IV: Case Study

Overview and Objectives

The following case study is used to illustrate the process and documentation required for a network design. This case study presents a scenario in which the XYZ Research Company has hired a Network Consultant Group to design their network. In order to help you organize this project, the scenario has been broken into eight phases listing requirements for each phase. A worksheet is to be completed for each part. A formal report, similar to what would be given to the company, will need to be created after all tasks have been completed.

This case study requires that you accomplish the following:

- Use the resources provided, diagram and narrative, to set up the physical network

- Set up an IP subnetting scheme using VLSM

- Configure the routers as required

- Set up and configure the switches and VLANs as required

- Verify and troubleshoot all connections

- Provide detailed documentation in the appropriate format

- Provide a written final report

Scenario

The XYZ Research Company is small company that is developing high-speed wireless products. The main office occupies two buildings in Sydney. One building is for the Administration Group. The other building is for the Sales and Marketing Group, and the larger Research and Development Group. The Research Group and the Sales and Marketing Group will each have employees located on all three floors of the main building. The XYZ Research Company also has a Sales Branch Office located in Melbourne.

The company is implementing a wired network that should support 100% growth over the next five to ten years. A logical diagram has been provided. The task is to design, implement and fully document the XYZ Research Company network. In addition to a formal report, the XYZ Research would like to see a prototype of the network built, before it is fully implemented, to verify that it will meet the company's needs.

Phase 1: Requirements

Partially completed logical diagram
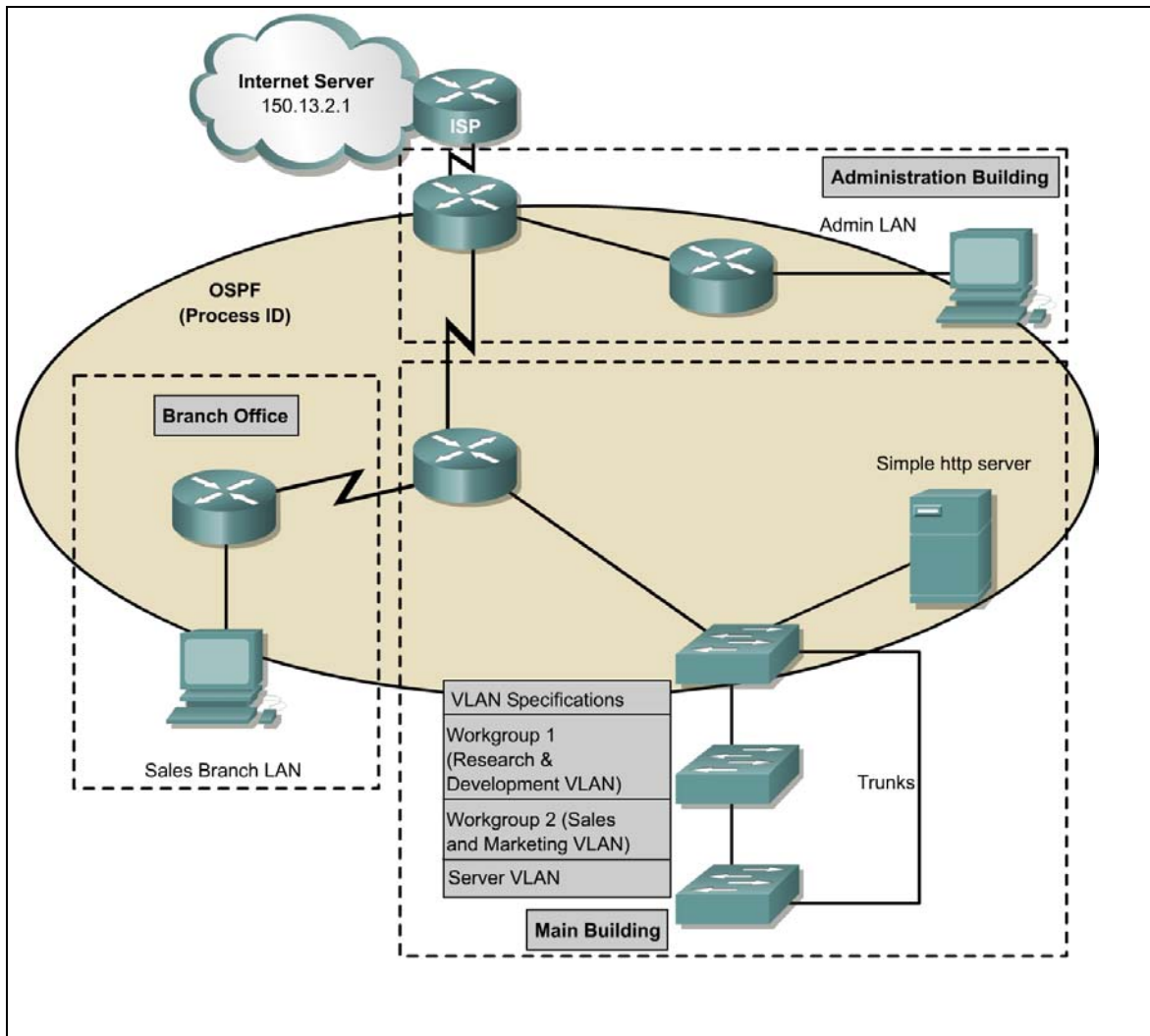
Requirements

