FACULTY OF COMPUTING
SEMESTER 1 2024/2025

SECR 1213 NETWORK COMMUNICATIONS
SECTION 02
PROJECT TASK 3
LECTURER: ASSOC. PROF. TS. DR. ISMAIL FAUZI BIN ISNIN

GROUP FOUREVER

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LAN Devices

    1. Router

In a network, a router is a device that links several devices such as computers, phones and tablets to the internet and to one another. It ensures that information delivered from one device reaches its destination.

    1.1 Wired Router

A wired router is a device that uses Ethernet connections to link PCs and other devices to the internet. It provides a quick and stable connection since data passes straight via the cable, which makes it perfect for settings in workspaces. All linked devices must be plugged in using cables because wired routers do not use Wi-Fi like wireless routers do.

Wired Router	Cisco RV345 Dual WAN [1]	TP-Link ER 7206 [2]	Ubiquiti EdgeRouter ER-4 [3]
Price	RM 1400.00	RM 1099.00	RM 1304.00
WAN Ports	2 WAN ports for load balancing	Multi-Gigabit WAN ports	4 Gigabit Ethernet ports
VPN Support	IPsec, L2TP over IPsec, Cisco VPN	IPsec, PPTP, L2TP, OpenVPN	Full VPN support, including IPsec
Firewall Security	Advanced Firewall	Advanced Firewall	Advanced Firewall
Network Management	-	Centralized via Omada SDN	Robust management interface

Cisco RV345 Dual WAN Gigabit VPN Router is the best option due to its dual WAN ports, 16 LAN ports, robust VPN and security features, so it is ideal for handling large numbers of users and providing secure connections. Although it is priced higher at RM1400.00, its functionality and performance make it well suited for lab demands.

    1.2 Wireless Router

A wireless router in a university allows students and staff to access the internet without the use of wire. It provides multiple connections across several devices, offering access to learning platforms, internet resources and communication tools in classrooms, libraries and other locations.

Wireless Router	Netgear Nighthawk AX12 (RAX200) [4]	TP-Link Archer AX73 (AX5400) [5]	Asus ROG Rapture GT-AX11000 [6]
Price	RM 3099.00	RM 499.00	RM 2436.00
Wi-Fi Type	Tri-band Wi-Fi 6	Dual-band Wi-Fi 6	Tri-band Wi-Fi 6
Speed	Up to 10.8 Gbps	Up to 5400 Mbps	Up to 11000 Mbps
Streams	8-stream support	6-stream support	Not specified
LAN Ports	Not specified	Not specified	8 Gigabit Ethernet ports
Special Features	Not specified	Multiple antennas for extensive coverage	Gaming acceleration, customizable QoS

TP-Link Archer AX73 (AX5400) is the best budget option for this project. At RM 499.00, it offers good speed (up to 5400 Mbps) and coverage with dual-band Wi-Fi 6. The Netgear Nighthawk AX12 and Asus ROG Rapture GT-AX11000 offer faster speeds, but they are much more expensive. As a conclusion, **TP-Link Archer AX73** provides great value for project needs at a lower cost.

2. Switches

Switches are the essential components for any network. They link several devices on the same network, including servers, printers, wireless access points, and PCs, within a building or campus.

2.1 Access Switches

Access switches are used to control local traffic and link endpoints to the network.

Access Switch	CiscoWS-C2960X-48 TS-LL Catalyst 2960-X [7]	HPE 2930F [8]	C9200-48T-A - Cisco Switch Catalyst 9200 [9]
Price	RM 9955.43	RM 21800.00	RM 18,039.88
Ports	48 x Ethernet 10/100/1000 Gigabit ports	(24) RJ-45 autosensing 10/100/1000 ports (4) SFP+ 1/10GbE ports	48 ports data

Forwarding Bandwidth	100Gbps	-	261.9 Mpps
Switching Bandwidth	100Gbps	128 Gbps	176 Gbps
RAM	256MB	1GB	4GB
Flash Memory	64MB		4GB

The **Cisco C9200-48T-A Catalyst 9200** is the ideal choice due to its outstanding performance. Of the available alternatives, it provides the maximum forwarding rate (261.9 Mpps) and switching bandwidth (176 Gbps). Additionally, it comes with 4GB of RAM and 4GB of flash memory, which ensures efficient operation of advanced network functions. Although the price is slightly higher than CiscoWS-C2960X-48TS-LL Catalyst 2960-X, it justifies the cost with its enhanced capabilities.

2.2 Core Switches

Core switches connect all access switches, which provide high-speed interconnectivity. They act as the foundation for creating high-performance, high-availability networks by supporting a variety of network protocols and services.

Access Switch	C9500-24X-E - Cisco Switch Catalyst 9500 [10]	Aruba Networking CX 6400 [11]
Price	RM44140.09	RM 56135.00
Ports	16-port 10G switch	10 I/O module slots, maximum
Switching Bandwidth	960 Gbps	28 Tbps
RAM	16 GB	16 GB
Flash Memory	16 GB	32 GB

Of the two options, the **Aruba Networking CX 6400** is the preferable one. Its 28 Tbps switching bandwidth is a lot more than the Cisco C9500-24X-E Catalyst 9500's. While both core switches have 16 GB of RAM, Aruba offers 32 GB of flash memory along with 10 I/O module slots for more expandability. This makes it perfect for high-performance, large-scale networks requiring scalability and flexibility.

3. Cables

Communications cables are used to interconnect, connect and transfer data and information

between computers, routers, switches and storage area networks. It establishes multiple physical connections that enable direct communication between devices.

