CASE STUDY

32524 LANs and Routing

(Spring 2024)

Due Date:

IPv4 Addressing M
By **Week 5** (Emailed

Video Demonstrati
By **Week 10** (Email **4**)

1. Preamble

This Case Study offers students an opportunity to put into practice the network design, implementation, and troubleshooting skills they will have gained through studying *LANs and Routing*.

The Case Study is structured to guide groups through the gradual completion of the entire project, enriching their learning journey. The Scenario provides a broad overview of the project, including the rationale behind network construction. Then, the Case Study is broken down into various tasks, each accompanied by detailed requirements to lead your group through successive steps. It is important to thoroughly read and comprehend each requirement, and complete the tasks on a weekly basis to advance your study.

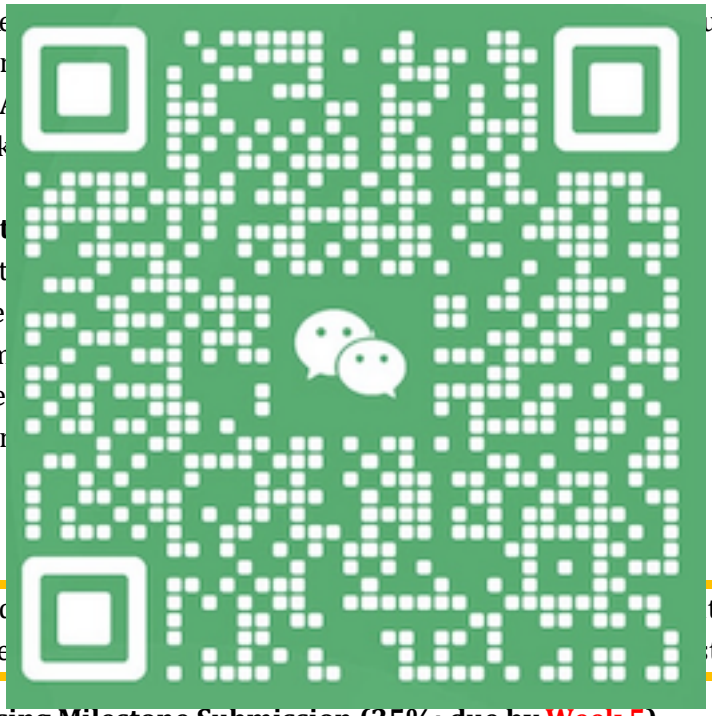
2. Objectives and General Assessment Criteria

Objectives

- Design IPv4 addressing schemes that meet the addressing requirements.
- Configure OSPFv2, including simple route redistribution, for IPv4.
- Configure static, de uting for IPv4.
- Configure switchi routing.
- Configure static N
- Verify the network

General Assessment Crit

- Requirements met
- Correctness of the
- Functionality of im
- **Justification** of de
- **Verification** of fu



3. Assessment

The case study is intended ts total marks being awarded individually. The tage submissions:

1.1 Part A: IPv4 Addressing Milestone Submission (25%; due by Week 5)

Each group as a whole is required to Email their IPv4 subnetting and addressing scheme (including Tables A, B, and C on Page 10 of the book) to their lab instructor by the end of Week 5. Feedback on this milestone submission will be provided during the following week's lab class.

1.2 Part B: Packet Tracer based Video Demonstration (75%; individually assessed; due by Week 10):

By the end of Week 10, students as groups are required to submit **a recorded video** showing each member orally present their Packet Tracer (PT) network, explaining how each part of their network was designed and implemented to meet the specified requirements.

Additionally, the group must submit a copy of their completed PT file for reference. **PS. The marking is purely based on students' presentation in their submitted video.**

For further information about the demonstration, please refer to **Section 7** on **Page 9** of this Case Study book.

4. Suggestions and General Requirements for Case Study Completion

It is expected that each student needs to spend approximately six hours to complete this Case Study.