The XYZ Research Company has provided a partially completed logical diagram of the required network. The company has also provided networking equipment for development and demonstration. In some instances the equipment provided does not have all the required LAN interfaces. If this is so the company allows configuration of loopback networks, as alternatives.

XYZ Research Company Requirements

- 18 employees in the Research and Development group.
- 9 employees in the Sales and Marketing group.
- 7 employees in the Administration group.
- 5 employees in the remote sales office.
- Lifetime Max of 5 servers on separate subnet, regardless of company growth.
- Use subnet 200.200.100.0/30 for connection to the Internet router.
- Use public class C network 223.0.0.0 for internal addressing.
- Use VLSM for IP addressing.
- Expect 100% growth of current IP requirements when determining size of subnets.
- All networking devices must have IP addresses

Worksheet

1. Produce a logical diagram that includes:

- Router and switch names
- Router interface details
- Network addresses
- Number of hosts per network
- DCE Serial interfaces are to be clearly indicated
- Link Speeds

2. The company expects the use of VLSM Design to maximize the use of IP addresses. A table is to be produced showing all possible subnets that meet the Companies requirements using a VLSM design. Subnets that will not be used are to be clearly identified in the table.

(Note to Instructor: The following is only an example and answers and design by students can and will vary. Also this case study is fairly extensive and students will require a fair amount of time to complete.)

A sample table layout for recording the VLSM design is below.

Number of host addresses required	Network Address	Subnet Mask	Max Number of Host Possible	In Use (Yes/No)	Network Name
6	223.0.0.0	/27	30	Yes	Sales_BR_Lan
2	223.0.0.32	/27	30	Yes	VLAN2_http_srv
19	223.0.0.64	/27	30	Yes	VLAN3_R&D
10	223.0.0.96	/27	30	Yes	VLAN4_Sls_mrkt
4	223.0.0.128	/27	30	Yes	VLAN1_Sw_mgmt
8	223.0.0.160	/27	30	Yes	Admin_Lan
	223.0.0.192	/27	30	No	
	223.0.0.224	/27	30	No	
2	223.0.0.224	/30	2	Yes	MEL_SYD1_link
2	223.0.0.228	/30	2	Yes	SYD1_SYD2_link
2	223.0.0.232	/30	2	Yes	SYD2_SYD3_link

3. For each location, including the Internet, a further set of tables is required. These will assist with design and development activities and used when configuring switches and routers. A separate table should be created for each router and switch at each location. (NOTE: Some fields in the switch table will be completed in Scenario (part 4).)

Below is a sample layout for routers.

