

**CME 3204**  
**Data Communications and Computer Networks**  
**Midterm Project**  
**2023-2024 Spring**  
**Metropolitan Area Network Simulation**

Computer Network planning and design is an iterative process, including topological design, network architectures, and network traffic characterization. Well-designed computer network architecture should support maximum number of network users, traffic load with minimum delay, and adequate hardware support for network expansions. However, the designer should keep the balance between the cost of network hardware and the system requirements.

In this project, you are expected to build a Metropolitan Area Network (MAN) by using Cisco [Packet Tracer](#) software.

The network requirements and specifications are given below:

1. Metropolitan area network design includes two distinct branches office in a city, which are connected by routers (at least two routers for each branch) over an ISP (Internet Service Provider). You also should consider connection technologies between ISP and branches.
2. First branch's network is comprised of 3 distinct facilities and each facility has different units and requirements. All specification for the first branch office is as following:
  - a. First facility has 3 workstation (PC) users, 3 wireless users (laptop) and 3 smartphone users. All of the users in this facility have the ability to **browse web, send e-mails and transfer files** by using their devices.
  - b. Second facility has 6 workstation users who are able to use **Web and FTP**. 2 of workstations are used for **VoIP conference** events.
  - c. Third facility has a server farm including **10 Web servers, 4 FTP servers, 1 DHCP server, 1 mail server and 1 domain name server (DNS)**.
3. Second branch includes 3 distinct facilities and each facility includes different units and requirements.
  - a. First facility has 5 workstation users, 5 wireless users and 5 tablet users, who are able to connect to the **Internet** using **wireless connection, browse Web and use e-mail applications**.
  - b. Second facility has 5 workstation users and 2 smartphone users. They have the ability to **browse the web, edit applications and transfer files**.
  - c. Third facility has 5 workstations and 2 mobile devices that are used to **browse Web, send and receive emails**.

## Simulation Scenarios

Following activities should be simulated and analyzed within your model. You should test these scenarios and **explain them in detail in your report**.

1. A wireless user from first facility of second branch wants to read emails and browse Web.
2. A computer engineer from second facility of second branch developed a web application and wants to send his/her code files to FTP server in the third facility of first branch.
3. Two users from second facility of first branch want to talk via VoIP.
4. A user in the second facility of first branch wants to send an email message to his friend in the second facility of second branch.
5. A user from first facility of second branch pings Web server of second facility of first branch.
6. A laptop user from first facility of first branch office wants to send email to her friend in the first facility of second branch office.
7. A smartphone user from third facility of second branch office wants to use ssh to connect to a Web server in the third facility of first branch office.

You are expected to create **two more activities** to simulate and analyze your design. These activities should be different from those we specified. You should also define and document these activities in your report.

After the development of your system and tests;

1. Prepare an official report stating the problem, design and design parameters, including the systematic, IP addressing scheme, configuration parameters etc.
2. In the appendix of your report, you should give your design and simulation results.
3. You have to upload your report to the system.
4. You are expected to upload your design file to the system. Please be careful during this process. Your uploaded file should be your **error-free working version** of your design.
5. Your report prepared by using at least MS Word 2016.

Your report file name should be: `studentNumber(s)_Report.docx`

Your design file name should be:

`studentNumber(s).Design.pka` or

`studentNumber(s)_Design.pkz`

### **Samples:**

`2032510001_2032510004_2032510076_Report.docx`

`2032510001_2032510004_2032510076_Design.pkz`

Evaluation of your homework will be carried out with;

1. Design, contents and presentation of your report
2. Error-free working of your project
3. Similarity of other projects. (Please prepare your own design. DO NOT COPY design of others.)

When necessary, you may be called to explain your report or project face-to face. Please be on-time when called.

# Project Report

The project report should include designed network architecture with the given requirements, network traffic analysis results and your evaluation. **You should show both logical and physical view of your design in your project.**

The project report should be in an academic format and should have **at least 5** chapters. The chapter names are Introduction, Network Requirements, Network Architecture, Traffic Analysis and Simulation Results, and Conclusion. In the report there should be Content Table, Figure Table, Abstract and References. References should comply with IEEE Citation Style.

