AGH University of Krakow
Faculty of Computer Science, Electronics and Telecommunications
Teleinformatyka

Metodyki Projektów Teleinformatycznych

Netcamps

Design, configuration and documentation of the exemplary computer network for a campus of dormitories

Jan Ściga, Marcin Wolak, Aleksandra Mardaus, Krzysztof Pałka, Adam Zielina, Krzysztof Kasprzyk, Rafał Piwowarczyk

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Contents

1 Document description

This document provides an extended description for the NetCamps project that was implemented during the 'Metodyki Projektów Teleinformatycznych' summer course at AGH University of Krakow 2023/2024. Its summarized version can be found in the main github repository located in NetCamps Repo. If the document reader desires to contact the product authors in terms of any NetCamps-related topics, it is welcome to do this github channel.

2 Abbreviations

This section contains a list of common abbreviations presented in the document content

- **OSI/ISO** – The OSI (Open Systems Interconnection) model is a conceptual framework for network protocol design.
- **OSPF** – Open Shortest Path First - is a routing protocol used in computer networks to determine the most efficient path for data packets to travel from a source to a destination.
- **IP** – IP, or Internet Protocol, is a fundamental protocol that forms the basis of communication on the Internet
- **VLAN** – A Virtual Local Area Network, is a network segmentation technique that allows the creation of logically isolated networks within a physical network
- **DHCP** – Dynamic Host Configuration Protocol, is a network protocol used to automatically assign IP addresses and other network configuration information to devices on a network
- **VOIP** – Voice over Internet Protocol (VoIP) is a technology that enables the transmission of voice and multimedia content over the internet, replacing traditional telephone networks
- **FTP** – File Transfer Protocol (FTP) is a standard network protocol used for transferring files between a client and a server on a computer network.
- **HTTP** – Hypertext Transfer Protocol (HTTP) is the foundation of data communication on the World Wide Web. It is an application layer protocol that facilitates the transfer of information between a client (such as a web browser) and a server.

3 Preface

This comprehensive guide has been crafted to provide you with in-depth insights into the features, functionalities, and optimal usage of NetCamps product. Whether you are a new user exploring the capabilities of NetCamps or a seasoned professional seeking detailed reference material, this documentation is designed to cater to the needs of potential user.

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4 Overview

This section provides a brief overview of the NetCamps product portfolio and potential audience for this document.

4.1 Introduction

Building, designing, and testing complex computer networks come with a unique set of challenges due to the scale, complexity, and dynamic nature of large-scale networks. Successfully addressing these challenges requires a combination of expertise, careful planning, and the adoption of appropriate technologies and best practices in network design and management. These needs could be addressed by the NetCamps product portfolio in a following way:

- Providing an exemplary topology, configuration and documentation for the campus computer network along with the used tools
- Being a source for business use cases occuring during similar projects and its technical solutions
- Presenting detailed and structured list of costs related with building campus computer network
- Delivering educational or instructional materials regarding networking and telecommunication areas

4.2 Audience

The documentation for NetCamps is designed to cater to a diverse audience with varying levels of expertise and responsibilities. Potential audiences for this documentation include potential customers, training departments, project managers or compliance officers. By addressing the needs of this diverse audience, the documentation aims to provide comprehensive support and guidance to ensure a successful experience with NetCamps.

5 Supported use cases

This section provides reader with the description of NetCamps supported use cases.

5.1 Layer 3 (OSI/ISO) connectivity between campus network end-devices

Layer 3 connectivty is a common requirement from the potential customers of network design and configuration solution providers, the demand can be defined as follows:

> ***As a user, I want to be able to communicate with another campus network device directly after connecting to the internal network***

For this reason, the network has been configured with the OSPF protocol. Open Shortest Path First (OSPF) is a routing protocol used in computer networks to help routers dynamically exchange information about network topology. It is an interior gateway protocol (IGP) designed to efficiently determine the best path for routing packets within an autonomous system, typically a single organization's network. OSPF uses a link-state routing algorithm, where routers exchange information about the state of their links with neighboring routers, allowing each router to build a detailed and up-to-date map of the network.