Location: Melbourne Sales Branch Office

Router Name: MEL

Interface/Sub Interface Type/Number	Description and Purpose	DCE/DTE (if applicable)	Speed or Clock rate	Network Name	Network Number	Interface IP Address	Subnet Mask
	Sales_lan	--	--	Sales_lan	223.0.0.0	223.0.0.30	/27
	Link to SYD1	--	--	Mel_SYD1_link	223.0.0.224	223.0.0.225	/30

Location: Sydney Main Building

Router Name: SYD1

Interface/Sub Interface Type/Number	Description and Purpose	DCE/DTE (if applicable)	Speed or Clock rate	Network Name	Network Number	Interface IP Address	Subnet Mask
S0/0	Link to MEL	DCE	56000	MEL_SYD1 link	223.0.0.224	223.0.0.226	/30
Fa0/0.1	VLAN2	--	--	VLAN2 http server	223.0.0.32	223.0.0.62	/27
Fa0/0.2	VLAN3	--	--	VLAN3 R&D	223.0.0.64	223.0.0.94	/27
Fa0/0.3	VLAN4	--	--	VLAN4 Sls mrkting	223.0.0.96	223.0.0.126	/27
Fa0/0.4	VLAN1	--	--	VLAN1 switch mgt	223.0.0.128	223.0.0.158	/27
S0/1	Link to SYD2	--	--	SYD1_SYD2 link	223.0.0.228	223.0.0.229	/30

Location: Sydney Main Building

Router Name: SYD2

Interface/Sub Interface Type/Number	Description and Purpose	DCE/DTE (if applicable)	Speed or Clock rate	Network Name	Network Number	Interface IP Address	Subnet Mask
S0/0	Link to MEL	DCE	56000	MEL_SYD1 link	223.0.0.224	223.0.0.226	/30
Fa0/0.1	VLAN2	--	--	VLAN2 http server	223.0.0.32	223.0.0.62	/27
S0/1	SYD2_ISP link	--	--	SYD2_ISP link	200.200.100.0	200.200.100.1	/30

Location: Sydney Main Building

Router Name: SYD3

Interface/Sub Interface Type/Number	Description and Purpose	DCE/DTE (if applicable)	Speed or Clock rate	Network Name	Network Number	Interface IP Address	Subnet Mask
S0/0	Link to MEL	DCE	56000	MEL_SYD1 link	223.0.0.224	223.0.0.226	/30
Fa0/0.1	VLAN2	--	--	VLAN2 http server	223.0.0.32	223.0.0.62	/27

Below is the sample layout for the switch tables.

Location: Sydney Administration Building

Switch Name: Switch1

Switch IP address: 223.0.0.129/27

Interface/ Sub Interface Type/Port/ Number	Description and Purpose	Speed	Duplex	Network Name	Network Number	Subnet Mask	VLAN	Switchport Type	Encapsulation (if needed)
1 – 4	VLAN3	10	Auto	VLAN3 R&D	223.0.0.64	/27	3	10BASE-T	ISL
9 – 15	VLAN4	10	Auto	VLAN4 sls	223.0.0.96	/27	4	10BASE-T	ISL
16	VLAN2	10	Auto	VLAN2 srv	223.0.0.32	/27	2	10BASE-T	ISL
	VLAN1	100	Auto	VLAN1 mgmt	223.0.0.128	/27	1		ISL
A	Sw1_SYD1	100	Auto	Sw1_SYD1			1	Trunk	ISL
B	Sw1_Sw2	100	Auto	Sw1_Sw2			1	Trunk	ISL
24	Sw1_Sw3	10	Auto	Sw1_Sw3			1	Trunk (redundant)	ISL

Location: Sydney Main Building

Switch Name: Switch2

Switch IP address: 223.0.0.130/27

Interface/ Sub interface Type/Port/ Number	Description and Purpose	Speed	Duplex	Network Name	Network Number	Subnet Mask	VLAN	Switchport Type	Encapsulation (if needed)
1 - 6	VLAN3	10	Auto	VLAN3	223.0.0.64	/27	3	10BASE-T	ISL
7 – 8	VLAN4	10	Auto	VLAN4	223.0.0.96	/27	4	10BASE-T	ISL
A	Sw2_Sw1	100	Auto	Sw2_Sw 1	--	--	1	Trunk	ISL
B	Sw2_Sw3	100	Auto	Sw2_Sw 3	--	--	1	Trunk	ISL

