to day. Chris Oggerino mentioned in his book different way (11), clear the content of high availability. In 1990, contacting individuals at some companies via electronic mail was possible but a decade later, thousands of highly reputable companies were offering consumers the ability to actually products from their web sites on the internet. As the internet's become more a part of our lives, we are becoming dependent on them.

We have come to depend on the use of computers, access to the internet, and the help of our internet sites. Many people regularly shop for things on the internet. Today, networks don't just carry sales transaction and business information. In fact, in some places, customer pick up a telephone, dial a telephone number. Voice traffic is becoming yet another part of data networks and data networks are becoming part of the telephone system.

In computing the term availability is used to describe the period of time when a service is available, as well as the time required by a system to respond to a request made by a user. High availability is a quality of a system or component that assures a high level of operational performance for given period of time. Erikaheidi (12), explained everything about high availability like, how it is work? Components of high availability and why is important in network infrastructure.

High availability functions as a failure response mechanism for infrastructure. The way that it works is quite simple conceptually but typically requires some specialized software and configuration.

The high availability is important because during setting up robust production system, minimizing downtime and service interruption is often priority. Regardless of how reliable the systems and software are, problems can occur that can bring down the applications and servers.

Implementation high availability for the infrastructure is a useful strategy to reduce the impact of these types of events. Highly availability system can recover from server or component failure automatically.

The main goal of high availability is to eliminate single points of failure in the infrastructure. A single point of failure is a component of technology stack that would cause a service interruption if it became unavailable.

To eliminate single point of failure, each layer of stack must be prepared for redundancy. For instance, let's imagine user have an infrastructure consisting of two identical, redundant web server behind a load balancer. The traffic coming from clients will be equally distributed between the web servers, but if one of the servers goes down, the load balancer will redirect all traffic to the remaining online server.

The web server layer in this scenario is not a single point of failure because:-

- *Redundant components for the same task are in place*
- *The mechanism on top of this layer is able to detect failure in the components and adapt its behavior for a timely recovery.*

The load balancer layer itself remains a single point of failure. Eliminating the remaining single point of failure. Redundancy alone cannot guarantee high availability. A mechanism must be in place for detecting failures and taking action when one of the components of stack becomes unavailable. Failure detection and recovery for redundant system can be implemented using a top-to-down approaches: the layer on top becomes responsible for monitoring the layer immediately beneath it for failure. In previous example scenario, the load balancer is the top layer. If one of the servers becomes unavailable, the load balancer will stop redirecting request for that specific server.

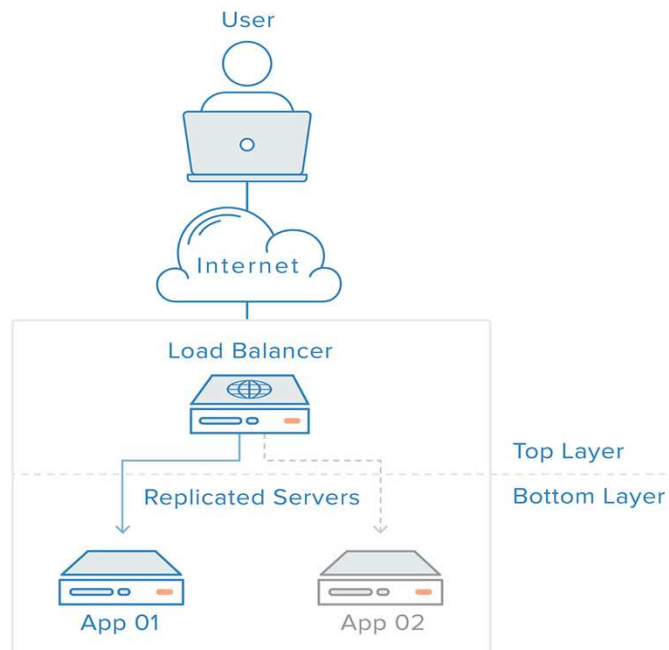


Figure 9: Top to bottom layersource (12)

This approach tends to be simpler, but it has limitation; there will be a point in the infrastructure where a top layer is either nonexistent or out of reach, which is the case with the load balancer in an external server would simply create a new single point of failure.

According to scenario, a distributed approach is necessary. Multiple redundant nodes must be connected together as a cluster where each node should be equally capable of failure detection and recovery.

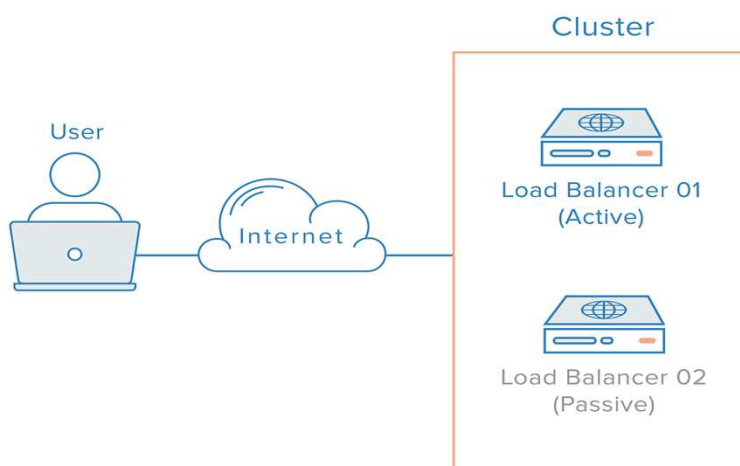


Figure 10:Load balancer case source (12)

In the load balancer case, however there's an additional complication, due to the way name server work. Recovering from a load balancer failure typically means a

failure to a redundant load balancer, which implies that a DNS change must be made in order to point a domain name to the redundant load balancer's IP address. A change like this can take a considerable amount of time to be propagated on the internet which would cause a serious downtime to the system.

A possible solution is to use DNS round-robin load balancing. However, this approach is not reliable as it leaves failover to the client-side application.

A more robust and reliable solution is to use a system that allows for flexible IP address remapping, such as floating IPs. On-demand IP address remapping eliminates the propagation and caching issues inherent in DNS changes by providing a static IP address that can be easily remapped when needed. The domain name can remain associated with the same IP address, while the IP address itself is moved between servers.

This is how a highly available infrastructure using Floating IPs looks like:

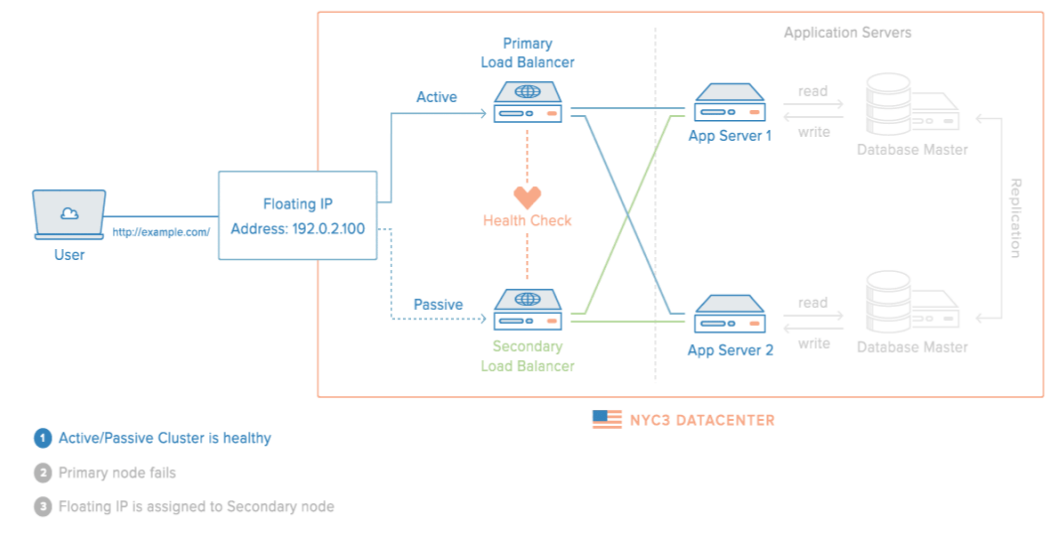


Figure 11: High availability source (12)

There are several components that must be carefully taken into consideration for implementation, high availability in practice. Much more than a software implementation, high availability depends on factors defined Erikaheidi (12), in her Article about the components of high availability following as:-

1. Environment: - If all the servers are located in the same geographical area, an environment high availability condition such as earthquake or flooding could take the whole system down. Having redundant servers in different datacentres and geographical areas will increase reliability.

2. **Hardware:** - highly availability servers should be resilient to power outages and hardware failures, including hard disks and network interfaces.
3. **Software:** - the whole software stack, including the operating system and the application itself, must be prepared for handled unexpected failure that could potentially require a system restart, for instance.
4. **Data:** - data loss and inconsistency can be caused by several factors, and it's not restricted to hard disk failures. Highlyavailability system must account for data safety in the event of a failure.
5. **Network:** - unplanned network outages represent another possible point of failure for high available systems. IT is important that a redundant network strategy is in place for possible failures.