Students as groups are encouraged to plan and work on the Case Study on a weekly basis, as the relevant topics covered in class, as outlined below. This strategy guarantees comprehensive completion of all tasks and ensures students derive the utmost advantage from this task. However, only two submissions are required and marked.

Weeks 4&5: complete Task One – IPv4 Addressing (Part A submission due by Week 5)
Week 6&7: complete Task Two – Static and OSPF Routing
Week 8: complete Task Three – Switching
Week 9&10: prepare PT Video Demonstration (Part B submission due by Week 10)

Please note, postponing the Case Study until the last week or day(s) could potentially lead to a poorly designed network and restrict the advantages it offers for your final assessments. Hence, we strongly suggest adhering to the recommended weekly plan to secure a successful outcome.

5. Scenario

The objective of this Cas *Institute of Technology* (AIT), a training organisat in the city. This move necessitates a comprehen has been engaged as AIT's ICT consultants fo by a new network, a prototype of which will be .

AIT's campus network e artial logical Topology Diagram shown in Fig. 1. networks, including a simulated ISP, utilising the work prototype before full deployment to ensure

To help your group organi specific requirements. Upon accomplishing all ta d using Packet Tracer, followed by a demonstration of its operational capabilities in a recorded video.

The AIT, which you are tasked with designing a network for, operates across two campuses. The City Campus encompasses three key locations: **Main Building**, **West Tower**, and **East Tower**. In contrast, the Branch Campus is situated in a suburban area and will be linked through a leased line serial connection, due to cost considerations.

- The **Thomas and Jones Street buildings** serve primarily as the AIT Teaching and Learning hub. Various employee groups are situated in these two buildings. Due to the size and complexity of LANs, the company wants to create *VLANs* to control broadcasts, enhance security and logically organise user groups because these VLANs are essential for the organisation's operations.
- The **Main Building** site features one exit link, offering Internet access and external service connectivity. Leased Line serial connections link the Main Building to both the West Tower and East Tower sites.
- Also, at the **Main Building** site, AIT houses its private Servers and intranet services, catering to both internal and external users.
- To avoid single-point failure and allow certain levels of redundancy, users in the switching network on the City Campus have two exit points, *i.e.* via West (default) and East, respectively.
- Furthermore, AIT Internet and external services: one via M primary path and the backup path thro rimary Main-ISP link becomes unavailab