Location: Sydney Main Building

Switch Name: Switch3

Switch IP address: 223.0.0.130/27

Interface/ Sub Interface Type/Port/ Number	Description and Purpose	Speed	Duplex	Network Name	Network Number	Subnet Mask	VLAN	Switchport type	Encapsulation (if needed)
1 - 8	VLAN3	10	Auto	VLAN3	223.0.0.64	/27	3	10BASE-T	ISL
A	Sw3_Sw2	100	Auto	Sw3_Sw 2			1	Trunk	ISL
	VLAN1	100	Auto	VLAN1	223.0.0.128	/27	1		ISL

4. To complete the IP design, assign and tabulate PC/workstation and server addresses for each LAN in each location. A DHCP server will assign PC/workstation addresses. **(Use the simple HTTP server as a DHCP server.)**

Server addresses will be statically assigned. **(Http server will be 223.0.0.33/27)**

For the demonstration, the company agrees that it is enough to statically assign all PC/workstation and server addresses.

LAN name	PC or server Name	IP address	Subnet Mask	Gateway	Services Provided
Sales_Br_LAN	Host 1 of 5	223.0.0.1	/27	223.0.0.30	N/A
VLAN2	http_server	223.0.0.33	/27	223.0.0.62	http/DHCP

VLAN3	Host 1 of 19	223.0.0.65	/27	223.0.0.94	N/A
VLAN4	Host 1 of 9	223.0.0.97	/27	223.0.0.126	N/A
Admin_LAN	Host 1 of 7	223.0.0.161	/27	223.0.0.190	N/A

The tables and supporting text will be part of the documentation delivered to the XYZ Research Company.

Before you commence with the next task the logical diagram and tables need to be approved by the company.

Instructors Signature: _____Date:_____

Phase 2: Routing protocols

The company wants a recommendation for a routing protocol for the network.

Worksheet

The possible routing protocol alternatives and properties are to be identified in a brain storming session. Each property is assigned a plus, neutral, or minus value for each of the routing protocols. Alternatively a numerical value can be used, for example 0 to 4. A recommendation is made and the decision matrix presented to the Company.

Routing Protocol	Property 1 (+, neutral, - , or a numeric value) Simplicity	Property 2 Scalability	Property 3 Convergence	Property 4 Robustness	Total
RIP	+	-	-	-	1
IGRP	+	+	-	-	2
EIGRP	-	+	+	-	2
OSPF	-	+	+	+	3

Group Recommendation for Routing Protocol: **OSPF**

Instructors Signature:_____Date:_____

Phase 3: OSPF

The Company has decided that it will use OSPF as the routing protocol.

XYZ Research Company Requirements

- OSPF process id 50

- All routers in a single area, area 0

- Loopback address assigned on each router

- Loopback address used as the OSPF router ID

- There is one multi-access network in the Administration Building and a DR will need to be elected

- Determine whether to use Router ID or interface priority to determine the DR in the Administration Building **(On SYD2 in Admin Building – Loopback interface)**

Worksheet

1. The IP address tables produced previously needs to be updated to include the loopback addresses.

2. A decision is to be made about which router and router interface will be the DR. The group has a discussion about these issues, records the major points of the discussion, documents these and makes recommendations.

   Explain your reasons for choosing router ID or interface priority to determine DR. **– (Router ID, as Loopback provides stability…as it is always up)**

   Explain your reasons for choosing router **SYD2** in the Administration Building as DR. **(It is a border router, centrally located, and close to admin)**

3. Will a DR need to be elected on the serial connections between buildings and the remote branch office? **No** Why? **Only 1 DR needed, although SYD1 should be BDR**

   Update the diagram with OSPF information.

   The location tables, router and IP address table, and diagram are modified to include this information and are presented to the Company.