Each layer of a highly available system will have different needs in terms of software and configuration. However, at the application level, load balancers represent an essential piece of software for creating any high availability setup.

HAProxy (High Availability Proxy) is a common choice for load balancing, as a it can handle load balancing at multiple layers and for different kinds of servers including Database servers.

3.4Security System

The traditional approach to internet security engineering has been to try to erect preventative measures. Networking issues when dealing with windows clients is the poor application of basic security services and features. There are some issues mostly create in small network infrastructure:

3.4.1 Networking Issues

According to Shimonsk (13) focus on window networking problems and explained which type of issues are most common:-

- **Initial Configuration** - There are many components to a typical network and as sizeand use grows, so do its complexities and the possibilities for problems to arise.
- **Credential, permission and rights problem** - When you configure and connected all system without issues but the problem that comes to mind with window system is credential, permission and rights. Most time, user wants to try access a host but they cannot **login** or they do not have permission to access resources once they are logged in.
- **Network performance** - The most common issue with networking in general. Speed and latency issues can be result of slow connection or from a network that is connected with data. For **example** if user will be use gigabit Ethernet between your

hosts, cabled connections will give you up to **1000 Mbps** of speed. Sometimes, switching to a wireless connections will drastically impact your network communication because today LAN based wireless will not produce more than about **54-100 Mbps** of transfer. In this **situation users will feel the pinch**.

Internet browsers can also issues. When use the newest version of internet explorer, if users apply all security settings, such as phishing filter but when to verify the site which also could resemble a network issues. Just remember that internet is not only the part of issues as well as system resources, bandwidth and other devices are responsible could be causing slowness.

- **TCP/IP and other protocol problems** - There are many reasons for creating the issues in networking system like ISP based protocol issues, DHCP, APIPA, IP addressing or different protocol. If you use DHCP , it is important to consider how IP tools like tracer, net stat, ping and patching can help but there are many users can use when not working with TCP/IP related problems.

If user does not have a network protocol configured, he will not be able to communicate over a network. **For example**if client computer cannot speak with the DHCP server which provide with its IP information, it will not function at all and be disconnected from the network.

- **General security concerns** - It is a fact that most of the network very easily over wireless connections. One common form of attach is intrusion. When someone surfing your neighbourhood jumping on an open wireless connection and using your resources (Such as Internet).

3.4.2 Network security resources

Around 20 years ago, the number of potential users was small and scope of the users' activity on the network was limited to local network only. As the internet expanded in its reach across national boundaries and as the number of users increased, potential risk to the network grew exponentially. Over the past 10 years ecommerce related activities such as online shopping, banking and social networking have permeated extensively, creating a dilemma for both service providers and their potential clients. The security policy must be a factor in client's level of access to the resources. John R. Vacca, James Joshi (14), explained their book about the current **objectives** of network security:-

- *Confidentiality*: - Only authorized users' can access to the network.
- *Integrity*: -Data cannot be modified by unauthorized users.
- *Access*: - Security must be designed so that authorized users have uninterrupted access to data.

Finally the responsibilities for the design and implementation of network security:-

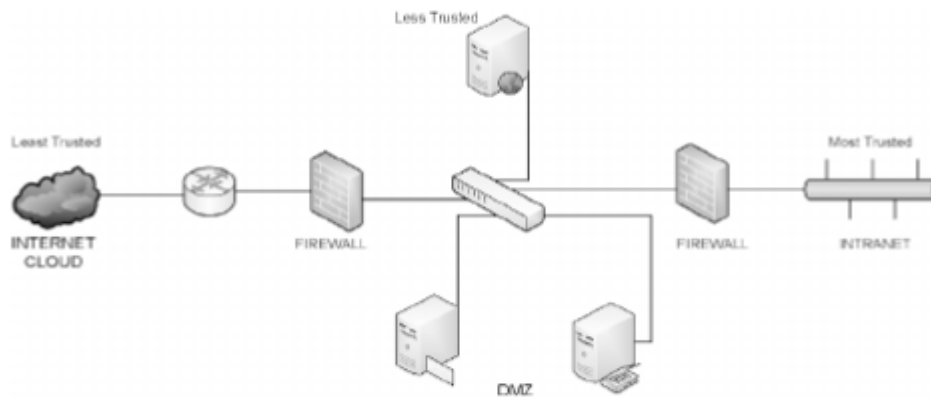


Figure12:Security Design (11)

The firewall to protect the infrastructure. The firewall uses like a filter, to control the speed of evolution seen in the area of infiltration tools, an approaches designed to put a stop to attacks will be less and less effective. A **firewall** is a barrier or shield that is intended to protect your PC, tablet, or phone from the data-based malware dangers that exist on the Internet. Data is exchanged between your computer and servers and routers in cyberspace, and firewalls monitor this data (sent in packets) to check whether this is safe or not. . John R. Vacca, James Joshi (14), described the types of firewall such as Packet filtering, Application-Layered firewall and Stateful-inspection Layer. We've been talking mainly about blocking hackers and various types of remote access malware so far, but firewalls are capable of more than this. As well as protecting personal directories from ransom ware, firewall applications might also feature the option to block particular online locations.

VPN Vulnerability- VPN use tunnelling protocols that encrypt data so it can travel safely through otherwise increase public internet. VPNs can even be extended to the LANs networking so they can have secure access to corporate resources over their cable or DSL connections. But if telecommuter has set up a wireless network in the company for sharing files, printer and even the internet access connection, the RF signals can be picked up but hackers hiding but outside. To prevent this from happening either corporate security staff must get involved in helping company to set up encryption or there must be corporate policy against the telecommuters using wireless technology as a condition for being allowed to work out of the company.

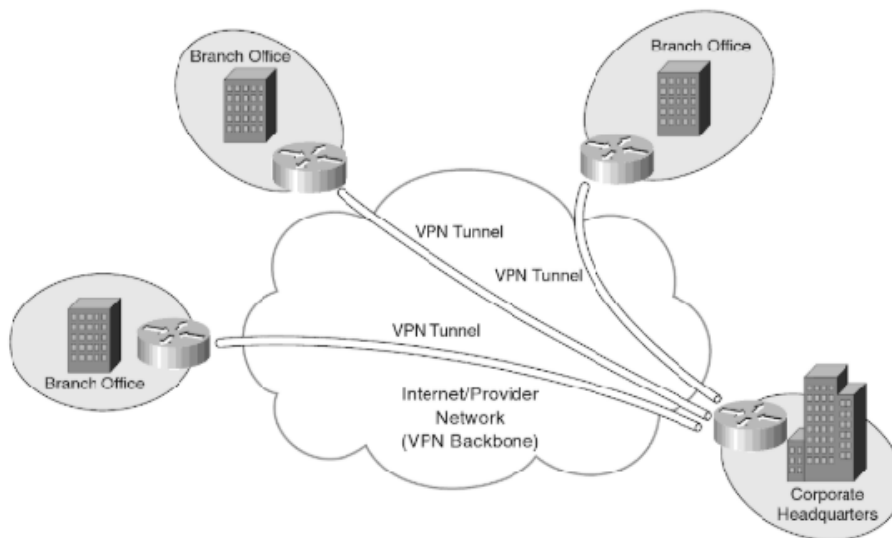


Figure 13:VPN Server (15)

A virtual Local Area network is a group of devices that share the same broadcast domain as if they are connected to the same wire, but in fact they are not. VLAN are used to group network devices and other equipment according to the type of data or security rules they share. The advantage of using switch VLANs over using routers are numerous. One of the important features is performance: while switches are fast to forward data, routers have created bottlenecks in the networks, slowing down the process. The other benefit is how easily the virtual groups are formed and how fast the data is forwarded between the members of the same group. In addition, VLAN it is easy to apply various security rules and access policies to the users, if they are in the same group. The most common way to implement VLANs is to select a group of ports on the switch and assign a set of rules to the PCs or similar devices that are connected to these ports. This approach is called port-based VLANs.

The **security features** of a network operating system are the first line of defence. Usually users having to enter a logon ID and password to access the internet but password should be having minimum six or seven characters. Anything less and they can be too easily broken by brute force guessing. Wrong nothing is that plain-text passwords are especially vulnerable on LANs, since each guess increase the chance of unauthorized entry by a factor of $1 \cdot N$ where N equal the number of password on the LAN to decrease the chance of a good guess.

Nathan J. Muller (16), this author provides the simple and easy solution regarding to password security. There are two systems of password protection that companies can employ to maintain security: **Hierarchical or specific**. Using hierarchical passwords users can employ a defined password to gain access to a designated security level as well as all lower levels. Specific passwords, on the other hand users can access only the intended level and not the other above or below. Although, specific-level passwords offer more security.

The Database security is also very important for LANs network. Nathan J. Muller (16) explained how to secure the data by data encryption:-

"The advantages of data encryption are clear: protection of messages, documents files and database from unauthorized access. But there are also risk and challenges associated with data encryption, including the increased latency in performance due to encrypt-decrypt processing which especially affects internet and wireless connections, and the restricted ability to look inside encrypted packets for routing and switching."

