MAKE LIFE EASIER ON CAMPUS WITH HIGH-SPEED NETWORK

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Abstract:
In this paper I have shown that with the evolution of technology, networks and the Internet have become an almost daily necessity, being an essential part of our individual, economic and social life. On their well-functioning depend our governmental, commercial and even personal activities. The modern information society is already a reality, which ignores frontiers which may pass any spatial or temporal limitations due to the communication system. Economy, politics and society today are based ever more on a computerized infrastructure.

Key words: *networks, distance education, broadband, project, university*

1. Development of network technologies. Furthermore, governments, public and privet enterprises, national and international financial bodies, education, culture and scientific research, all benefit from these efficient means of leadership, information and communication. Internet communications become ever more important in everyday life, thus needing to be managed and monitored in order to ensure the quality of services. Using computer networks demands may be complied to such as:

- distribution, multiple distribution and multiple source connections;
- temporary access (nomadic);
- mobile access (wireless);
- negotiation of services' quality (bandwidth, delay, package loss);
- connection security (authentication of final points), protection and encryption;
- network and applications' scalability;
- interoperability;
- high capacity traffic with a high performance.

However, in order for networks to provide these advantages, they must be designed, installed and appropriately managed as to improve and avoid any possible problems. Almost instantaneous communication speed and efficiency provide numerous trumps, but major disadvantages as well, the latter being caused by internal, as well as external threats to information security. During this project, a presentation will be provided of several principles and modern technologies used in designing and

implementing a campus network, be it of a university, of a corporation or any other type of organisation in need of a modern and state of the art and modern network. The study case presents the redesign and implementation process of various components of the “Lucian Blaga” University of Sibiu network, especially the most important part: the central core. This redesign is done on a physical, as well as a logical level, the objective being a network providing optimal performance, availability and scalability to transparently integrate new services and facilities.
Industry has developed a network life-cycle called (Planning-Design-Implementation-Operation-Optimization) which describes the various phases a network goes through.

Planning phase: detailed requests for the network are identified and the existing network gets revised.

Design phase: the network is projected according to the initial requests and supplementary data are identified during the analysis of the existing network. Alterations are implemented depending on the possible needs identified.

Implementation phase: the network is implemented according to the approved plan.

Operation phase: the network is operational and in monitoring. During this phase final test of design are done as well.

Optimisation phase: during this phase, any detected issues get corrected, either before or after a malfunction takes place. If numerous issues are detected, a redesign of the network might be required.

Retreat phase: although is not a part of the PDIOO acronym, this phase is necessary when one of the network parts is obsolete (outdated) or no longer necessary.

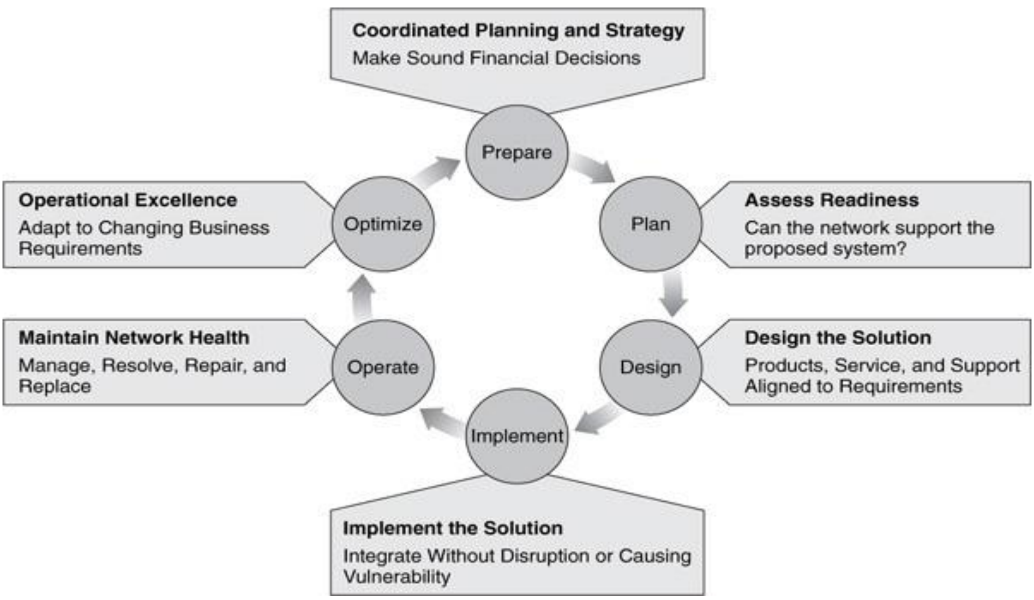

Figure1. *PDIOO CYCLE*
Source: CISCO Systems

2. Hierarchic design. *The hierarchic model separates the network in three functions/layers, which are:*

- Access layer: provides users access to the network resources.
- Distribution layer: implements organizational policies and provides connections between working groups and the core.
- Core layer (kernel): provides nigh speed transfer between equipment in the distribution layer and access to various resources.