Instructors Signature: _____Date:_____

Phase 4: VLANs

The company now wants information about VLANs. These are required in the Main Building. The company has provided the following information:

XYZ Research Company Requirements

- There are 18 Research and Development employees

- There are 9 Sales and Marketing employees.

- 8 Research personnel and 2 Sales personnel are on Floor 3.

- 6 Research personnel and 4 Sales personnel are on Floor 2.

- 4 Research personnel and 3 Sales personnel are on Floor 1.

- Floor 1 also has the Server LAN. Five server machines are planned but at this time only one is available.

- There are separate rooms on each floor for the workgroups.

- There is sufficient space in each room to accommodate growth.

- The 100% predicted growth will occur uniformly per floor.

- Switches in the Main building are connected in a loop so that if one switch fails an alternative path is used.

- There will be one switch per floor shared among the different subnets.

- Spanning tree root is to be placed in an optimal position.

Worksheet

1. Tables documenting Switch VLAN port assignments are to be produced for the available demonstration equipment. Any unassigned ports are to remain in the default VLAN.

The table below is an example of the documentation that the company requires.

Switch Details

Switch Name	Model	# of Ports	location	IP Address	Gateway	Management VLAN	VTP Mode	VTP Domain	STP Root
Sw1	1900	24	Floor1	223.0.0.129	223.0.0.158	1	Server	XYZ	Yes
Sw2	1900	24	Floor2	223.0.0.130	223.0.0.158	1	Server	XYZ	No
Sw3	1900	24	Floor3	223.0.0.131	223.0.0.158	1	Server	XYZ	No

VLAN Port Assignments

Update the switch tables, located in the worksheets of Scenario (part 2), with the VLAN and port information for each server, workstation, interconnect between switches, and the interconnect to the router in the Main building.

2. Before submitting the documentation, justification is required for the decision made about the STP root bridge. Write one paragraph justifying the choice to the company. **(Root bridge is in the MDF and closest to Administrator)**

Instructors Signature: _____Date:_____

Phase 5: Physical layer design

The Company needs a proposal which will include the growth projections for the physical layer design.

The document should include the number of cable runs, recommended equipment including patch panels, and labeling rules must also be specified.

For each floor, a table similar to the one below should be included in the documentation.

Main Building Floor 1 IDF/MDF/POP

Equipment Type	Model No	Qty	No./Type Ports	Description/Function	Cost
Router	2620	1	2 Ser/1 Fa	SYD1 Core\Distribution Layer	See web
Switch	1900	1	24 10Mb, 2 100Mb	Switch1 – Access Layer	See web

Main Building Floor 2 IDF

Equipment Type	Model No	Qty	No./Type Ports	Description/Function	Cost
Switch	1900	1	24 10Mb, 2 100Mb	Switch2 – Access Layer	See web

Main Building Floor 3 IDF

Equipment Type	Model No	Qty	No./Type Ports	Description/Function	Cost
Switch	1900	1	24 10Mb, 2 100Mb	Switch3 – Access Layer	See web

Branch Office

Equipment Type	Model No	Qty	No./Type Ports	Description/Function	Cost
Router	2620	1	2 Ser/1 Fa	MEL Core\Distribution Layer	See web
Hub			12 – 100Mb ports	Access Layer	$ 100.00

Administration Building

Equipment Type	Model No	Qty	No./Type Ports	Description/Function	Cost
Router	2620	1	2 Ser/1 Fa	MEL Core\Distribution	See web