3.5IT security Management Framework

Information technology service management (ITSM) refers to all the activities policies and process that organization use for deploying managing and improving IT service delivery. The most famous ITSM framework is the information technology infrastructure library. ITIL was introduced in the 1980 through the United Kingdom's central computer and telecommunication Agency, but it is certified by AXELOS. Joe hertvik (17) defined the different frameworks regarding to needs. According to this knowledge company can select which framework will be better for his business as follows:-

- Business process framework.
- Control objectives for information and related technology (COBIT).
- Information technology infrastructure library(ITIL).
- ISO/IEC
- Knowledge centred service.
- Microsoft operation framework(MOF).
- Service integration and management (SIAM)/multisource service integration (MSI).
- SixSigma.

According to research(14), **ITIL** is the best for new network infrastructure. The ultimate goal of ITIL is to improve IT delivers and supports valued business services. ITIL is not just technology management or process management. It also focus on improving the capabilities of people, process and technology. ITIL provides value for an organization, it's resources and capabilities, including employees and customers. Adoption of the framework can be the foundation for success of other initiatives such as DevOps, cyber security, cyber-resilience, internet of things (IOT), and other emerging trends and technologies.

4. Practical Part

The main focus of this research is to analyse the current network structure of small middle size company, solution of the issues, provide better security and classify users with regard to their involvement and provide the high availability during the working hours. Hence, following research questions are derived for this study:-

The practical work carried out in this research is described in this chapter. The subchapters are based on the steps mentioned above. The case study based on the Fxnet Company. It is situated in Prague, Czech Republic. Fxnet LTD is a investment Firm (CIF), providing online trading services on Forex and CFD (Contracts for different business). This company apply Market Execution, which means that our Clients can expect order execution with no rejection and no re-quotes. Fxnet is managed by professional with a decade's worth of experience in the financial industry.

Even though the office workers use desktop computers and laptops in the offices in their daily operations, these computers are not networked. The only means of connecting with each other is via Internet using a router and switches. This system is very primitive and the communication is not efficient. Sharing construction project details and accessing them is not convenient at the moment and it affects the productivity of the company. Therefore Fxnet wishes to implement a cutting edge network system in their offices to resolve these issues.

4.1 Description of the Company

Fxnet is another mainstream Forex broker that is domiciled in Limasol, Cyprus but the broker has its clients located in over 50 different countries across the world. It is established in 2012 as an online currency trading dealing centre by now Fxnet has grown into mature investment company with widespread clientele from all over the world. This company has 300 employees they are enhance the daily operation. The location of this company in Prague is on the figure below. The headquarter of this company is situated in Cyprus. In 2014, Fxnet opened an office in South Africa and became authorized and regulated by the financial services board(South Africa). This company officially informed leading industry direction that they have voluntarily left 4 regulations in 2015, these regulations included of Russia, BaFin of Germany, Italy and FSP of New Zealand.



Figure 14:Map of FX net Company(18)

According to the company website (18), the main role of this company is to provide exceptional customer service, to excellent trading conditions and provides to customers always top priority. The company aspires to continue to improve the services and maintain the highest spectrum of customer satisfaction. Fxnet is using different trading software like, Met trader 4, Simple trader available for Android, IOS and Windows. Fxnet Forex broker distinguishes itself from the rivals by offering platinum accounts with Zero spreads, being thus the lowest spread on the market. Zero spread Forex allows customers to perform peaceful and low-cost trading not worrying about disbursement inherent to currency trading.

As well as the minimum deposit Forex with Fxnet broker is only 100 dollars and offer the best condition available on the market the company makes its services the most transparent, secure and trustworthy. The innovative ideas applied to the broker's trading software and investment technologies are the integral part of the general effectiveness demonstrated by fxnet's customers. Being registered and licensed in Cyprus the broker has necessary and sufficient regulation not to differ much from the other participants of the industry.

This company uses different languages in communication with customers such as, English, Arabic, Japanese, German, Greek, Russian, Chinese, Czech language. The other instruments of this company are commodities, currencies, shares, bonds, indices and (crypto currencies) like Bitcoin, Ethereum and Lightcoin. It provides some types of accounts, but the main account is Live account. This account uses by the customers for starting the online trading in a share Market. Fxnet also provide the Demo account facilities according to this account customer can get trail and experience if the customer wants to start trading with this company. This figure shows the all office structure how this company is setup:-

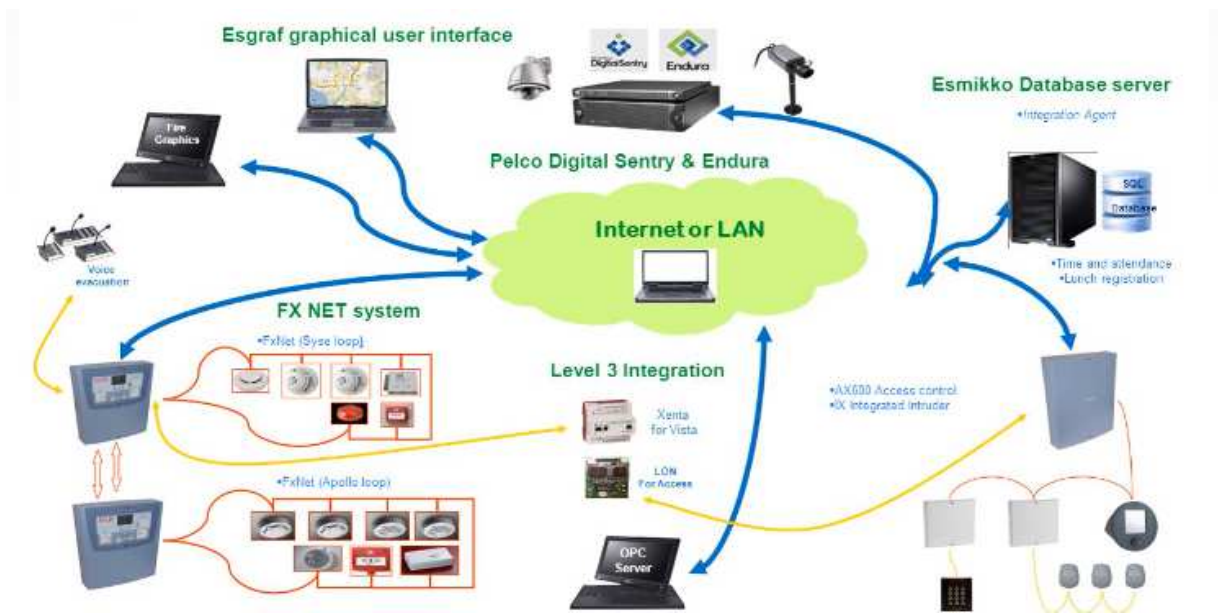


Figure 15:Structure of FX net company(18)

4.2 Current network infrastructure

Initially the existing system with its issues is discussed and then a new network design is proposed in this report considering the requirements of Fxnet. The new design proposes to have a servers, firewall, switches and routers they are connected to nodes and digital products Financial cost analysis is also included using the rough cost estimates. Finally, the benefits of the new network solution and recommendations are specified. In this structure uses routers to allow communication between those devices and the internet and also attached the firewall to protect the personal computers and private network from malicious mischief. Digital products are also parts of this structure because this is a sales broker company so the main use of these products.

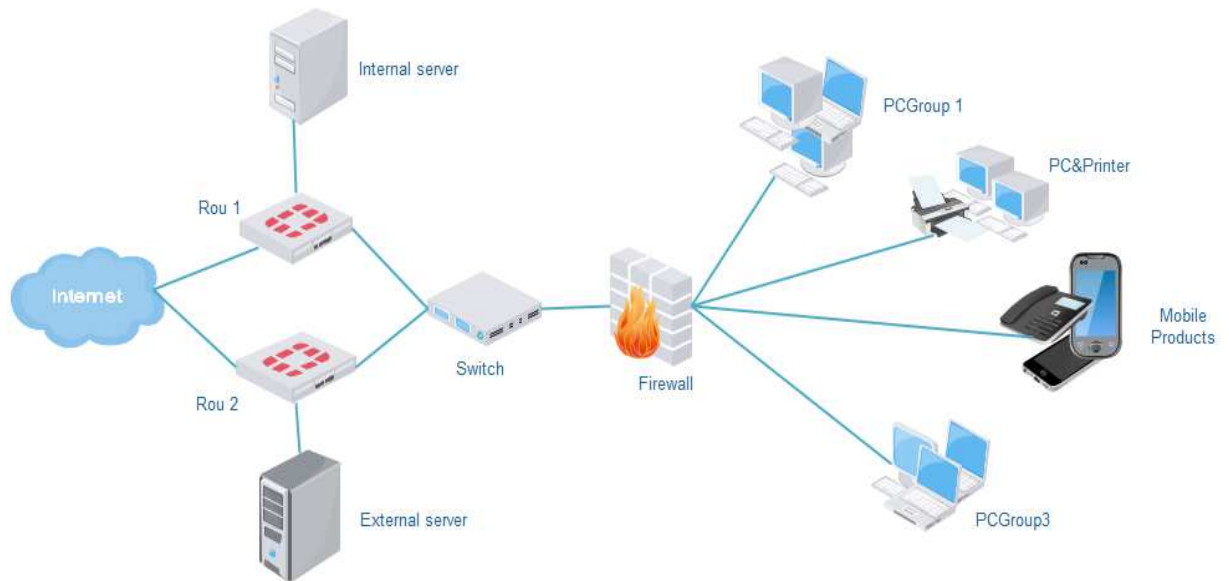


Figure 16:Current network infrastructure (own)

This is not efficient due to the increasing number of projects in the company Fxnet is looking forward towards implementing a modern technology infrastructure which solves the issues in reporting and monitoring of its projects and which increases the efficiency of communications.

