



## **School of Computing**

**SRM IST, Kattankulathur – 603 203**

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<b>Title</b>	Network Design Proposal for small office
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## **ABSTRACT**

The project outlines the steps involved in structure network design and deployment for a small office need. It presented the steps (or phases) of a structured network design and demonstrated a practical implementation of the steps using a real life case study. The design was first simulated using Cisco Packet Tracer software and WireShark protocol analyser. Specifically, the paper demonstrated first hand, how a small network may be set up using the five phases beginning with the needs analysis and ending with deployment/testing. The result of simulation and results of the postdeployment test revealed that the network met the client's needs.

## **OBJECTIVE**

Below are the main goals of the network being to achieve several operational objectives which are:

- All users should be able to access the internet through the ADSL internet connection.
- All users should be able to print via the network.
- All users should have secure wireless access to the network, with the flexibility to connect via LAN.
- A file server for sharing files on the network.
- Hosted Email servers for email access.
- Administrator should be able to remotely view and control the file server from any location on the internet.

# **INTRODUCTION**

Extensive planning should go into a network installation/implementation. Just like any project, a need is identified and then a plan outlines the process from beginning to end. A good project plan will help identify any strengths, weaknesses, opportunities, or threats (SWOT). The plan should clearly define the tasks, and the order in which tasks are completed. The main goal of structured systems analysis is to more accurately represent users' needs, which unfortunately often are ignored or misrepresented. Another goal is to make the project manageable by dividing it into modules that can be more easily maintained and changed. Structured systems analysis has the following characteristics

- The system is designed in a top-down sequence.
- During the design project, several techniques and models can be used to characterize the existing system, determine new user requirements, and propose a structure for the future system.
- A focus is placed on data flow, data types, and processes that access or change the data.
- A focus is placed on understanding the location and needs of user communities that access or change data and processes.
- A logical model is developed before the physical model. The logical model represents the basic building blocks, divided by function, and the structure of the system. The physical model represents devices and specific technologies and implementations.
- Specifications are derived from the requirements gathered at the beginning of the top-down sequence. A network that is a patchwork of devices strung together, using a mixture of technologies and protocols, is usually an indicator of poor initial planning. These types of networks are susceptible to downtime, and are difficult to maintain and troubleshoot. Therefore, at the planning stage, the network engineer needs to take account of the existing equipment and technologies the network would have to operate with and their compatibility with the proposed equipment.

# **REQUIREMENT GATHERING AND ANALYSIS**

All the necessary information needed is gathered during a site survey and also from the client. A site survey provides much information to the network engineer/designer and creates a proper starting point for the project [2]. It shows what is already on site, and gives a good indication as to what is needed. Some of the more important pieces of information that can be gathered during a site survey include:

1. Number of users and types of equipment
2. Projected growth
3. Current Internet connectivity(if any)
4. Application requirements
5. Existing network infrastructure and physical layout.
6. New services required
7. Security and privacy considerations
8. Reliability and Uptime expectations
9. Budget constraints

It is a good idea to obtain a floor plan, if possible. If a floor plan is not available, the technician can draw a diagram indicating the size and locations of all rooms [1]. It is also ideal to make measurements where the cable would be run. An inventory of existing network hardware and software is also useful to provide a baseline of requirements.

## **DEVICES AND EQUIPMENTS USED**

- Router 2811(NM-ESW-161 port) and Router 1841



The Cisco 1841 router is designed for secure data connectivity and provides significant additional value compared to prior generations of Cisco 1700 Series routers by offering more than a fivefold performance increase and integrated hardware-based encryption enabled by an optional Cisco IOS<sup>®</sup> Software security image. The Cisco 1841 dramatically increase interface card slot performance and density over the Cisco 1700 Series while maintaining support for more than 30 existing WAN interface cards (WICs) and multiflex trunk cards

- 2960-24TT Switches



Cisco Catalyst 2960 Series Switches with LAN Lite software are fixed-configuration, standalone switches that provide desktop Fast Ethernet connectivity for entry-level wiring closet and small branch-office networks . These switches simplify the migration from non-intelligent hubs and unmanaged switches to a fully scalable managed network. Cisco Catalyst 2960 Series Switches have lower cost of ownership with features such as intelligent switch configuration using Auto Smart Ports, installation with Auto Install and enhanced troubleshooting to facilitate ease of use.