				Layer	
Router	2621	1	2 Ser/2 Fa	SYD3 Core\Distribution Layer	See web

To help with the physical layer design the company has provided a diagram from their old site.
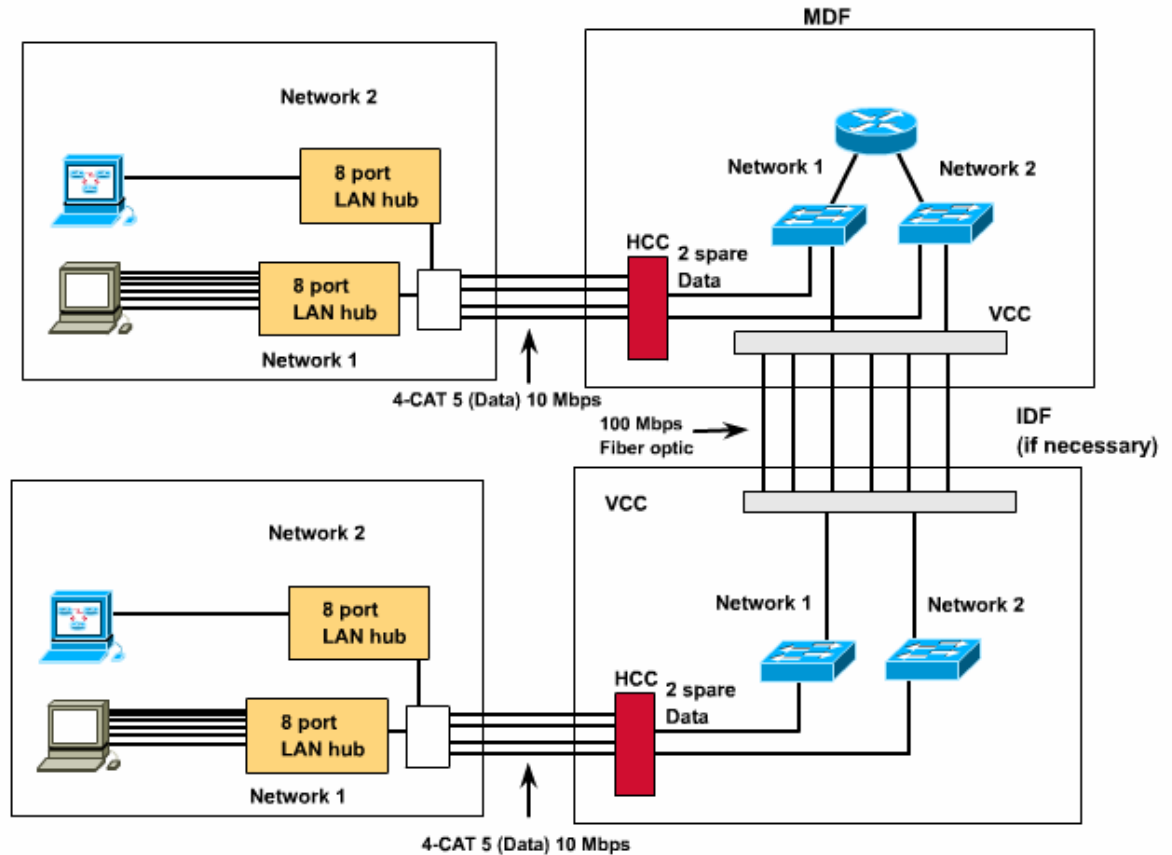
(Student should create and complete a similar drawing as above…could be hand drawn or use done using a graphics program)

The company requires a similar diagram for the Main Building. The Main Building has three floors and will use Category 5 throughout for the LANs.

The diagram must include the following:

- The length and number of cable runs. Count all runs and adhere to TIA\EIA standards. **(Student should count all runs and adhere to TIA\EIA standards)**

- The labeling convention for each of the outlets and patch panel. Generic room names and port names such as IDFFloor 1, Floor1Room1Port1. HCC1:Floor1Room1Port1; VCC1:Floor1XFloor2Port1 are acceptable. If any standards apply in the region then these should be used.

On each floor the horizontal cable runs will be no more than 30 meters. The length of cable needed between consecutive floors is 15 meters.

The documentation should include a description of how cross connects for all trunks will be patched for the required logical topology. The pinout (straight or crossover) cable types should be listed.

Instructors Signature:_____Date:_____

Phase 6: Test network

The Company requires a demonstration of the functionality of the Main Building network and asks that a logically equivalent network be wired up with the equipment provided. The company requires an http server machine to be set up in the Server VLAN and a minimum of a single client host on each of the other VLANs. The company requires that all devices be configured. All configurations, routing tables and VLAN databases are to be recorded as part of documentation.