What's more, NetCamps product also predicted the neccesity of introducing DHCP server that provides connected end-devices with the IP address, and allows them to communicate directly with each other right after connecting PC to the internal network. Dynamic Host Configuration Protocol (DHCP) is a network management protocol used to automatically assign and configure IP addresses to devices within a network. It eliminates the need for manual IP address assignment, making it more efficient to manage a large number of devices on a network.

5.2 Link Redundancy and VLAN subnetting configuration

Providing VLAN subnetting and link redundancy, might be a key part of client requirements for a better performance of campus network

> ***As a user, I want to be able to communicate with another campus network device despite the fact of backbone link failure***

Link redundancy is crucial in campus networks to ensure high availability, reliability, and fault tolerance. Campus networks typically connect various buildings, departments, and users within an organization's physical location. Redundant links help mitigate the impact of link failures, improving the overall performance and resilience of the network.

> ***As a user, I want to secure selected switchports from communicating with devices by assigning them VLAN not supported on trunk link***

When it comes to assigning VLAN to the unused one, this security measure helps mitigate potential VLAN hopping attacks where an unauthorized user attempts to gain access to traffic in a VLAN other than their own. By assigning switch ports to the top unused VLAN, you create an isolated VLAN that is not in active use, reducing the risk of unauthorized access and potential security breaches. Because of that, given scenario presents two relevant simulations of securing the switch port by assigning it to and unused VLAN and link redundancy scenario which relies on deleting redundant links in the backbone part of the network.

5.3 Dormitory webpage

Providing an internally hosted webpage can be a very common customer requirement, not only for dormitory residents but also for every kind of orgnization that want to enhance the sense of community by providing a space for its members to connect.

> ***As a user, I want every organization member to use an internally hosted web page for inter-organization communication***

An internal webpage serves as a centralized platform where students can access essential resources such as event schedules, facility updates, and important announcements. It facilitates seamless communication between residents and dormitory management, ensuring that everyone is well-informed about policies, regulations, and upcoming activities. Additionally, the internal webpage can enhance the sense of community by providing a space for students to connect, share information, and collaborate on various initiatives, ultimately contributing to a more vibrant and connected living environment within the dormitory. That's why a given scenario

5.4 Dormitory e-mail configuration

Internal email is essential in organizational networks as it serves as a primary means of communication among employees within the company. It facilitates efficient and instantaneous information exchange, contributing to streamlined collaboration, project coordination, and overall productivity. Internal email enables employees to share documents, updates, and announcements, fostering a centralized communication hub within the organization.

As a user, I want to communicate with the all organization members via internal email system

Mail configuration within a network involves setting up the necessary protocols and parameters to enable the exchange of electronic messages among users within the network. Proper email configuration is crucial for a seamless and secure communication environment within a network. It involves a combination of server settings, security measures, and user education to ensure efficient and protected email communication.

5.5 File Transfer Protocol system configuration

File sharing system can be a crucial element for every organization, therefore NetCamps product want to facilitate the process of planning such feature and suggest a following requirement

As a user, I want to posses the possibility to transfer files over a secure and reliable protocol

File Transfer Protocol (FTP) is a standard network protocol used for transferring files between a client and a server on a computer network. FTP operates on a client-server model, where the client initiates a connection to the server to upload or download files. It utilizes two separate channels for communication: a command channel for sending commands and receiving responses, and a data channel for transferring the actual files.

5.6 Dormitory VOIP service configuration

VoIP (Voice Over Internet Protocol) is a technology that allows you to make and receive phone calls over the internet. It is an important requirement for a dormitory, as it provides internal voice communication inside a building. It can server also for other organizations for an alternative method of communication especially useful in emergency situations.

As a user, I want every dormitory member to use an VOIP communication over devices present in the network

Voice over Internet Protocol (VoIP) is a technology that enables the transmission of voice and multimedia content over the internet, replacing traditional telephone networks. VoIP converts analog voice signals into digital data packets, allowing for efficient and cost-effective communication. It leverages the internet infrastructure to facilitate voice calls, video conferencing, and other multimedia services, offering businesses and individuals a more flexible and scalable communication solution. VoIP has become increasingly popular for its affordability, versatility, and the ability to integrate various communication channels seamlessly.