4.3 Analysis of Business Challenges & Design of the New Network

According to analysis the current network infrastructure, the main issues in this structure is Poor high availability means (Single point failure problem)SPOF Internet has become so pervasive and integral for conducting business and communicating with customers, partners and employees, that network performance and high-availability required for running the day-to-day operations of an organization. Network downtime not only loss costs money and loss of productivity, it can also affect a company's reputation among customers and partners. In this situation, their entire business strategy depends on how well the network performs.

According to market research firm infonetics, large enterprises typically lose one-half percent to 16 percent of their annual revenues due to network downtime. The more companies are suffering service-provider interruption. According to survey, retailers are affected the most with service providers more than 30 percent of their downtime costs. Another cause of failover is human error, which accounts 5 percent loss of costs. . This company needs to implement the network structure for increasing the high availability between servers and users. This figure describing which type of problems can be occur during the daily operation:-

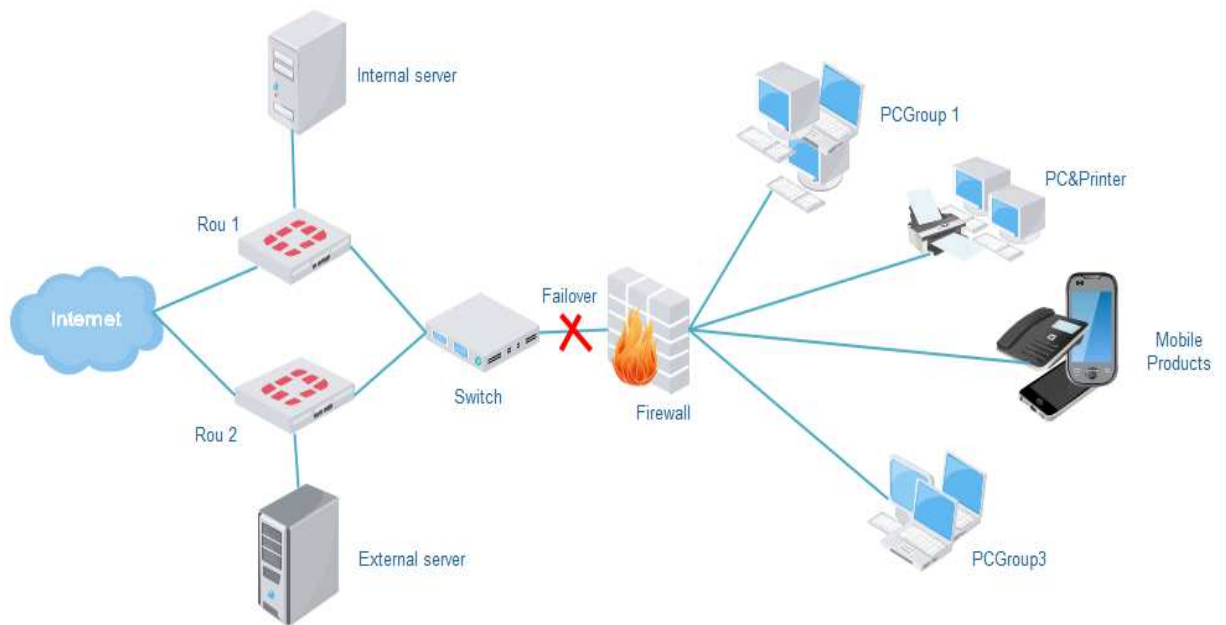


Figure 17:Analysis Structure(own)

Failover within a communication network is the process of instantly transferring tasks from a failed component to a similar redundant component to avoid description and maintain operation. Automated failover is the ability to quickly reroute data automatically from a failed component such as a server or network connection, to a functioning component and is essential for mission-critical systems.

Types of failure

Machine failures, physical or virtual are the most obvious examples of single point of failure. Here is a quick list of potential issues:

- Physical or Virtual database server
- Physical or virtual web or application nodes.
- Physical or virtual web or application nodes that store data on the node's file system or memory.

Other physical or virtual infrastructure that can be Single Point of failure:

- Routers
- Data Centers
- Proxies

- Power

Credit cards used to sign up for a SAAS solution used in the platform.

Turning our attention to people and processes has the following examples of single point of failure:

- Only one person has the knowledge or credentials to deploy to production.
- Only one person knows how something in a product works.
- Only one person has credentials to any supporting to any supporting system for a product, for example the aggregated of an application.

Tests or validation can only be run by one person on one single physical machine.

Different components may be configured for either cold standby (human intervention), warm standby (automatic but delayed) or hot standby (automatic) failover. The three critical elements requiring failover configuration are power, network connectivity and server capacity.

Device failures situation involving a device, such as a firewall, router, WAN controller server load balancer, disk drive, web server etc. Data is transferred to the same type of redundant component to ensure there is limited interruption in data flow and operation. If a primary component serves as a backup and takes over for its failed counterpart. The capability to switch automatically to a redundant or standby system or network upon failure without human intervention. Automated failover is essential in servers, systems or networks requiring continuous availability and high degree of reliability-that are responsible for mission-critical processes and data.

4.3.1 Business Requirements

4.3.1.1 Network Scale Requirements

Fxnet is looking for a new network solution that connects all of its offices with each other. The data centre should be located in Headquarters. There are about 300 employees who need direct access to company network from their branch offices. Each branch and office should have a private network to access these files and to communicate with each other. In the company for employees should be flexible, they can use their digital products, laptop and other devices. The LAN ports on any scale computing nodes are in an active/passive bond used for failover. This means that only one LAN port is ever active at a time. There is a primary and secondary port: which physical port is correlates to in the system is different ports, 1GbE, 10 GbE SFP+ nodes but will always be designated LAN0. For redundancy, both LAN0 and LAN1 ports on a node should always be attached into the switches.

LAN IP address should be assigned from your primary data network and are used by user system's nodes to communicate data between the system and network. Andrews, Jean(19) A small company can rely solely on private IP address for its internal network and use only the one public IP address assigned to it by its ISP for internet communication. IEEE recommends that the following IP address be used for private networks:-

<i>LAN address range</i>
10.0.0.0 through 10.255.255.255
172.16.0.0 through 172.16.255.255
192.168.0.0 through 192.168.255.255

Table2: LAN address range(19)

Power: -Power failure being one of the most common reasons for network and systems failures. All critical network components at either the primary data enter, call centre or failover site must be connected to a power source that has very high-availability – 99.999% in the case of data enter.

Large data centre and critical operations, such as call centres,must really on multiple electric power companies to provide utility power to their locations. If power is interrupted by an accident that severs electric lines at a particular location, the other utility can continue to provide uninterrupted power.

Network redundancy: -Level of redundancy should be determined for the primary and backup networks based on the identification of critical network components, impact analyses and established recovery objectives. There should be consideration for redundancy of network devices such as switches, routers, gateway etc. There should also be consideration given to redundant components such as power supplies, CPUs and circuit cards for the network switches and routers.

4.3.1.2Security requirements

Regardless of the size of business, the most effective security measure to deploy to block threat actors from gaining access to servers, workstation and data is a hardware firewall. A hardware firewall will ensure the digital assets are well protected but how should firewall be configured for optimal network security? If users follow network segmentation best practices and set up firewall security zones than user can improve security and keep internal network isolated and protected from web-based attacks.

The firewall offers protection by controlling traffic, hosts and security zones, whether at the IP, port or application level.

4.3.1.3 Network Service Requirements

Following networks services are required for Fxnet Company.

- Authentication Service
- Email
- Printing
- Network File System
- Directory Service
- Voice over IP
- World Wide Web (Internet)

4.3.1.4 Network System Requirements

Following network system requirements are required by Fxnet Company.

- The network must function properly. It should accommodate all services, tasks, data and systems of the different groups in the office.
- The network must be able to grow (scalability) as the Fxnet Company has future growth plans. It should consider all aspects of the future expansion of the offices.
- The network should be designed by considering future technology advancement (adaptability). It should minimize design elements that would limit adoption of new technologies.
- To keep with user expectations and industry standards, the network design should accompany design elements to increase its reliability as much as possible.
- The network shall use **ISP**, internet service provider is offers website hosting and related services. ISP acts as “Data warehouse” leasing out their large computing capacity to many thousands of website operators, non-profit groups and government agencies.
- The network should have a firewall to provide sufficient security.

