

CME 3204 - Data Communications and Computer Networks

Project

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, a metropolitan area network (MAN) design and simulation using [Packet Tracer](#) is expected.

The network requirements and specifications are given below:

1. Metropolitan area network design includes two distinct campuses of a university, which are connected by routers (at least two routers for each campus) over an ISP (Internet Service Provider). You also should consider connection technologies between ISP and campuses.
2. First campus network is comprised of 3 distinct facilities and each facility has different units and requirements. All specification for the first branch campus is as following:
 - a. First facility has 10 workstation (PC) users, 5 wireless users (laptop) and 5 smartphone users. These users **browse web, send emails and transfer files** by using their devices.
 - b. Second facility has 10 workstation users who **use database, Web and FTP**.
 - c. Third facility has 10 workstations and 10 tablets which are used to **browse Web, send and receive emails**.
3. Second campus has 3 distinct facilities and each facility includes different units and requirements.
 - a. First facility has 10 workstation users, 5 wireless users and 5 tablet users who connect to the **Internet** using **wireless connection, browse Web and use email** applications.
 - b. Second facility has 10 workstation users and 5 smartphone users. They use **web browsing, editing applications and transfer files**. 5 of workstations can be used for **VoIP conference** events.
 - c. Third facility has a server farm including **2 Web servers, 2 FTP servers, 1 DHCP server, 1 mail server and 1 domain name server (DNS)**.

Simulation Scenarios

Following activities should be simulated and analyzed with your model:

- 1- A smartphone user from first facility of first campus wants to send email to her friend in the 3rd facility of first campus.
- 2- A user from second facility of first campus wants to browse a Web page.
- 3- A computer engineer from second facility of second campus developed a web application and wants to send her code files to FTP server in the third facility of second campus.
- 4- Two users from second facility of second campus want to talk with VoIP.
- 5- A user in the second facility of first campus wants to send an email message to his friend in the second facility of second campus.
- 6- A user from first facility of second branch pings Web server of third facility of second campus.
- 7- A tablet user from first facility of second campus wants to read her emails.

You are expected to create **three more different activities** to simulate and analyze your design.

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 or ACM 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.