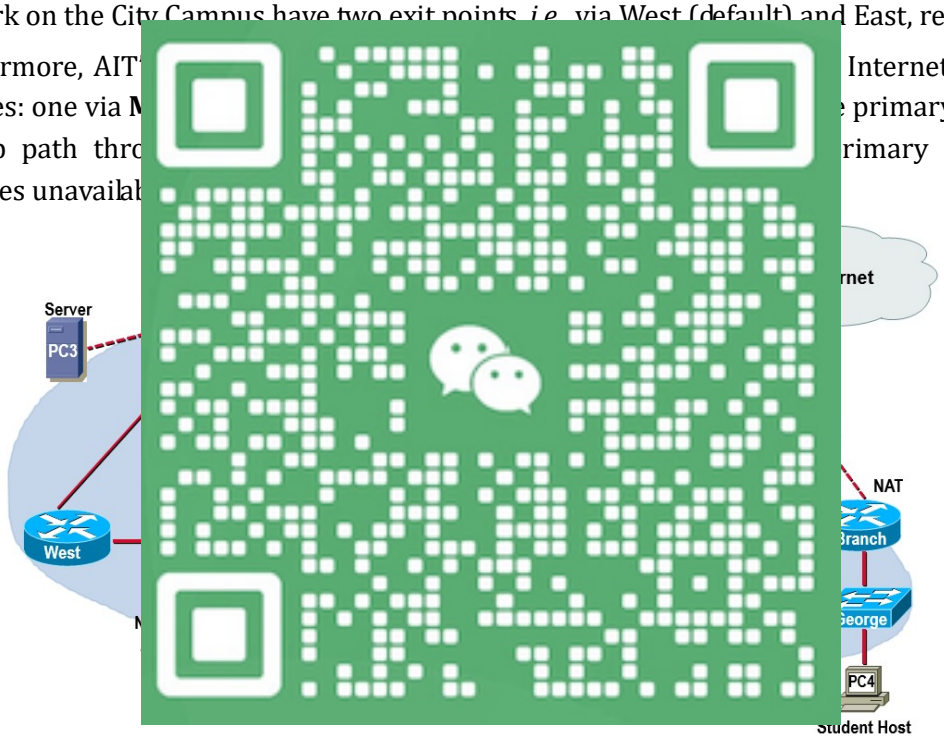


Fig. 1. Basic network topology

AIT has agreed to use **OSPF** for its entire internal networks. At this stage, only IPv4 is considered. AIT also wants to use private IPv4 addresses for the entire internal network and appreciates efficiency and address conservation in their design. NAT for IPv4 will also be implemented on the border routers.

6. Requirements in Tasks

In order to help your group organise this Case Study, the scenario has been broken into **four tasks** and detailed requirements are listed for each task. A prototype of the network is expected to be implemented using Packet Tracer to demonstrate its functionality when all tasks are completed.

Discussion questions are provided at the end of each task for students to consider when justifying their design and implementation. However, there is no requirement to submit these discussions.

Task One: Addressing the Network

The ISP links:

The ISP has allocated **one of the following public IPv4 address spaces for your group**. A '/30 address space' will be used for each of the two ISP links:

- Group A (or 1): **209.165.199.80/29**
- Group B (or 2): **209.165.199.88/29**
- Group C (or 3): **209.165.199.96/29**
- Group D (or 4): **209.165.199.104/29**
- Group E (or 5): **209.165.199.112/29**
- Group F (or 6): **209.165.199.120/29**

The Internal Network:

As part of the network redesign, the AIT has allocated **one of the following private address spaces for your group** for addressing the internal network:

- Group A (or 1): **172.17.80.0/21**
- Group B (or 2): **172.17.88.0/21**
- Group C (or 3): **172.17.96.0/21**
- Group D (or 4): **172.17.104.0/21**
- Group E (or 5): **172.17.112.0/21**
- Group F (or 6): **172.17.120.0/21**

The expected number

For the **West** swi

- 500 hosts fo
- 120 hosts fo

On the **Main** site

- 10 hosts on

On the **Branch** si

- 200 hosts in ram)
- 300 hosts in

The AIT requires that:

- ☐ The use of **VLSM** c
- ☐ **All networking d** **sses** and the PC hosts' **gateways** will use
- ☐ Each of the ISP lin
- ☐ The **Management** **ost** (referred to as the "Network Admin H ministration usage.

At this stage, AIT agrees that it is sufficient to assign all hosts with an IPv4 address statically.

Milestone Submission: Tables A, B and C

1) IPv4 Network subnetting **Table A**, which shows possible subnets that meet the design requirements; Subnets that are not used are to be clearly identified in each table ('not in use').
2) Detailed IPv4 addressing tables (**Tables B and C**) showing all networking devices' names and their interface details. Note that, the gateways of the VLANs will be implemented as *sub-interfaces*, e.g., Fa0/0.10 as the gateway of VLAN10.

Discussion Questions: Consider how you do subnetting so as to meet each of the requirements.

Task Two: Routing the Network

Routing to and from ISP

The AIT network has purchased **two ISP links** to access the Internet and external services, *i.e.*, via the **Main** and **Branch** respectively. AIT's policy requires that the backup ISP link via Branch is only used when the primary Main-ISP link becomes unavailable.

Since the ISP also serves many other customers, routing to and from ISP will use static routing only, and a **standard static route** should be used on ISP to forward traffic to the AIT internal network only when needed.