4.4Design of the New Network

4.4.1Implementation

The new proposed design has the following functionality,

- The new design supports e-mail exchange, web-application, active directory and VOIP.
- E-mail service will provide the easiest and flexible way of communication. This is important for the smooth flow of confidential and financial data.
- Through the configured Active Directory server Single Sign on can be provided to all the users. Further this will facilitate highly secured access to data through the usage of security policies and unified access to resources.
- The proposed design also has two firewall, connected in between with router and which servers are connected. This firewall is to restrict unauthorized access to the network. This is security part of network infrastructure so every user or organization should have deep knowledge about the security device. This new network design secure by firewall. Actually this is a small company, it has some issues related to network architecture. There are many security devices are available in the market but user should know which device will be better for security.
- To minimize the load balance and to increase the reliability, high availability the proposed design follows a top-down hierarchical network structure (Core - Distribution-Access).
- This moment each group successfully passes the stage of authentication, they can easily communicate directly with each other.
- The new network design is connected to Internet Service provider (ISP) , that provides internet access to companies, mobile users etc. ISP use fibre-optics, satellite, copper wire and other forms to provide internet access to its customers.
- Internal server and External server also uses in this structure. Internal server is software that runs inside the server. This server check user system resources and Reports to processes back in real time. USER can track a wide range of variables such as the server's memory usages, CPU load and network traffic using this type of server.

If server goes down completely, internal server won't be able to alert user as to the problem. External monitoring service will know of the outage within second and will alert user via phone call, email and sms text message. Internal server is not enough to protect your website server. If company want to protect server fullest, they need either rely on an external server monitoring service or a combination of external server and internal server.

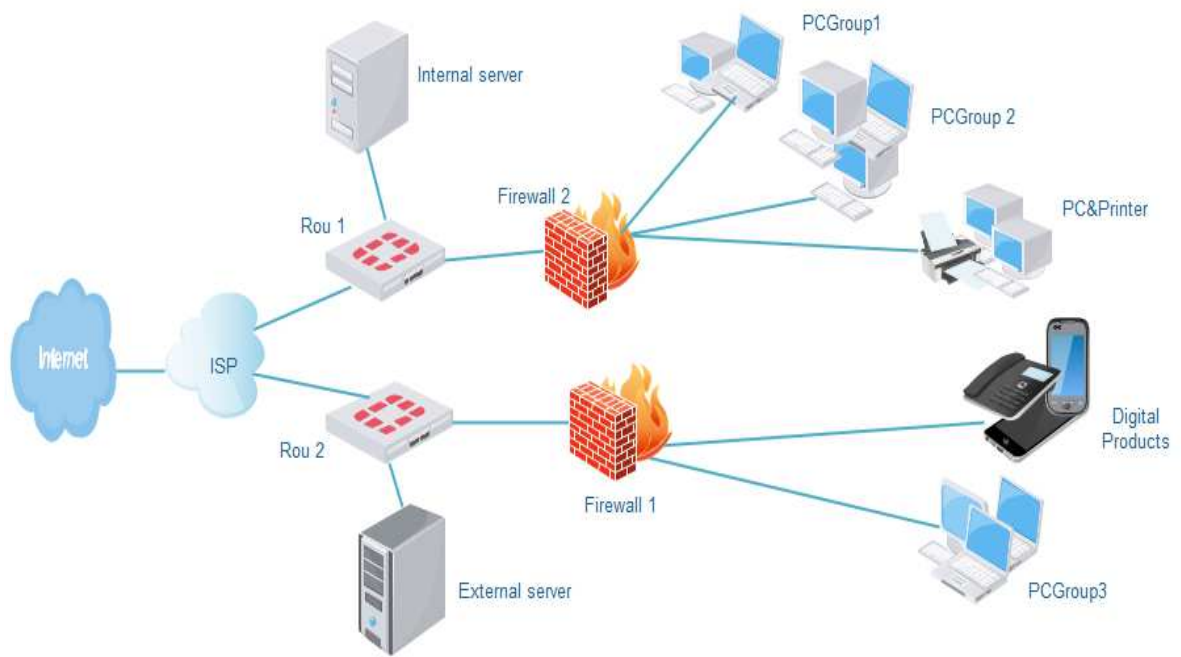


Figure 18:New Network Design source (own)

The table below shows how a server protected by a firewall to different request depending on the policy being applied to the destination port:-

<i>Client Packet Type</i>	<i>NMap Command</i>	<i>Port Policy</i>	<i>Response</i>	<i>Inferred Port State</i>
TCP	nmap[-St l-Ss]-Pn <Server>	Accept	TCP SYN/ACK	Open
TCP	nmap [-St l-Ss]-Pn <Server>	Drop	(none)	Filtered
TCP	nmap [-St-Ss]-Pn <Server>	Reject	TCP RESET	Closed
UDP	nmap -sU-Pn <Server>	Accept	(none)	Open or Filtered
UDP	nmap -sU-Pn <Server>	Drop	(none)	Open or Filtered
UDP	nmap -sU-Pn <Server>	Reject	ICMP port Unreachable	Closed

Table 3:Firewall Policy Source (own)

The first column indicates the packet type sent by the client. In the second column, users included the nmap command that can be used to test each scenario. The third column indicates the port policy being applied to the port. The fourth column is the response the server will send back and the fifth column is what the client can infer about the port based on the response it has received.

4.4.2Network Cabling

The network cable used to connect the devices inside each of the offices optical fibre cable because this is a transmission medium commonly used in data networks, passive optical networks and others. It can be defined by a thin, transparent flexible glass or plastic, by which light pulses are sent in order to represent data to be transmitted. This fibre is widely used in telecommunication, since they allow sending large amounts of data at a great distance and having higher bandwidth than other forms of communication.

Ethernet cables are of different types and ranges. These types are defined by Electronic industries Association and Telecommunication industry Association. The new structure used cat 5E cables, cat6 cables and cat 7 shielded Booted Cables. Specification is paramount to network cables, so do the cat6 and cat7 Ethernet Cables. Besides, Cat7 is backwards compatible with traditional cat5 and cat6 Ethernet.

ISP will more supply with a copper medium, such as that used for DSL or cable broadband. This works by sending electrical pulses through a copper wire. Broadband is cheap and provides excellent internet service to the small company.

4.5Financial cost of New Network infrastructure

A rough estimate of the costs of the New Network Implementation is given below in Czk. Before explaining these devices should know what is the use and why using in new network design.

Internal Server(HP ProLiant ML10 G9 Intel Xeon E3-1225v5 Quad Core) delivers a full featured single-socket tower server with the right features at a competitive price easy to use maintain for growing small business and remote branches. What's new in this clear OS, an easy to use OS with an applications marketplace, allow user to build a fully functional server that just right for user at no more cost. Features of this product as Processor model- G4400, CPU frequency-3.3 GHz, chipset-intel c236 chipset, Cash memory-8MB(1*8MB) level 3 cache and so on.

The second device is **External server**(Dell Power Edge T30) has processor series Intel Xeon. Data processing is handled by a quad-core processor E3-1225 v5 skylake, which operates at 3.3 GHz. The processor works with 16 GB DDR4 RAM, which perfectly performance of the server with four slots, user can easily increase the

operating memory up to a maximum of 64 GB. Data can be store with a pair of HDD units with a total capacity of 2,000GB. Number of processor core are 4*. This PowerEdgw T30 by sharing information, helps to improve acces to information and get more done in less time. Also it is consolidate data, images and vidios stored on multiple media and multiple locations with user can store data and organize stacks of DVDs, USB drives and external hard drives.

Enhance productivity

- Save time when moving or coping files between locations:- Aserver offers faster data transfer compared to cloud storage or email.
- Attain better business-transaction response times.

Secure and manageable

- Backup and restore:- Easily implemment automatic data backup with Microsoft windows server.
- Easy management:- Update software applications in one place instead of multiple PCs to simple task and save time.

Business growth

- Easy attach additional devices : with up to 10 external USB ports
- Expand flexibly: with four PCI/PCIe slots and allow to grow the pace
- Consolodate data and media files: it has large storage capacity.
- Drive applications and media quickly: with a powerful intel@multi-core processor
- Support large memory capacity:with up to four DDR 4 to enhance application response time.

The third devices are **Firewalls**(Dell Sonic Wall TZ300 Firewall).This firewall gives small businaess to full advantage of high-speed connectivity without compromising the highly effective protection to cyber attacks. Moreover it also provide full-featured security that combine intrusion prevension, antivirus, anti-spyware and anti-spam.

Fast, reliable, improved performance: This firewall use the patented Ressembly-free Deep Packlet Inspection to test traffic on all ports without slowing down the network. It also provide bandwidth for critical business applcations while blocking non-productive applications. **Mobile users**native VPN remote access clients for Apple iOS, Google Android, Windows, Mac OSX and Linux with this firewall.