5.7 SNMP

Simple Network Management Protocol (SNMP) is an Internet Standard protocol for collecting and organizing information about managed devices on IP networks.

As a user, I want to enable network administrator to manage posessed devices via the SNMP commands

SNMP, which stands for Simple Network Management Protocol, is a widely used protocol for managing and monitoring network devices and systems. SNMP enables network administrators to monitor the performance, health, and configuration of network devices, such as routers, switches, servers, printers, and more. It is an integral part of network management systems and is designed to be simple and extensible.

5.8 Internet of Things

The Internet of Things (IoT) refers to the interconnected network of physical devices, vehicles, appliances, and other objects embedded with sensors, software, and network connectivity, enabling them to collect and exchange data. Essentially, IoT allows these devices to communicate and interact with each other over the internet, facilitating the seamless exchange of information and enabling users to remotely monitor and control these devices.

> ***As a user, I want to use an efficient and intelligent IoT devices, to save energy and increase security in the network***

In a campus network, the integration of the Internet of Things (IoT) holds significant importance for several reasons. Firstly, IoT devices can enhance campus infrastructure by providing real-time monitoring and control of various systems such as lighting, heating, ventilation, and air conditioning (HVAC), ensuring optimal energy efficiency and resource utilization.

5.9 Wi-Fi

Wi-Fi, short for Wireless Fidelity, refers to a set of wireless networking technologies that allow devices to connect and communicate with each other without the need for physical cables. Wi-Fi technology is based on the IEEE 802.11 family of standards, which define the specifications for implementing wireless local area networking (WLAN) communication.

> ***As a user, I want every organization memmber to communicate with each other with Wi-Fi interface***

In campus networks, Wi-Fi plays a crucial role in providing connectivity and flexibility for both students and faculty. That's why, this service needs to be both reliable and secure for potential users.

> ***As a user, I want every organization memeber to have Wi-Fi security assured with Layer 2 techniques based on WPA2 protocol with AES encryption algorithm***

5.10 Firewall

Modern networks are commonly exposed to variety forms of attacks. That's why they need to posses some form of checkpoint that will allow to filter malicious traffic. Firewalls are designed to fill this gap. Their primary function is to act as a firewall, controlling and monitoring traffic between different network segments and protecting against unauthorized access.

> ***As a user, I want to posses firewall in front of the servers, filtering selected traffic from accessing organizational services***

In campus networks, the necessity of having firewall is even more crucial because of the possibility to cut the access from particular member.

5.11 Wireless Security

IoT (Internet of Things) security is of paramount importance in today's interconnected world. As we witness the proliferation of smart devices and the integration of technology into various aspects of our daily lives, the need to safeguard the vast network of interconnected devices becomes crucial.The significance of IoT security lies in its ability to protect sensitive data, privacy, and the overall integrity of systems

> ***As a user, I want to boost IoT security by providing as many protections as possible into the campus network***

In the context of campus networks, the importance of IoT security is magnified due to the diverse and interconnected nature of devices within an educational institution. Campus networks often integrate a wide array of IoT devices, including smart classrooms, security systems, building automation, and various other connected technologies.

6 Topology design

6.1 Campus map

A dormitory network serves as an exemplary model for network configuration due to its unique requirements and challenges. The diverse needs of students, faculty, and staff within a confined space demand a well-organized and robust network infrastructure. The configuration must efficiently accommodate a large number of users with varying devices, from smartphones to laptops, while ensuring seamless connectivity and sufficient bandwidth for academic and recreational activities. Therefore, the NetCamps project assumed to use dormitories as presented in Figure 1.