When correctly implemented, all hosts within the AIT network must be able to reach *all* external addresses, via the Main-ISP link, or the Branch-ISP link when the Main-ISP link is unavailable, in both directions.

Note that, for the demonstration purpose, use a loopback interface with the address of **1.1.1.1/32**, on ISP to simulate the Internet. Also, NAT at both border routers will be considered in Task Four.

Routing the Internal Net

- AIT's policy is

Your design and imple manner.

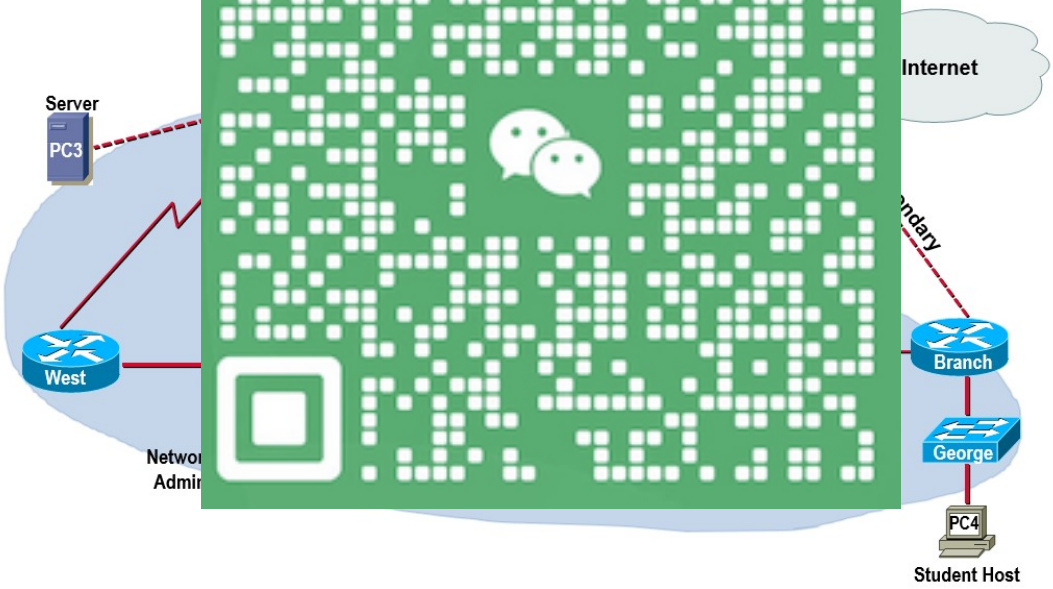


Fig. 3. Routing the network dynamically and statically

Discussion Questions:

Consider how you **implement** and **verify** the following functions:

1) OSPF routing for the internal networks.
2) Static routing and failover routing via the two ISP links.

Task Three: Switching Network at City and Branch Campuses

Because of the size and complexity of LANs, AIT wants to use **VLAN** technologies to control broadcasts, enhance security and logically organise its user groups. 802.1Q trunk-based Inter-VLAN routing is to be implemented to advertise all VLAN networks.