Key properties: It has a firewall througput of up to 750 Mbps and VPN up to 300 Mbps. It features 5x 10/100/1000 LAN nad 1x USB ports. It allows up to 50,000 connections (SPI and DPI) and provides 25 VLAN interfaces and so on.

Another important device is Routers (HP JD431A HP A-MSR20-10 Multi-service). It has modular design that delivers flexibility for small to middle-sized business, while reducing complexity and increasing control. These routers enable an agile,

flexible network infrastructure that offers the ability to quickly to changing business requirements and easy to manage platform.

Notebook used in the company (HP 15-ra041).15.6 “Notebook“, Matte HD Display, Intel core processor(2.48GHz), memory card reader, DVD drive, numeric keypad, webcam and window operating system. User can store 500GB hard drive that can easily accomodate both photos and important documents. In addition, wireless path is available with Bluetooth and Wi-Fi.Also Desktop (Dell MFS18 PRO Optiplex)used for daily operation.It is retractable telescopic handle allows easy to carry the MFF desktop, stand and monitor.

Mobile devices also important part of this company because this is a sales company. Nokia mobile products use this company because the battery back-up is better in the handsets produced by this company and fast internet surfing speed on these phones as they are based on some of the best technologies. In the end will be describe the cables connections. In this structure used Fibreoptic cable, Coaxial cable and Ethernet cable for connect router to each device in the company.

Table 4: Hardware cost estimates for the New Network

Item No	Item Description	Qty	Unit Price	Amount
1	Internal Server (HP ProLiant ML10 G9 Intel Xeon E3-1225v5 Quad Core)	1	10,999 Czk	10,999 Czk
2	External server (Dell Power Edge T30)	1	24,000Czk	24,000Czk
3	Firewall (Dell Sonic Wall TZ300 Firewall)	2	15,000 Czk	30,000 Czk
4	Router (HP JD431A HP A-MSR20-10 Multi-service)	2	13,000 Czk	26,000 Czk
5	HP 15-ra041ncBlackNotebook (3FY44EA #BCM)	3	5,000 Czk	15,000 Czk
6	Dell All in one stojaMFS1PRO Optiplex MFF (452-BCQC)	4	2,500 Czk	10,000 Czk
7	Mobile devices	5	8,00Czk	4,000 Czk
8	Total cost cables (Fiber Max advertised speed (down/up))		2,800 Czk	2,800 Czk
	Total Hardware Cost			122,799Czk

Table 5: Total cost estimates for the new network

Labour Cost of Installation & Configuration

Calculated by 1 **hour (50Czk)**, total hours 8,40 hours =42,000 Czk

Total Hardware cost=	122,799 Czk
Labour cost	= <u>42,000</u> Czk
Total Cost	<u>164,799</u> Czk

Financial costs also known as “financing costs and borrowing costs”. Companies finance their operation either through equity financing or through borrowings. Finance costs are usually understood to be referred to interest costs. The term “finance cost” has broader and also include costs other than just interest expense. Finance costs also include:

“Finance charges in respect of the finance leases.”

Some people are motivated by the desire to be on the leading for an employee service. For full time employees, salary is generally described in annual, monthly, bi-weekly or weekly amounts. For part-time employees it is generally describes as an hourly amount.

To determine an appropriate salary and salary range that company is willing to pay for a position, employee must:-

- Establish the value of the position based on employee organizational requirements.
- Understand what the market is paying for a similar position.

Defining compensation is an important activity for all companies, including start-ups:-

Affordable: for the company.

Structured: to ensure that employees efforts are directed to achieving the company’s goals.

Reasonably competitive: such that it attracts & retain quality people.

According to this financial cost mentioned above by the help of table total hardware cost and labour cost. Table describing how many devices used for implemented the new network infrastructure and how much cost of per devices but the total costs including the labour configuration. Labour costs based on how many hours did work during this process after doing the calculation 8,40 hours are used in this process. These hours not only one employee is calculated total employees. Regarding to Czech Republic each employee can do 40 hours work in one week and other employees such as analyst, programmer and tester do according to work. This financial cost based on three month processing.

5 Results and Discussion

In this chapter will be discus about two different companies. They have different network structure, separate to each other. Although it doesn't carry quite the same attraction, investing in start up and established business can be as profitable as running them. Firstly we should have knowledge of the infrastructure before establish the company. There are often opportunities to make direct investment in a business owner have some knowledge of area and process of the company setup. Both types of investments carry a level of risk that matches the outsized rewards if a business is successful, so it is important to thoroughly research these opportunities.

Today, most companies engage in strategic planning although the degrees of sophistication and formality considerably. A strategy means a long-term action plan to achieving the objectives defined. A strategy leads to single measures that are necessary to achieve the objectives. Nadine Pahl (20) described in his book about SWOT analysis clearly and mentions strategy planning process consists of the following six steps:-

THE STRATEGIC PLANNING PROCESS

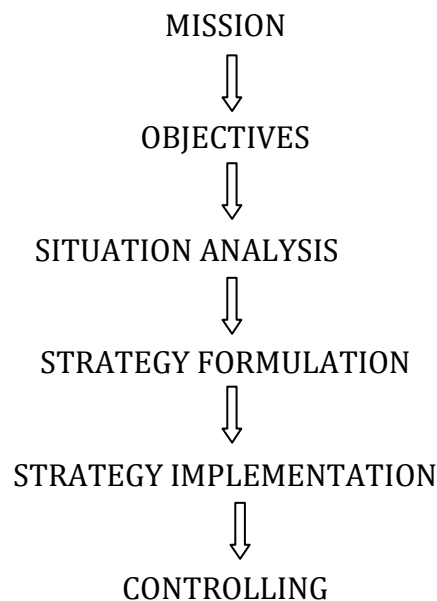


Figure shows how strategies being with objectives, which naturally follow from a company's mission that is the reason for being objectives are concrete goals that a company seeks to reach. The Swot analysis is a tool for such a situation analysis. The abbreviation SWOT stands for strengths, weakness, opportunities and threats. The SWOT analysis provide a framework for analysing strength and weakness (internal) and (external). It helps to focus on strength, to minimize weakness and to take the greatest possible advantage of opportunities. Alan, Saraby (21) explained in his book clearly what is factor of SWOT and how it is helpful for organization. It will describe the parameters of SWOT analysis by this figure:

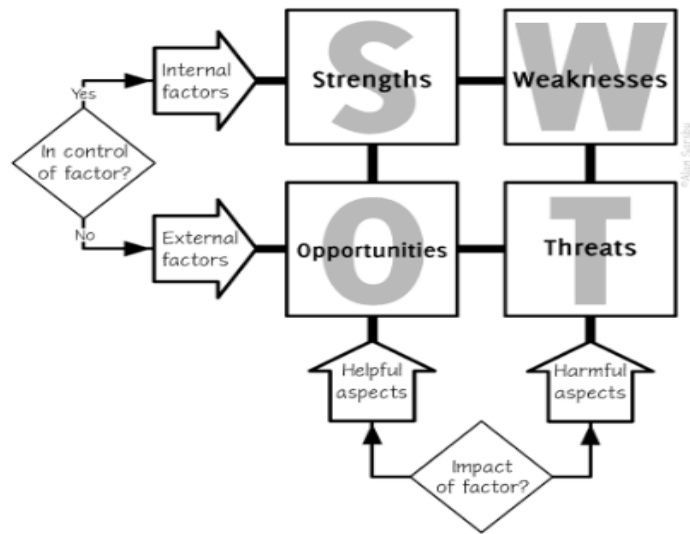


Figure 19: SWOT analysis (21)

Internal factors: Internal factors are those company and company owner have control over.

External factor: External factor which company has little or no control.

Helpful factors: Helpful factors are assist company success.

Harmful factors: Harmful factors are stop or block company success.

SWOT quadrants

Strengths factors that support an opportunity or overcome a threat. It might include:-

- Financial strength: balance sheet, cash flow, credit rating.
- Technologies advantage: Structure, devices, know-how.
- Customer services: marketing, sales, service, reputation.
- People: Talented, dedicated, skilled, well-trained.

Weaknesses are harmful objective. These are factors unable to take advantage or are vulnerable to a threat. It might include:-

- Financial weaknesses such as high budget.
- Old or inflexible technology or processes.
- Customer service weakness like long process, time or poor customer communication.
- Skills shortage or poor employee skills.

Opportunities are external factors but could be helpful. It has many sources such as:-

- Competitors withdrawing from the markets.
- New social trends.
- Technological innovations.
- Opportunities can be tangible, such as new products, or intangible such as enhanced reputation

Threats are external and harmful factors which company have no control. Threats are also tangible or intangible. A tangible threat could be a new competitors or theft. Intangible threats include potential loss of reputation or brand damaging factors. Factors exist in several places on a SWOT analysis. A few examples gave Allan Saraby (21) follow as:-

“User proprietary software does what user want it to do, and hence might be a strength. On the other hand, the cost of maintaining software might be expensive and hence a weakness.”