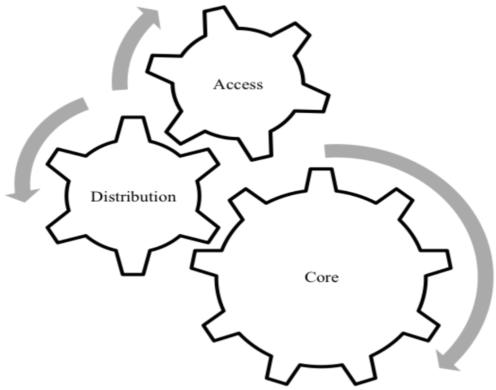

Figure 2. *Hierarchic layers*

One may consider these layers as modules, each with specific functions to be implemented using optimal equipment to meet specific requirements for the module.

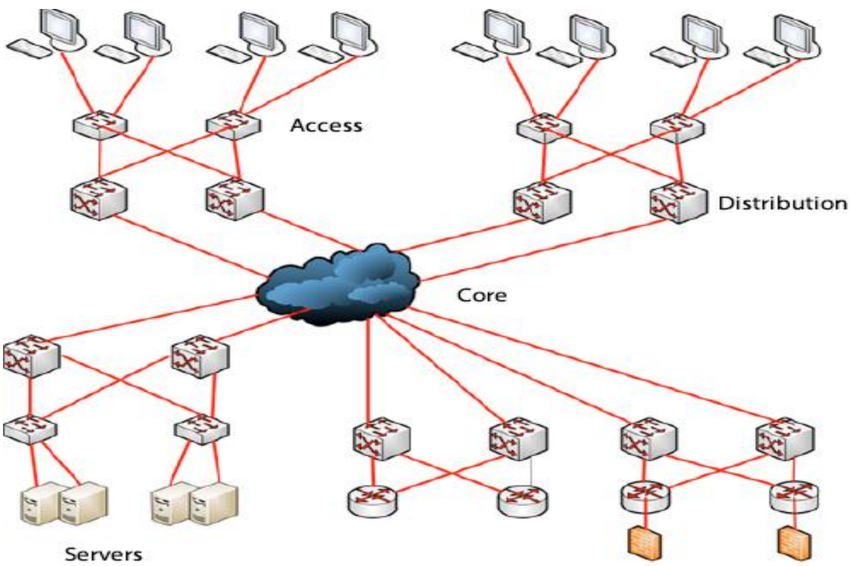

Figure3. *Example of a hierarchic network*

Are there different equipment required for each layer? No. The TCP/IP, an implementation of the OSI model, suit may be considered. The TCP/IP model combines some of the OSI levels. For example, the application level of the TCP/IP presents the application levels, presentation and session of the OSI. Consequently, implementing the hierarchic model may combine more functions in a single physical equipment, especially if it is a small network.

***3.Study case*.** The practical realization is implementation and design of a computer network for a university campus. This article presents design and configuration aspects of a physical and logical level, making use of various technologies and protocols to resolve imposed requests. This project is partially implemented and developing on the “Lucian Blaga” University of Sibiu campus and it is a redesign of the current network, in order to produce a network that ensures an optimal level of performance, reliability and scalability, not only for the services it provides, but also for the applications already on the network and those implemented in the future. The project focuses on all network levels: access, distribution and core, the latter being the most important component of the network, connecting all other components to each other. Initially, the computer network of the university was used mostly for internet access, but as various network attached services were implemented (such as computerised educational management, e-learning, central storage of documents, etc.), the importance of the network and of the services it provided within the university grew. Furthermore, the desire to implement future new services, such as central management of faculty computers using the Active Directory domain, the central storage of student aimed files for laboratory, replacing the classic phone network with Voice Ip, as well as many others, require a high performance level, availability, scalability and security; traits not provided by the current design of the network.