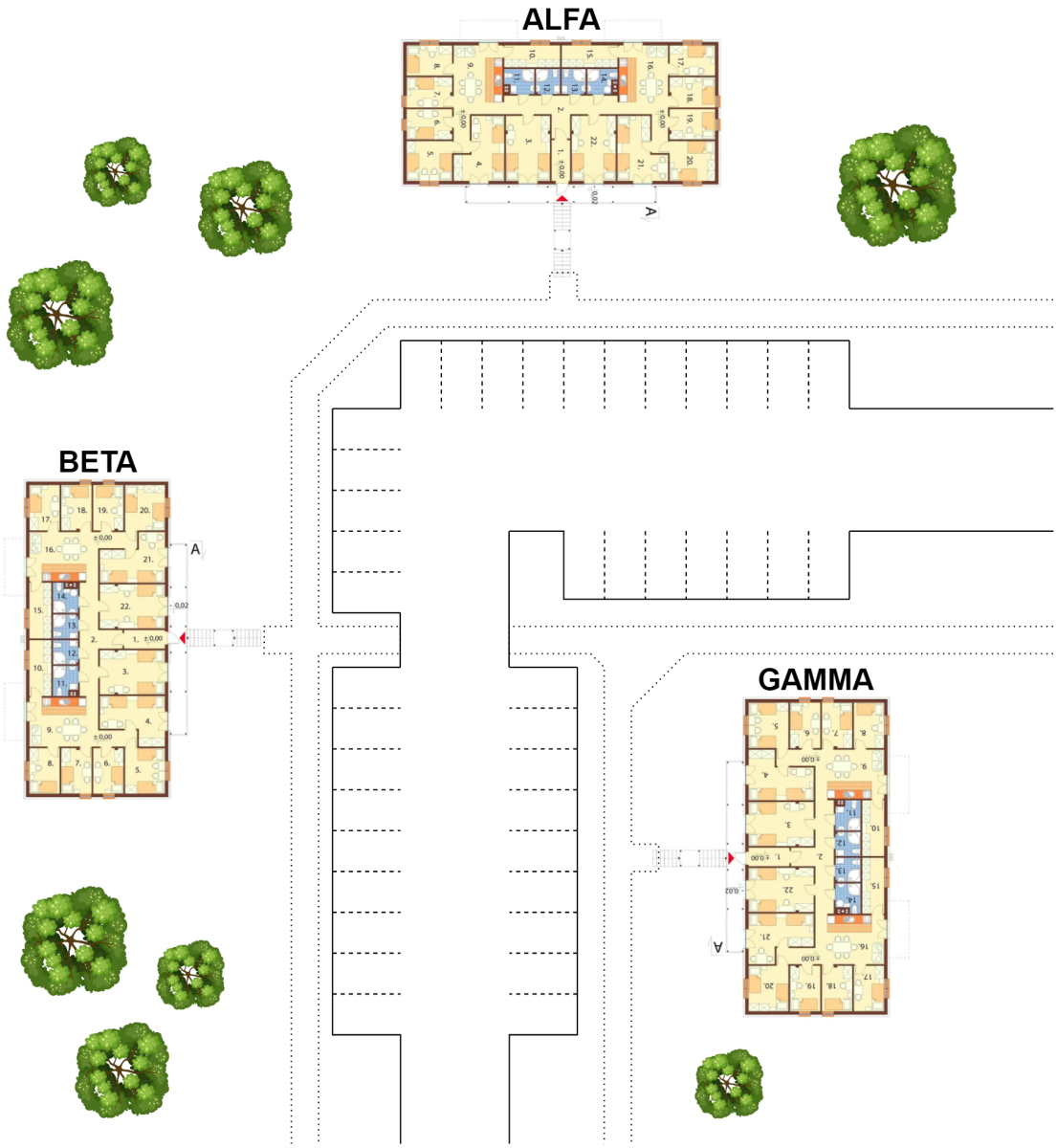

Figure 1: Building map for NetCamps project

6.2 Network Architecture Concept

A well-designed network concept and architecture are essential to ensure the seamless and efficient flow of information in today's interconnected world. A robust network infrastructure forms the backbone of modern communication, supporting diverse applications and services. A thoughtfully crafted network concept addresses factors such as scalability, reliability, and performance, allowing organizations to adapt and grow without compromising functionality. Architecture concept is presented in the Figure 2. Much more detailed diagrams are offered by product in Netcamps Network Design and Architecture