“ if customer billing system may be robust and reliable, satisfying, regulatory standards for billing and invoicing, it is strength, But in the context of an opportunity that requires flexible invoicing, customer billing system might be weakness.”

5.13i Infotech Ltd Company (India)

It is a IT company in India. According to source (22) headquarter of this company in Mumbai, India since 1993, this company has been driving business in all industries. This company has around 5000 employees, near about 24 offices across 12 countries. It has 1500+customers in 50 countries. This company offer set of IP based software solution and a wide range of IT services. 3i Infotech is growing successfully business operation of customers globally.

The company has a very strong foothold and customer base in geographies like South Asia, middle East and Africa, Asia pacific, Kingdom of saudi Arabia. Among its countries of IPR based solution the flagship products of the company are premis, Mfund, Kastle and Amlock, infrastructure Management, Testing & compliance, application development & Maintenance, consulting and its BPO offering. The company's global delivery solution for today's agile business enviroments. The Revenue of this company is 9.912 billion INR , (March 2018).

The company's quality certification include ISO 9001:2008 for BPO, IMS, ADMS & BI, ISO/IFC 27001:2013 for Data Centre, ETG and Support functions, CMMI Level 3 for Development and services.

The goal of this company are **innovation, Insight, Integrity**. Flexibility is the key to our offering and the spirit of innovation that to our products and services-from the

stage of design to implementation and customer support. 3i Infotech strives to provide service to its customers emphasis on continuous improvement, pro-active approach, courtesy, timely response and accuracy, with a goal of achieving total customer satisfaction.

Customer Support:- Customer Direct is one-stop shop for resolution of all software issues related to products and services provided by 3i Infotech.

- Users are never far away from help, whatever your location. Just log on, register the issues and company support services swing into action immediately.
- Through the 3i Infotech Foundation, users carry out corporate social Responsibilities (CSR) initiatives focused on nurturing the earth and supporting its people.
- 3i Infotech Foundation supports sahayog by providing monetary aid and participating in initiatives like coaching grade 10 to 15 students and organizing a mobile science Laboratory. This company also provide financial and hardware support for several other activities such as:
 - Setting up new school
 - Medical camps to address region-specific medical problems
 - Proper sanitation facilities for girl's school.



Figure 20: Map of 3i Infotech

Now will be described how this company works on daily operation in the office and provide the services to the customers. Some important information about this company like as Revenue Run-rate of US\$ 300 million, Net Margin 15%, World Wide Presence, Focused BFSI players with 75% revenue, Software development in Mumbai, Chennai, Bangalore and Hyderabad in India, CAGR of 61% in revenue in last four years, out of which 41% is Organic and 21% Inorganic and Platform ready to take off for a major growth.

Technical structure of this company describe how this company technically attached business Tier, Business Objects and Data Tier? How this company store important data according to this structure? This figure shows as:-

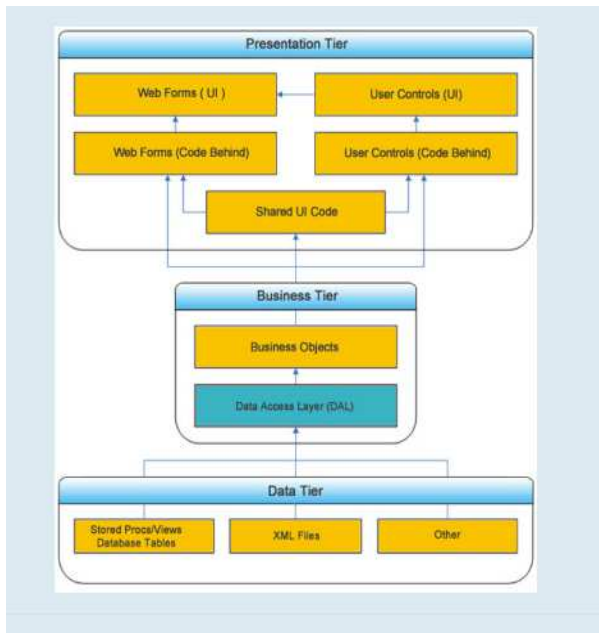


Figure 21: Technical Architecture(22)

This figure shows Development Architecture of 3i Infotech:-

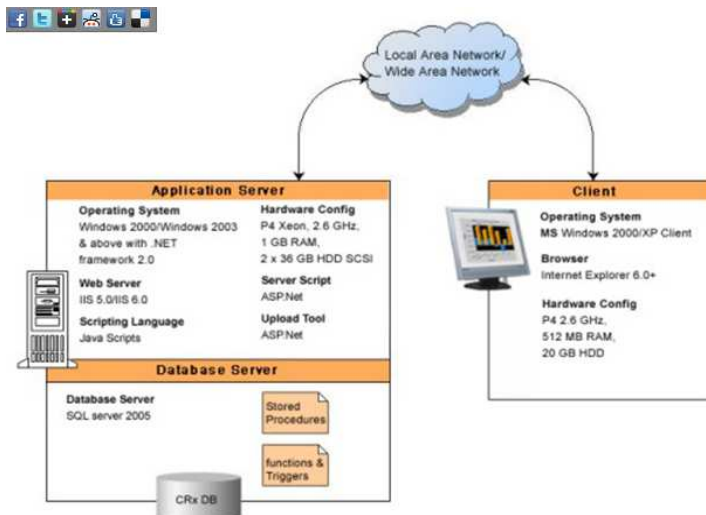


Figure 22: Development Architecture (22)

The current network structure of 3i Infotech company and represent the local workgroup and workstation. They are connected to each other by the help of MAUs (Multi-station Access Unites. It is also used server as central repository of data and various programs that are shared by users in a network. Most computer networks support one or more servers that handle specialized tasks. As a rule, The larger network in terms of clients that connect to it or the amount of data that it moves, the more likely it is that several servers play a role, each dedicated to a specific purpose.

This is a small firm so here used only one server according to amount of data. This network structure used two connections such as IBM connection and R.J 45 connectors. IBM connection is a collaboration platform that integrates email, activity and task management, instant messaging sharing, collaborative document editing and more into a unified solution. Second connector is used for Ethernet networking. Since Ethernet cables have an RJ45 connector on each end, Ethernet cables are sometimes also called RJ45. It is a standardized networking interface. There are many branches in this company such as Administration, human resources, Marketing and accounting departments. All the departments are connected to each other. Every departments has different works.

This network structure of human resource branche. How client and server are connected to each other? How they send information? Which type of devices used in this company? This network infrastructure is better or not? What is advantage and disadvantage of this structure? This figure shows as:-

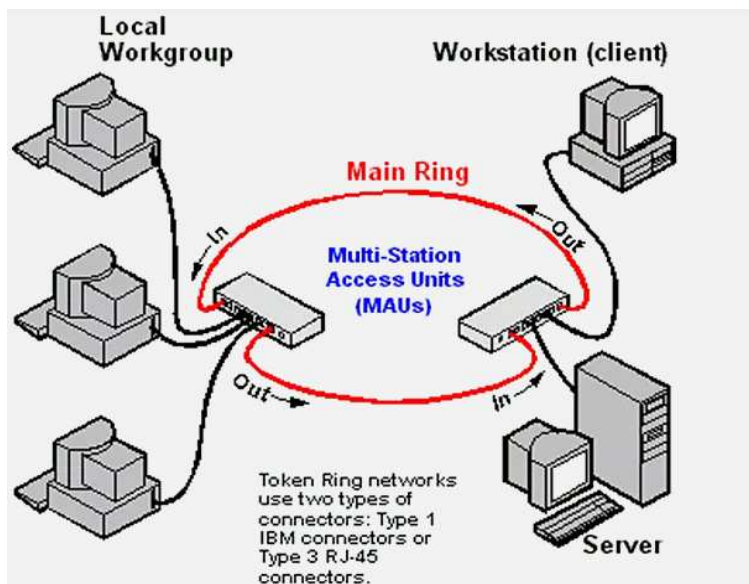


Figure 23: Network structure of 3i Infotech companySource (23)

- A multistation access unit or Ethernet media attachment unit are both abbreviated as MAU.
- Multistation access unit is hub or concentrator connecting a group of computers in a star topology while retaining the logical ring structure-actual wiring is in star topology with stations connected in a star pattern to a central MAU.
- MAU provides 8 or 16 posts for connecting stations to the “ring”-includes one ring-out and one ring-in connector.

- Advantage from actual ring is that –if one computer fails, the MSAU can bypass it and the “ring” will remain intact.

5.1.1 Advantage

The advantage of having a MAU operate without power is that they can be placed in areas without outlets.

MAU (also known as the transceiver) detects the carrier and signal activity on the media, when collisions occur and forwards this information to the remaining activity.

If you need to locate workstation at distance greater than 100 meters from the MAU, user can use repeaters or a powered MAU with built-in repeaters for greater lobe distances.