## 1. Introduction

In this chapter you should define the problem you are expected to solve, introduce main concepts and terminology you used. You should also state motivation and importance of project. Moreover you should write background of your project and explain tool you used.

### 1.1. Project Definition and Problem Formulation

You will state the project and problem you will handle.

### 1.2. The purpose and motivation of the project

Which motivations are there behind of this project? What is the purpose and business goals of the project? Why do you want to realize this project? (“For grade” is not a valid answer. You should assume it is a real project). What are the main benefits and risks?

### 1.3. Term Definitions

You should define all terms which are relevant to the project; including but not limited to “node”, “packet”, “channel”, “protocol”, “system” and “architecture”.

You can use either [top-down or bottom-up](#) approach for this section.

### 1.4. Related Work

If any, others’ works about network modeling/simulation and network design.

## 2. Method and Simulation

You should present network requirements and constraints that you consider while modelling and simulating.

### 2.1. Simulation and Modeling Concepts

Related definitions and issues about discrete-event simulation (yes, this project is an example of discrete event system) and modeling.

Benefits and challenges of modeling and simulation over real implementations.

## **2.2. Simulation Environment/Tool**

General information about simulation environments and tools

Advantages-disadvantages and concepts/approaches of simulation tool you chose.

Information about the tool:

- Architecture and modeling concepts
- What is its modeling approach?
- Capabilities and limitations
- How to program or run simulation?
- What are the modules, libraries, components etc. you will use?

## **2.3. Network Design Requirements**

In this section characteristics, architecture, structure, configuration, used protocols and design of your network should be given. You are also expected to write the number and type of components such as routers, switches etc., and can explain interconnection topologies. Figures and tables are welcome.

## **2.4. Requirement Analysis**

Functional requirements for different applications and services such as “the need to support VoIP”

The performance requirements including “the number of users that the network needs to support”, “the speed of the network” etc.

Defining constraints

## **2.5. Definitions of the System/Model**

What assumptions do you make about the components and the system?

What is the structure of the system?

Formulations and hypotheses on the values of input parameters.

### **Specifications for**

- Network topologies you used while designing your project?
- Network applications and services that will be modeled/deployed
- Network configuration including addressing, routing, and equipment configuration
- Data types, data sources Device types (hosts, managed devices etc. )
- Destination and number of users
- ...

## 2.6. Simulation Elements

Specifying simulation elements of your projects regarding following categories [1] [2]:

- System entities (e.g. computer nodes, server, the queue, packets, flows of packets etc.)
- System state variables (e.g. status of the channel which is either idle or busy etc.),
- Input variables (e.g. arrival rate, service rate etc.),
- Resources (e.g. bandwidth, the number of servers, transmission time etc.)
- Activities and events (e.g. delay, queuing, packet arrival etc.)

## 3. Traffic Analysis and Simulation Results

In this section you will write network simulation analysis results. Your analysis will include network functionality, information about protocol data units (frame, packet, and segment-datagram) and network traffic.

### Network Functionality

You should select proper application, make correct configurations and set parameters of PDU (Protocol Data Unit) to simulate given scenarios.

**Protocol Data Units Content:** For each scenario, you should show some activities on OSI layers and packet details using PDU information window in your report.

**Relevant events list:** You should write scenario-relevant event lists to show traffic moving through the network.

## 4. Conclusion

You should summary your project, explain incomplete works and original contributions if any.

## 5. References

List your references you cited in your report using IEEE Citation Style.

### References

- [1] A. Maria, "Introduction to modeling and simulation," in *Proceedings of the 29th conference on Winter simulation*, Atlanta, Georgia, 1997.
- [2] T. Issariyakul and E. Hossain, "Simulation of Computer Networks," in *Introduction to Network Simulator NS2*, Springer Science+Business Media, 2009.