- PC-PT Computers



PC

A device that performs processes, calculations and operations based on instructions provided by a software or hardware program. It has the ability to accept data (input), process it, and then produce outputs.

- Printer-PT



A Printer is a peripheral device which makes a persistent representation of graphics or text, usually on paper. While most output is human-readable, bar code printers are an example of an expanded use for printers.

- Server-PT servers



Servers are an entirely different breed when compared to other end devices. They have various functionalities and also have space for two network interfaces. The modules available for servers are the same as PC modules, except that the servers do not have the PC-HOST-NM-1AM module.

- Cloud-PT(Multi User)



Cloud allows us to implement cloud computing in our project. Cloud computing is the delivery of on-demand computing services -- from applications to storage and processing power -- typically over the internet and on a pay-as-you-go basis.



# **DESIGN AND SELECTION**

Devices and cabling were then selected based on the requirements outlined in the Analysis Report. Multiple designs were also created to be able to view the LAN from a documentation perspective and evaluate trade-offs in performance and cost. It is during this step that any weaknesses of the design can be identified and addressed. Factors considered when selecting the devices for a LAN were costs, number of ports (a function of the number of computers to be networked and the possibility for future growth or expansion), speed, expandable/modular and manageability.

Also during this phase, prototypes were created and tested. A successful prototype is a good indicator of how the network will operate. A simulator program such as Packet Tracer 5.0 is a good tool to test the network [3]. After the design was approved by the customer, implementation of the new network can begin. If the design exceeds the budget of the customer, adjustments could be made but with caution not to compromise quality that would have adverse effect on the network. Based on the above Analysis Report, the design below was drawn up and simulated using Packet Tracer 5.0.

# **CALCULATING THE NETWORK CAPACITY, BANDWIDTH AND ESTIMATING THE NUMBER OF USERS**

Bandwidth refers to the data rate that is supported by the network connection or the interfaces that connect to the network [4]. It is usually expressed in terms of bits per second (bps), or sometimes in bytes per second (Bps). Network bandwidth represents the capacity of the network connection, though it's important to understand distinction between theoretical throughput and real world result. For example, a 100Base-T (which uses unshielded twisted-pair cables) Fast Ethernet (FE) network can theoretically support 100 megabits per second, but this level can never really be achieved in practice because of hardware and systems software overhead. It is this very point that makes calculating bandwidth a challenge.

It is also important to understand that a wireless device listed speed (the data rate) refers to the rate at which the radios can exchange symbols, not the usable throughput (bandwidth) you would observe. A single 802.11g link may use 54Mbps radios, but it will only provide up to 22Mbps of actual throughput [4]. The rest is overhead that the radios need in order to coordinate their signals using the 802.11g protocol.

The time it takes for data to traverse a link is called latency, and high latency is commonly referred to as lag. Determining how much bandwidth needed requires asking the right questions –what applications will be mostly run and what is the performance Service Level Agreement (SLA) for these applications? There are two basic steps to calculating bandwidth: 1. Determine the amount of available network bandwidth 2. Determine the average utilization required by the specific application(s). Both of these figures should be expressed in Bytes per second (Bps). For the Fast Ethernet network, that would give 12,500,000 Bps. This is computed by taking the 100Mbps; which is 100 million bps and dividing it by 8 to come up with the bytes per sec. Thus,

$$100,000,000\text{bps}/8 = 12,500,000 \text{ Bps. ....(1)}$$

For the wireless network, it would be:

$$54,000,000 \text{ bps} / 8 = 6,750,000 \text{ Bps .....(2)}$$

(Note, the figures in equations (1) and (2) above are the capacities of the wired and wireless links respectively, however, the available internet bandwidth from the digital center is about 100kBps, ie,

$$100 * 1000 \text{ bytes/s} = 100,000 \text{ Bps} \dots\dots\dots (3)$$

The next step involves determining how much bandwidth each application is using and how much bandwidth each user consumes while using the same applications. This would enable one to know the number of concurrent users the network can support without causing congestion or bringing the network to a halt. A network analyser (e.g WireShark) is used to capture packets in the network and determine the number of Bps applications sends across the network. The Cumulative Bytes column of the network analyser will have to be enabled.