MAU that have automatic loopback functions on their ring-in/out ports. If a break in the ring occurs between two MAUs, the break is automatically detected and traffic is routed along a preconfigured backup path.

In token ring uses twisted pair medium is cheap and easy to install.

Since rings can be bridged by their wiring concentrators into what is effectively one ring, ring size has no practical limit.

5.1.2 Disadvantage

The disadvantage is that they must be primed each time the internal relays experience excessive force. The IBM 8226 MAU, while containing a power jack, primarily uses LEDs: relays are still used inside the unit but do not require priming.

Token ring is necessary of having a monitor function.

One problem is under condition of low load, substantial delay waiting for token to come around, even though network is idle.

This topology can require significantly more wire to be run than a bus architecture.

Token ring has fallen out of favor, the necessary hardware has gotten more difficult to buy and more expensive.

What is role of SWOT analysis in this company?

How this company will be increase the growth instead of weakness factor?

According to Swot analysis, this company has better performance, better opportunity and achievement as well as many factors to attach each other. Customer services, sales, people are talented, educated this is strength factor but on the other hand old technologies using this company, There are many issues for example in a token ring, all computers are standby monitors (SM) by default, but user check on the network in the role of an active monitor (AM). The decision as to which station will become AM and also which remain as SM. It will be discussed opportunity factor, nowadays new technologies are coming in the market so by this factor company can improve the performance rather than competitors. The solution is based on SWOT analysis such as:-

Originally Token ring was a 4 Mbps standard. The system in use today operates at 16 Mbps and some new systems operate faster. The device MAU is the hub of token ring topology. For example this topology as having each MAU on a separate branch in a company. If the cable connected from ring-out of MAU 2 to ring-in of MAU 3 is broken. In this condition MAUs respond by looping back the signal. The ring continues to function in this situation the cable segment can be repaired.

5.2 Enehan solution Company (Prague)

According to discussion (25) this company has different structure. “**Jiri Mach**” is a Founder & CRM, Marketing Consultant. It is situated in Prague (Czech republic). This company founded in Enehan solution as a company that combines IT and business connectivity with a focus on marketing, CRM and digital technologies. SFA (sales force Automation) is the part of most CRM systems. It includes business process support tools such as contact management, customer communication history, sales activities and sales process success assessment.

These changes affect and change customers behaviour, habits and preference. IT investment is essential to maintain competitiveness or gain a competitive edge. This company is also provide service cloud helps to manage service/support efficiently. Automate business and marketing Activities ahead of a flood of customer Data Prioritize business opportunities and fully focus on critical cases. Service cloud allow user to record all customer communications in one place, regardless of the communication channel.



Figure 24:Digital communication source (24)

Intelligent Routing-automatically assign customer requests to an available operator that meets the necessary condition.

SLA- Tracking time and deadlines to make the customer 100% satisfied. Knowledge base-equip operators with a knowledge tank. Now by this figure define the current network infrastructure of this company it based on Mesh topology:-

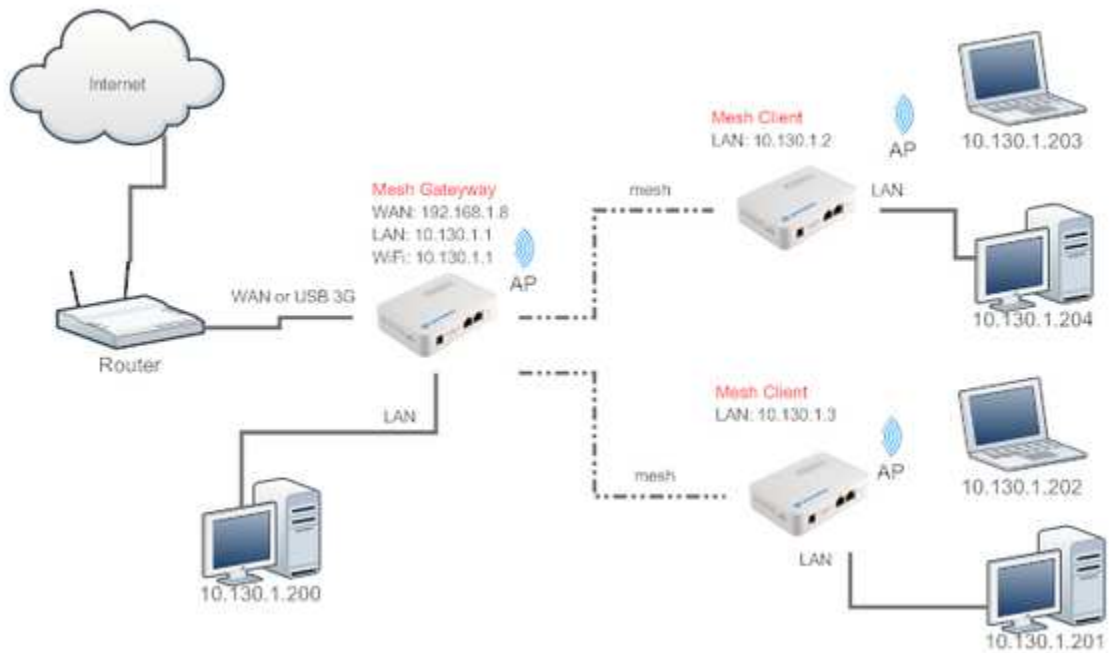


Figure 25:Network structure of Enehano solution source (25)

Mesh Wifi Network

In this topology, user should choose the devices to be a mesh gateway node or mesh client node.

- **Mesh Gateway:-** Use WAN port or USB 3G to get internet access from uplink router. It also shares the internet to its Mesh Network for other Mesh Clients. The Mesh Gateway also acts as a DHCP router for its mesh network.
- **Mesh Client:-** Connects to the Mesh Gateway via mesh network, it also bridge internet via the LAN and Wifi AP interface.

5.2.1 Advantage

Nomore problem of single point of failure, which is the issue in star topologies and even worse on bus topologies. If one node can no longer operate, the network has the ability to reroute which enables it to still communicate between the remaining nodes.

A fault is diagnosed and provides security and privacy.

Data can be transmitted from different devices simultaneously. This topology can withstand high traffic and network works minimal infrastructure and can therefore be deployed faster at a lower cost than traditional infrastructure.

Even if one of the components fails there is always an alternative present. So data transfer doesn't get affected.

Expansion and modification in topology can be done without disrupting other nodes.

There is no centralized authority in a mesh network. For that reason, some people compare it with what the internet was back in the day: localized, anonymous, citizen-based, secure communication.

A failure of one device does not cause a break in the network or transmission of data.

Adding additional devices does not disrupt data transmission between other devices. Since the devices in a mesh network can retransmit signals further, they have an ability to connect thousands of sensors over a wide area (ex: Cities). Other instances include operating in areas with large crowds or connecting devices in remote areas.

5.2.2Disadvantage

The first disadvantage of Mesh topology is the cost to implement is higher than other network topologies, making it a less desirable option. Building and maintaining the topology is difficult and time consuming. The chance of redundant connections is high, which adds to the high costs and potential for reduced efficiency.

Installation and configuration are difficult if the connectivity gets more.

In Mesh topology Cabling cost is more and the most in case of a fully connected mesh topology and Bulk wiring is required. The cost of deployed can sometimes be problematic in certain scenarios. However, it can be redeemed by downloading a software development kit, also called SDKs which enables user to become a participant node in the whole mesh instead of building it from scratch.

There are high chances of redundancy in many of the network connections and set-up of this topology is very difficult. Even administration of the network is tough.

Mesh networks can replace Wi-Fi providers, phone carriers and other middle men that provide connectivity to people. As a consequence, the middle man losses so for them there is no financial incentive to develop this technology.

Market and regulatory forces make mesh networking difficult to deploy.

After analysis describe the advantage and disadvantage. How company can be create better infrastructure for improving the growth and reputation regarding to competitors in the market. According to SWOT Analysis Company can use new devices, technology, talented and skilled employees, customer satisfaction and different sources then company can decrease the finance problem. This part of finance can use for other services then company will be increase the performance and profit in the market.

6 Conclusion

In this research, described a proposal and its implementation of small company Fxnet and implementation regarding to objectives. This is mentioned above about objectives how these are important for business and new project. Objectives of this case study are:-

Design and implementation of network infrastructure in the Fxnet Company will be elaborated and proposed. First do analysis and find what main problem in this infrastructure is. After doing analysis find the **SPOF problem**. By this problem will stop the entire system from working. SPOF are undesirable in any system with a goal of high availability or reliability. After this process need it the redundant resources for resolve this problem. Above described all the requirements used in the new network design and its implementation. In this structure used two firewall for increasing the security and high availability and servers, routers and cables according to devices.

Finally, the proposed solution will be evaluated, final recommendations and conclusion will be made. Now employees can use own devices such as mobile devices, laptop and other devices. If this company will grow the performance definitively new employees will be join this company so this structure will be fulfil this problem and it will not be create traffic problem. This network structure is reasonable according to company financially. Security problem is also solved by the help of firewall.

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