4. The initial state of the network. In the Figure 4, the initial state of the distribution network – core may be observed, which present the interconnection of facilities to the central core. At access network level in the facilities (generically represented by a cloud in figure 11) there were largely unmanaged network equipment (switches) and wiring was not organised, whenever a new location needed to be connected (a hall for example) ramification had to be made to the nearby switch. Thus, by not having any control upon the expansion of the network and not having the possibility for logical separation, a single network malfunction would affect all users (for example: a virus of a storm broadcast). A server (a desktop with low reliability and performance more often than not) was used as gateway for each building running various Linux operation systems, altered to serve as router and employed to grant IP addresses through DHCP (Dynamic Host Configuration Protocol) and NAT (Network Address Translation). This was further connected with speeds varying from 2 to 4Mbps (depending on the size of the building) via metropolitan network of a provider to the central core through a layer 3 switch.

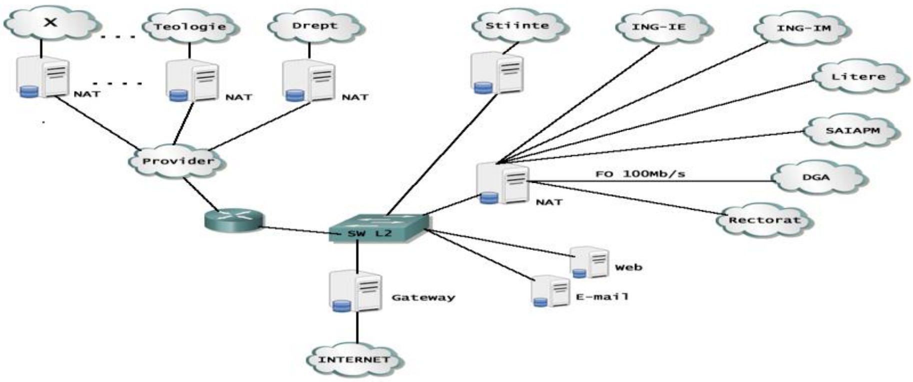

Figure 4. *The schema for the initial distribution network – core.*

Connecting buildings in the centre is done by optic fibre at a speed of 100Mbps, but connection is done directly at a level 2 layer via a server in the central core, the granting of IP and NAT addresses being accomplished at this level. All these building servers along with the university servers (e-mail, web, accountancy, UMS, etc.) being connected through a backbone network represented by a switch without management with a capacity of 100Mbps, this being where another server is connected, which provides Internet access. Once the network and number of users expanded, as well as the services provided, the current design proved inefficient. Since the equipment used is generally not network applicable (e.g. desktops used as gateways) it lead to low performance and availability levels. Thus, in the main network knot there were no redundant components and all malfunctions impacted the entire network. Major redesign is necessary on almost all network components, bot physically, as well as logically.

5. Network redesign. This process is accomplished taking into account various aspects and IT industry suggestions, but also different particular constraints, many of them of financial nature. The network was designed and configured using mainly a 3 level/layer model (core, distribution and access), but also traits of the ECN (Enterprise Composite Network) modular model. Access Level is the most basic in the network structure, but it is also the point where the users' gear is connected to the network. The old infrastructure was replaced with structured wiring, centralised at floor level in racks and interconnected at a central level. Administration equipment has been installed (switches and wireless access point) and on central level, the old gateway desktops were replaced layer 3 switches, better performance. Although the hierarchic model recommends access switches be connected redundantly to equipment in the distribution layer, equipment that also has to be double in number to provide better availability in case of malfunction; due to budget restraints this was not possible and an alternative solution to implement the redundancy was required. One possible approach would have been having multiple connections for the equipment on each floor to the only 3 layer central knot, as presented below.