To estimate the number of expected users, we divide the available (internet) bandwidth by the sort of application they will probably use. Assuming that all the users will mainly be browsing the web, From the table above, web browsing consumes between 50kbps to 100+ kbps per user; Converting the boundaries to bytes per second;

$$50 * 1000 / 8 = 50000 / 8 = 6250 \text{ Bps} \dots\dots\dots (4)$$

$$100 * 1000 / 8 = 12,500 \text{ Bps} \dots\dots\dots (5)$$

Now dividing the available bandwidth in (3) by the above bandwidth per user boundaries:  
i.e  $100000 / 6250 = 16$  users.

Since all users are unlikely to use the connection at precisely the same moment, it is common practise to oversubscribe available throughput by some factor (that is, allow more users than the maximum available bandwidth can support). Oversubscribing by a factor of 2 to 5 is quite common. In this case, the lower estimated number of users was oversubscribed by a factor of 2.125, bringing the estimated number of users to 17 users. Twelve users will be on the desktop while the wireless router would be configured to allow a maximum of 5 users. This is achieved by configuring the wireless router to lease only 5 IP addresses.

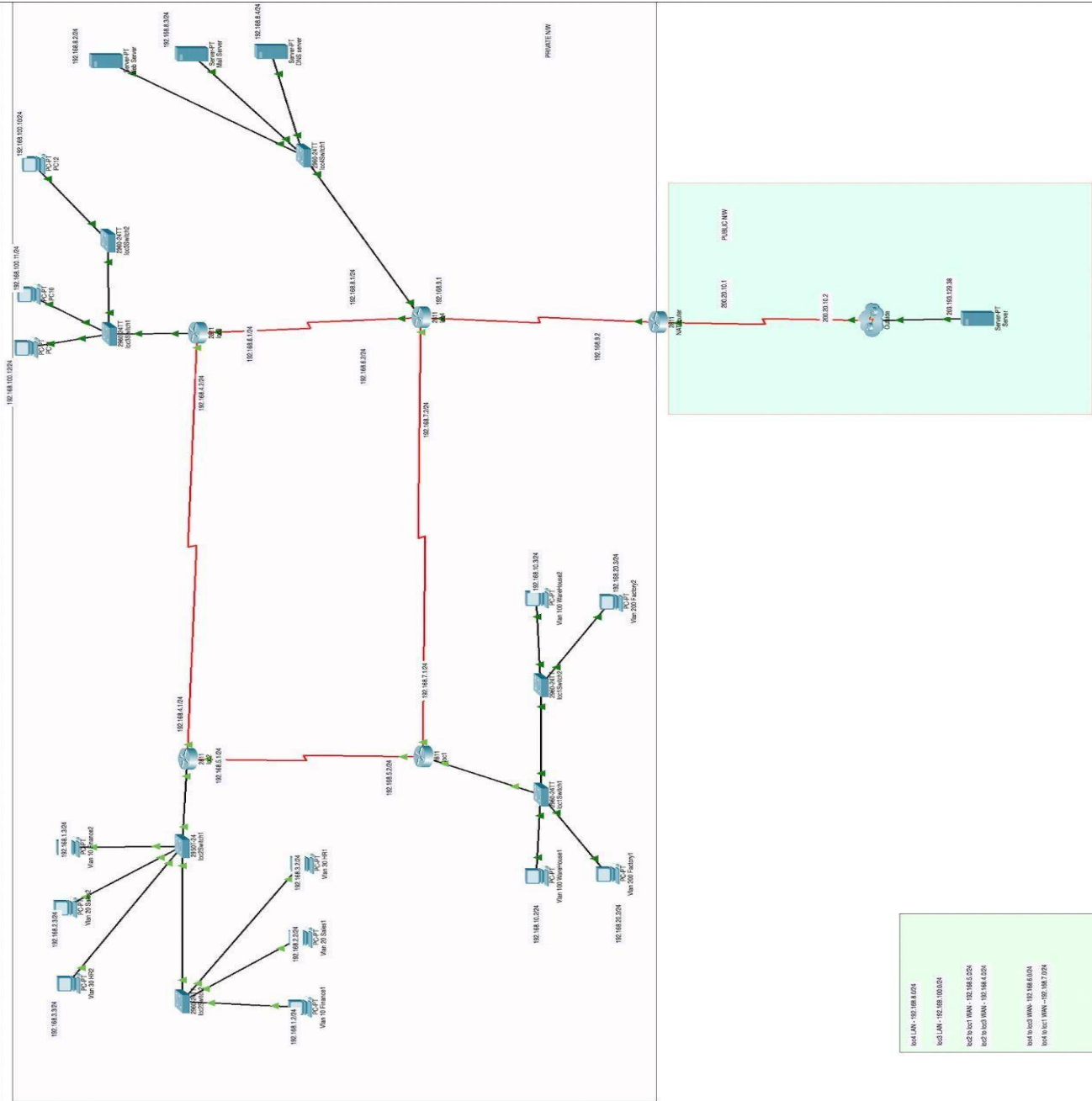
# **IMPLEMENTATION**

If there are tasks that have been overlooked in the earlier phases, they must be corrected during implementation. Creation of a good implementation schedule and allowing for some additional time for unexpected events keep disruption of the client's business to a minimum. During the implementation, there should be strict adherence to standards, such as colour codes, operational limits, etc. Staying in constant communication with the client during the installation was critical to the success of the project.

# **EXPLANATION OF THE DESIGN**

In the above design, all desktop computers and one of the router's Fast Ethernet ports were connected to the switch (a 16-port Linksys Switch). The Internet Port of the wireless router/access point was connected to the 600mW outdoor Access Point. Since there is no server available, the router acts as a DHCP server distributing IP addresses in the 192.168.4.1 – 192.168.4.49 range to the wireless clients and 192.168.4.100 – 192.168.4.150 range for the wired clients. To ensure security of the network, a WPA passphrase was used which is more secured than its counterpart WEP [6]. For the physical cabling, the cables were passed through the ceiling to the HOD's and his