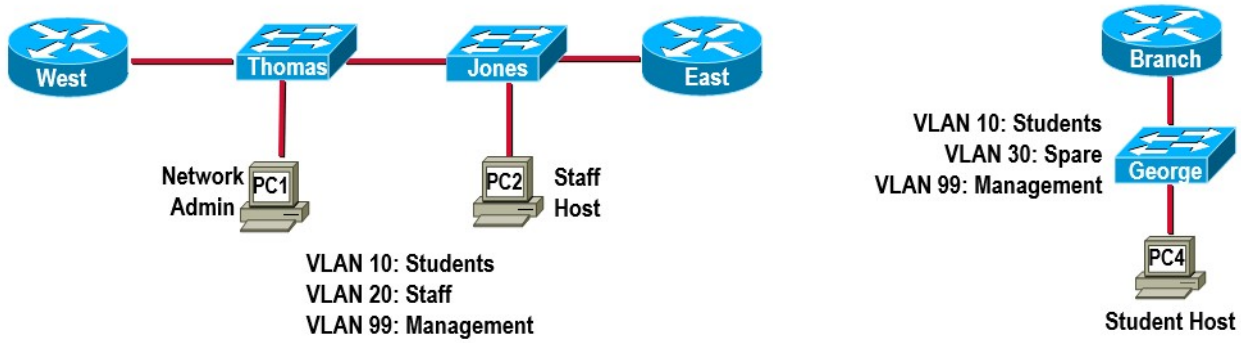


Fig. 2. The switching networks at the City Campus (left) and the Branch Campus (right).

The switching networks

- Create VLANs wit tworks:
  - VLAN 10 – S
  - VLAN 20 – S
  - VLAN 30 – S
- For the purpose c rts to each user VLAN on each switch.
- Create **VLAN 99** a VLAN on each switch. Use **VLAN 555** as
- Do NOT allow traff unk link(s).

Discussion Questions:

Explain, in detail, how you used from the device's running-configure outputs ving functions:

1) Creating VLANs a
2) SVI configuration and verification.
3) Inter-VLAN routing configuration and verification.

Task Four: IP Addressing Services

The company has been allocated one of the following blocks of public IPv4 addresses for the NAT pools:

- Group A (or 1): **209.165.199.160/28**
- Group B (or 2): **209.165. 199.176/28**
- Group C (or 3): **209.165. 199.192/28**
- Group D (or 4): **209.165. 199.208/28**
- Group E (or 5): **209.165. 199.224/28**
- Group F (or 6): **209.165. 199.240/28**

Requirements on NAT for IPv4:

- ☐ All devices and only these devices in the internal network are expected to have Internet connectivity using the available addresses from the public address pool **with overloading**. This connectivity should be maintained regardless of whether the Primary or Secondary ISP links are used.
- ☐ For demonstration purposes, define a **static NAT** for the **Server host** (PC3) using an available address from the pool(s).
- ☐ Adjust the **static routing configuration** on the ISP so that returning traffic from the Internet and external serv