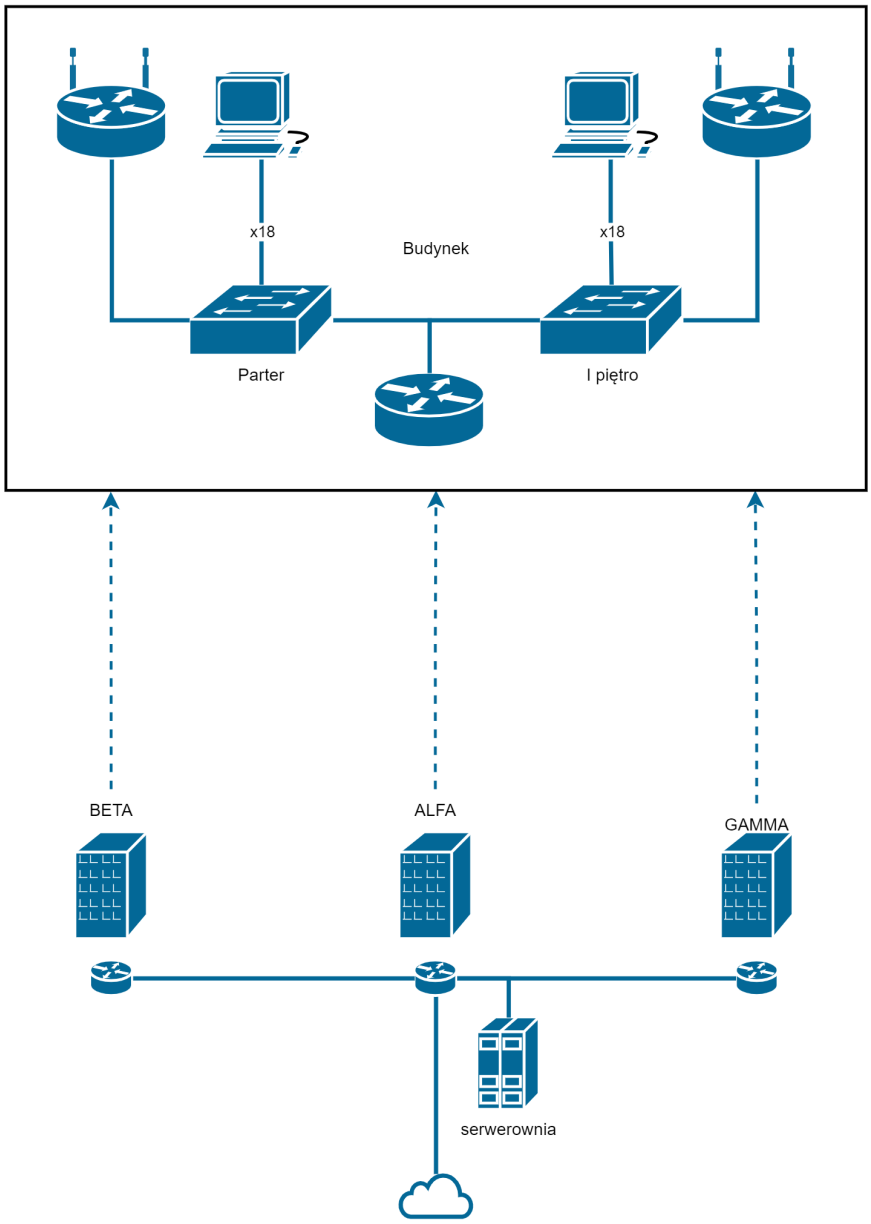

Figure 2: Netcamps network architecture

6.3 Network Equipment

The proper selection of devices is crucial for the effectiveness and efficiency of a network. Choosing the right devices ensures compatibility, performance, and scalability in line with the network's requirements. Different devices, such as routers, switches, firewalls, and access points, play specific roles in network functionality, and selecting them appropriately contributes to the overall reliability and security of the network. NetCamps product assumes a following device selection presented in Table **??** for the network design and configuration. Detailed list of network equipment selected for configuration is offered by the product in NetCamps Network Equipment Register.