Secretary's office. The cables were terminated with a patch panel nailed to the wall. The cables were bundled together using low cost cable managers instead of using trunks in order to save costs. Nevertheless, the cabling work was neatly done and aligned along the wall. The 400mW Outdoor Access point/Bridge was firmly mounted on a pole already fixed to the roof. The device is aligned to the line of sight of the digital centre for maximum reception.

## OVERVIEW OF ENTIRE NETWORK



VJAN 10 (Finance) - 192.168.1.0/24  
 VJAN 20 (Sales) - 192.168.2.0/24  
 VJAN 30 (HR) - 192.168.3.0/24  
 VJAN 100 (Warehouse) - 192.168.10.0/24  
 VJAN 200 (Factory) - 192.168.20.0/24

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loc4 LAN - 192.168.8.0/24
loc3 LAN - 192.168.100.0/24
loc2 to loc1 WAN - 192.168.5.0/24
loc2 to loc3 WAN - 192.168.4.0/24
loc2 to loc3 WAN - 192.168.6.0/24
loc2 to loc1 WAN - 192.168.7.0/24

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## **OPERATION**

The network is brought into service in what is termed a production environment. Prior to this step, the network is considered to be in a testing or implementation phase.

## **REVIEW AND EVALUATION**

After the network is operational, the design and implementation were reviewed and evaluated. For this process, the following steps are recommended:

- Compare the user experience with the goals in the documentation and evaluate if the design is right for the job.
- Compare the projected designs and costs with the actual deployment. This ensures that future projects will benefit from the lessons learned on this project.
- Monitor the operation and record changes. This ensures that the system is always fully documented and accountable.

# **CONCLUSION**

The report outlined the steps involved in structure network design and deployment for a small office need. It presented the steps (or phases) of a structured network design and demonstrated a practical implementation of the steps using a real life case study. The design was first simulated using Cisco Packet Tracer software and WireShark protocol analyser. The only problem encountered was the issue of unavailability of power at the site for configuration of the devices. However, UPS systems were used to overcome this issue since the devices are not high power devices and a laptop was used to configure and test the resultant configuration in place of the desktop computers.

# **REFERENCES**

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