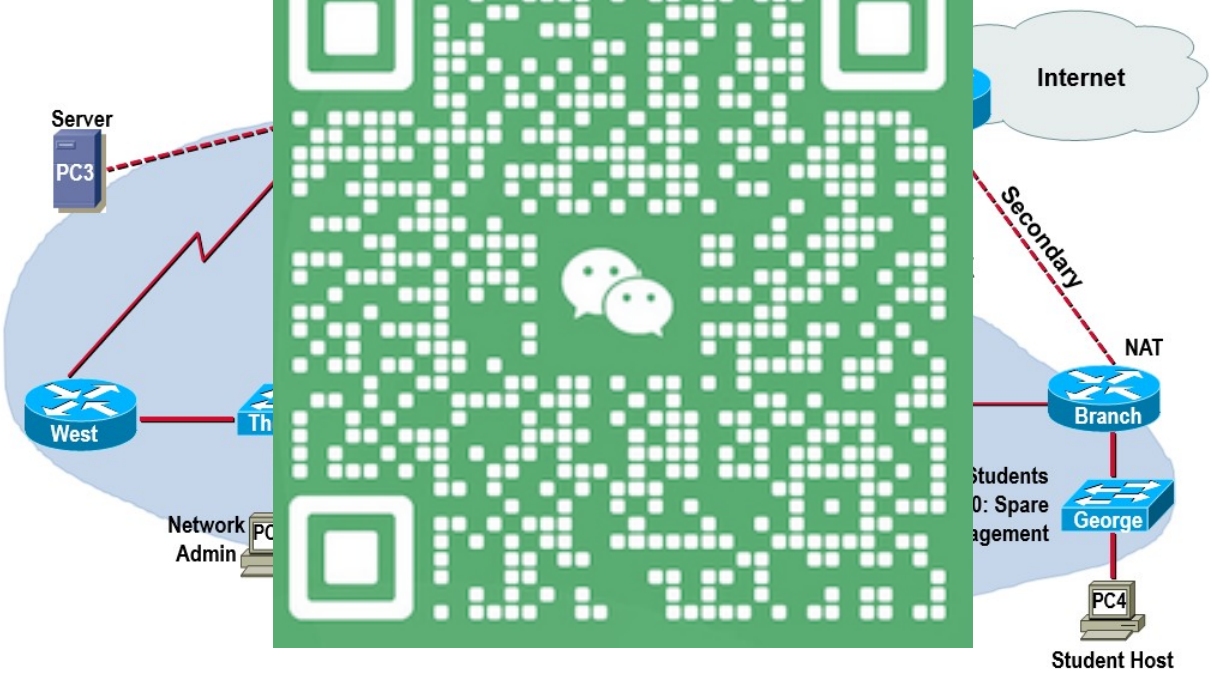


Fig. 4. IP Addressing Services

Discussion Questions:

1) **Show the details of your design**, such as NAT pools for IPv4, and **partial configuration scripts specific to this task** that justify your solution.
2) **Explain how the static routing over the two ISP links has changed with the implementation of NAT.**
3) **Discuss how you verify** that the functionality of your design meets all requirements.

7. Packet Tracer-based Video Demonstration

The company now wants a demonstration of the prototype network. To do this, you need to set up the network that you have designed and configure devices in Packet Tracer to demonstrate all the required functions.

The demonstration requires **basic settings on all routers and switches** including hostname, passwords, MOTD banner, management address and **SSH** access, detailed as follows:

- ☐ Configure basic device settings for routers and switches:
  - Configure **hostnames** as per the partial Topology Diagram.
  - Configure password **`cisco`** for console connections.
  - Encrypt the privileged EXEC mode using the password **`class`**.
  - Disable Domain Name Server **(DNS) lookup**.
  - Enable **logging synchronous** for console connections and all virtual terminal lines.
- ☐ Configure the interfaces of routers and hosts as per the Topology Diagram and your Addressing Tables B&C.
- ☐ Configure static a ...nent and your design.
- ☐ Configure VLANs
- ☐ Configure the Ma
- ☐ Configure the foll
  - **PC1** as the N
  - **PC2** as the S
  - **PC3** as the S
  - **PC4** as a Stu

  PS. The Company ...o control network traffic. At this sta ... demonstration purpose.

The Company requires the

- Verification of the
- Verification of the ...on.
- Verification of dyn
- Verification of stat
- Verification of the VLANs and inter-VLAN routing.
- Verification of NAT (including Overloaded NAT and static NAT).
- Verifying end-to-end connectivity of all hosts to each other and the ISP's loopback addresses.
- Verification of the redundant links.

Discussion Questions:

1) **Discuss how to verify each of the above functions (the commands, expected outcomes, and explanation on the device outputs)**.

Sample Partial Tables:

Table A - IPv4 Subn

Subnet Number*		Required	Maximum Hosts in Subnet	In Use (Yes or No)	Network Name

*"Subnet Number" is th tting.

Table B Device Interfa

Device		Subnet Mask
ISP		
West		
…		
Thomas		
…		

Table C Host Address

		Mask	Gateway
PC2			
PC3			
PC4			

Table D Switch Table

Switch Name: Switch Management IP Address:

Interface type & Port Number	Description of Purpose	Port Bandwidth	Network Name	Subnet Address	Subnet Mask	VLAN ID & Name	Switch Port Mode	Layer 2 Encapsulation

Table E VLAN Table

Switch Name	Number of Ports	Location	IP Address	Gateway	VLAN ID & Name