The company specifies the following network testing. The company is receptive to suggestions or recommendations about other testing and about future network improvements.

Testing and Verifying Strategy

1. Demonstrate routing between Main Building VLANs.

From VLAN/SW	To VLAN/SW	Protocol	Hosts	Pass/Fail
3/Switch1	2/Switch1	Telnet/TCP	1	Pass
4/Switch3	2/Switch1	Telnet/TCP	1	Pass
2/Switch1	3/Switch2	Ping/ICMP	1	Pass

2. Demonstrate access of all hosts to each other and http service on the server machine.

From Host	To Host	Pass/Fail
223.0.0.65 (VLAN3)	223.0.0.33 (VLAN2 Server)	Pass
223.0.0.97 (VLAN4)	223.0.0.33 (VLAN2 Server)	Pass

3. Demonstrate behavior of the internetwork when a single trunk link fails.

From Host	To Host	Trunk up/down	Route	Pass/Fail
223.0.0.65 (VLAN3)	223.0.0.33 (VLAN2 Server)	UP		Pass

4. Other demonstrations/tests (optional, group decision). **(Students may use a variety of other tests – should probably be determined by a brainstorming session, chaired by the instructor)**.

Recommendations for future network improvements. **(Upgrade to Gigabit speeds…other recommendations should be brainstormed by students)**.

Recommendation 1.

Recommendation 2.

Instructors Signature:_____Date:_____

Phase 7: Final demonstration

The company now wants a demonstration of the complete company internetwork. All devices are to be configured and access to the Internet Server address from all networks shown. The OSPF routing protocol with process id of 50 has been selected. Because the network is quite small, a single OSPF area is acceptable.

All configurations, routing tables, and outputs from connectivity testing are to be recorded and stored on a tftp server and on floppy disk.

Test summary results:

From Host	To Host	Path tested	Route Taken	Pass/Fail
223.0.0.1 (Sls _Br)	223.0.0.161 (Admin_Lan)	MEL-SYD1-SYD2-SYD3	Same	Pass
223.0.0.1 (Sls_Br)	223.0.0.33 (VLAN2 Server)	MEL-SYD1-VLAN2	Same	Pass
223.0.0.161 (Admin Lan)	223.0.0.65 (Host on VLAN3)	SYD3-SYD2-SYD1-VLAN3)	Same	Pass
223.0.0.1 (Sls _Br)	223.0.0.161 (Admin_Lan)	MEL-SYD1-SYD2-SYD3	Same	Pass

Instructors Signature:_____Date:_____

Phase 8: Presentation

The final task in this case study is to deliver a 10-minute presentation of the main features of the design decisions and recommendations. A formal written report should also be provided that contains all of the design documents as well as all the supporting worksheets (see case study deliverables). The document should be complete enough to allow a third party to install and configure the network without any additional documents.

Instructors Signature:_____Date:_____

CCNA 3 Case Study Deliverables

Once the case study problem has been solved, the network has been successfully designed and the prototype implemented and tested, a final report must be provided to your instructor. This report will include thorough and well-organized documentation of the process. It is highly recommended that all tables be completed using a spreadsheet program such as Microsoft Excel. Cisco Network Designer, Visio or a paint program can be used for the network diagrams.

The following items must be included in the final report:

- Outline
- Summary of the Company and Network Requirements
- Discussion on the implementation of IP address and VLSM
- Discussion on the implementation of Routing
- Discussion on the implementation of VLANs, STP, and switches
- Discussion on the physical layer design and equipment
- Discussion on testing and verification strategies
- Output of testing and verification commands from routers
- Output of testing and verification commands for switches
- Recommendations for future network upgrades
- Logical Diagram
- Physical Diagram
- IP Addressing Table
- Router Interface Table
- Switch Table
- PC addressing Table
- Routing Protocol Matrix
- Equipment Table
- Router Configurations (printed and floppy)
- Switch Configurations (printed and floppy)
- Testing Results (printed and floppy)