7 Configuration analysis

Conducting a thorough analysis before network creation is imperative to meet the specific requirements and challenges of an organization. Proper analysis helps identify the anticipated traffic patterns, user needs, and application demands, allowing for a tailored network design that optimizes performance. This preemptive examination assists in determining the appropriate network topology, hardware, and software components, ensuring that the infrastructure aligns with the organization's objectives. NetCamps product offers a detailed configuration description for every use case to facilitate this process in real-life configurations.

- L3 Connectivity
- Link Redundancy and VLAN subnetting
- HTTP Dormitory Web Page
- Dormitory Mail
- FTP Dormitory Files Share System
- VOIP Dormitory Configuration
- SNMP
- Internet of Things
- Wi-Fi
- Firewall
- Wireless Security

8 Cost analysis

NetCamps product delivered excell sheet for a detailed cost analysis which is located in NetCamps Cost Register, its summarized version is presented in Figure 3.

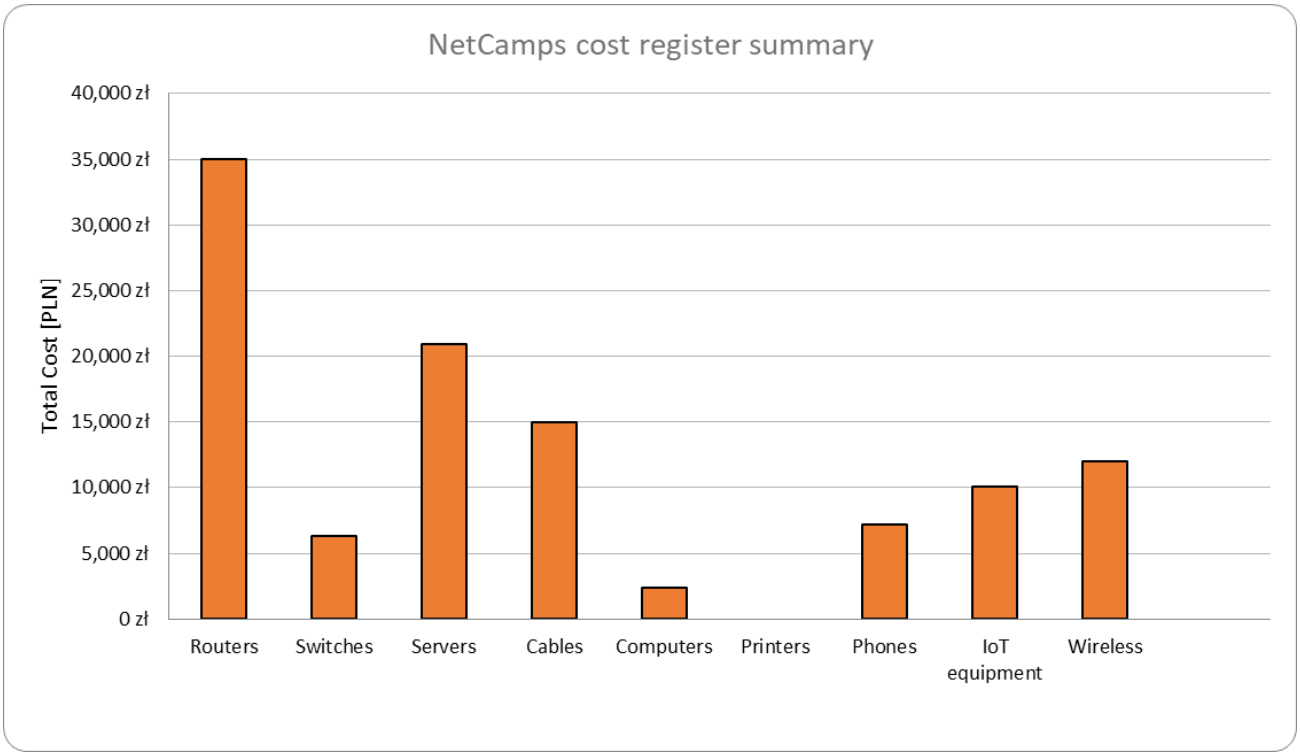

Figure 3: NetCamps Cost Register Summary

9 Summary

In summary, NetCamps product allow to perform thoughtful and justified deciscions throughout the processes of designing, configuring, simulating, testing and documenting campus computer networks.