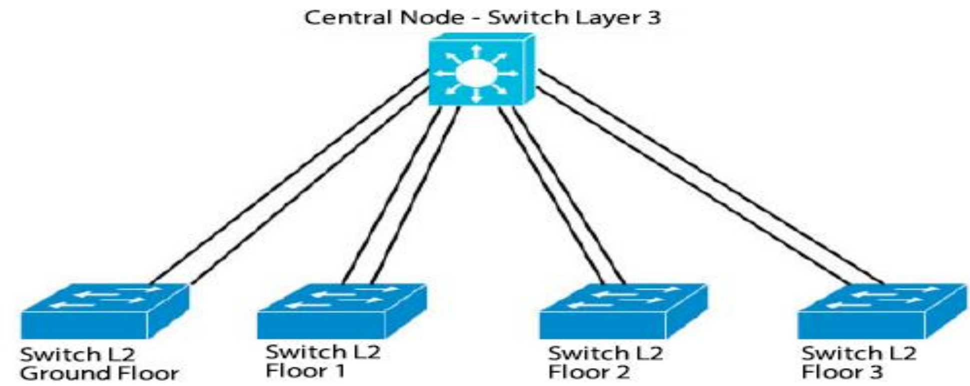

Figure 5. *Variant for redundant connection.*

This typology may provide a level of redundancy for one malfunction at one of the two connections to the central knot, but in case of a problem at the 3 layer switch, islands would be forming in the network at each floor, users not being able to communicate even internally. Switches used for the access layer of the buildings provide, depending on the model, 24 or 48 Ethernet ports at a 100Mbps speed plus 2 ports at a 1Gigabit speed, called uplink ports. These ports are used for connection either to the 3 layer switch from the central knot or another 3 layer switch from another knot. One of the reasons why this type of switches was chosen to equip the network is that it provides the possibility of stack connection, thus allowing more physical units to be observed and managed as one single logical unit. On the floors were more switches are being used, they are configured in stack and for redundancy on the uplink connections, the contact to the central knot is connected through the master switch, contact to the secondary knot is connected in slave switches. As much as 6 units may be connected in one stack. Within the university there are mainly 2 switch units' stacks. Since these redundant connections for a loop, at a logical level, some ports are deactivated, being used just for malfunctions of the main connections. Rapid Spanning Tree protocol is activated and used in a network to manage redundant connections and protect against loops. In order to influence a certain sequence in which these connections are used, the STP priority is specified on each switch. The **4096** value is being used on the 3rd layer central switch, **8192** on the 2nd layer central switch and the implicit value of **32768** on all the other switches.

SW_Litere_NIV1# conf
SW_Litere_NIV1(config)# spanning-tree mode rstp
SW_Litere_NIV1(config)# spanning-tree priority 8192

This configuration leads to the 3rd layer switch to become a root-bridge for the network and, thus, all other switches will select the directly connected ports to transmit data, the other ports remaining blocked. Only in the case of central switch malfunction, connections to the secondary knot switch will be activated.

6. Network monitoring*. Within the LBUS network, the administration of network equipment is done in two ways:*

- **outband** – using a separate dedicated physical network for equipment monitoring – the equipment found in the central knot benefit from such a network.
- **inband –** using the regular data network, but through dedicated administration virtual networks, through secured connections (e.g. SSH).

For a general view in real time on the main network equipment a “weathermap” application was implemented. The latter has the purpose to collect data from the network equipment interface at specific intervals and storages this data in a database. Then the data are processed and based on them statistics on bandwidth usage are generated. Furthermore, the data in this database are used to generate a map of bandwidth usage at equipment level from the distribution and core network, the latter being used to obtain quick information on the state and performance of the network.

***7. Conclusions and further development*.** Redesigning a network is a task which must be accomplished periodically as some technologies become outdated; these are replaced by others newer with improved traits. The continuous expansion of the networks’ size and the ever increasing number of devices requires efficient administration, demanding better research to design network management. Network designers are challenged to develop more complex and high performing networks using the newest available technologies, but these are in a continuous process of renewal. Within this project several levels of redesign were achieved in multiple key points of the network. The access network was reconfigured to provide an increased level of safety by creating virtual groups of users and by introducing a higher level of protection at equipment level. Improvements of the distribution network have also been accomplished, especially by designing new physical fibre optic routes, providing redundant ways of communication, thus substantially increasing the availability of the network. The most important part of the network, the core network was redesigned almost entirely, both as physical, as well as logical level.

References

Diane Teare, Catherine Paquet, 2005, “Campus Network Design Fundamentals”, *Cisco Press*

Priscilla Oppenheimer, 2008, “Top-Down Network Design Second Edition”, *Cisco Press*

Sean Wilkins, 2011, “Network Architectures for the Enterprise”, *Cisco Press*

Tanenbaum Andrew S., 1998 “Rețele de calculatoare”, *Editura Computer Press AGORA s.r.l., Tg. Mureș*

“Campus Network for High Availability Design Guide”, White Papers, Available at *http://www.cisco.com/application/pdf/en/us/guest/netsol/ns431/c649/ccmigration_09186a008093b876.pdf* accessed on. March 12, 2012

“CCNP: Building Multilayer Switched Networks” , *Course materials*