3.1 Fiber Optic Cables

A fiber optic cable is a network cable with glass fiber wires wrapped in an insulated casing. It connects switches located on separate floors.

Fiber Optic Cables	RS PRO 4-way TB [12]	FS OM4LCDX [13]	RS PRO 12-way TB Fibre Optic Cable [14]
Price	RM 1894.55	RM 20.00	RM 2340.00
Length (m)	200	1	100
Propagation Mode	OM4 Multi Mode	OM4 Multi Mode	OM4 Multi Mode
Number of Core	4	2	12
Maximum Operating Temperature	+70°C	+70℃	+70℃
Minimum Bend Radius	15 D	20 D	15D

RS PRO 12-way TB Fibre Optic Cable is the best option among these. It has the highest number of cores, providing higher capacity for scalability. Besides, it provides reasonable value at RM 23.40 per meter given its features, especially for multi-core connections.

3.2 Ethernet Cables

Ethernet cables are used to connect devices to the internet and to a local network. They connect to the Ethernet ports of various devices.

3.2.1 Cat 6a

Cat 6a cables are suitable to be used in high-performance areas to ensure reliable connections for labs and hybrid classrooms.

Ethernet Cable	RJ 45 2996AS-1GY [15]	ETHERLINE Cat. 6A Y [16]	RS PRO Shielded Cat6a Cable [17]
Price	RM 32.86	RM 46.23	RM 79.28
LAN Category	Cat6a	Cat6a	Cat6a

Length (m)	1	1	3
Speed	10Gbps	10Gbps (Industrial Ethernet)	10Gbps
AWG	26	22	26

RJ 45 2996AS-1GY is the best budget option. It has the lowest price but similar specifications with others, delivering excellent 10Gbps performance. Its Cat6a rating ensures high-speed, reliable connections for hybrid classrooms and labs.

3.2.2 Cat 6
Cat 6 are for general purpose use for spaces like the student lounge and common area, as they don't demand such high-speed or interferenc e-resilient connections.

Ethernet Cable	N/W N204-010-BL-DN [18]	SubTel CAT6-UTPF-XXX [19]	D-LINK NW-D-C6UF [20]
Price	RM 67.73	RM 11.00	RM 16.00
LAN Category	Cat6	Cat6	Cat6
Length (m)	3.1	3	1
Frequency	550Mhz	250 MHz	550MHz
AWG	24	32	-

D-LINK NW-D-C6UF would be a good option. At an affordable price as low as RM 16 per meter, it has a 550Mhz rating of frequency, which shows that it can support reliable high-speed connections, meeting industrial and educational needs.

3.3 Power-over-Ethernet (PoE) Cables
PoE Cables is to deliver DC power to devices over Ethernet, which eliminates the need for separate power supplies and outlets.

Ethernet Cable	MISUMI KB-T6POE [21]	Adoreen B093K9SX9F [22]	Ugreen NW102 [23]
Price	RM 104.24	RM 44.76	RM 24.21
LAN Category	Cat6	Cat6	Cat6

Length (m)	3	15.24	15
No. of Cores	8	8	8
PoE (Power Supply)	Compatible	Compatible	Compatible
Frequency	250MHz	550 Mhz	250MHz
Transfer Rate	1000Mbps	10Gbps	1000Mbps

The recommended choice for PoE Cables is **Adoreen B093K9SX9F**. It supports a transfer rate of 10Gbps at a frequency of 550 MHz, making the connections run smoothly and allow users to run high-speed applications. The price (RM 2.94/meter) is also worth it compared to MISUMI KB-T6POE which cost RM 34.75 per meter.

4. Wireless Access point

Wireless Access Point is the networking device that allows wireless-capable end devices such as PCs, laptops of staff and students in UTM to connect to the wired network. The router chosen as stated above does not have a built-in wireless access point. To include WiFi functionality to the **Cisco RV345 Dual WAN Gigabit VPN Router,** an access point is needed.

Comparison:

Access Points	Ubiquiti UniFi U7 Pro Max [24]	TP-Link Omada EAP783 [25]
Price	RM1700	RM5899
Wi-Fi Standard	802.11a/b/g/n/ac/ax/be (WiFi 6/6E, WiFi 7)	Wi-Fi 7 (802.11be), Wi-Fi 6 (802.11ax)
Speed (Data Rate)	2.4 GHz: 688 Mbps (BW40) 5 GHz: 8.6 Gbps (BW240) 6 GHz: 5.7 Gbps (BW320)	2.4 GHz: 1376 Mbps 5 GHz: 8640 Mbps (BW160) 6GHz: 11520 Mbps (BW320)
Coverage Area	1750 ft^2	2150 ft^2
Number of Supported Devices	500+	760+
Power Options	PoE+	PoE++
Security Features	Wireless Security WPA-PSK,	WPA3

	WPA-Enterprise (WPA/WPA2/WPA3/PPSK)	
Multi-SSID Support	BSSID 8 per radio	up to 24 SSIDs
Management Options (Local/Cloud)	Local (Ethernet)	Centralized Cloud Management

The **Omada EAP783** has a higher speed, and wider coverage, making it a better choice for the new faculty buildings. Hence, the Omada EAP783 is chosen as the wireless access point to provide wireless access to the Internet within a wide range of 2150ft^2.

5. Patch Panel

A patch panel is the hardware device used in networking to manage and organize multiple cables in a centralized location. Patch panel provides an interface for the cables to be connected, arranged or disconnected easily without affecting the whole system.

Patch Panel	QuickNet™ Shielded Patch Panel [26]	Leviton OPT-X™ UHDX Fiber Panels [27]
Price	RM930.31	RM 470.40
Number of Ports	48 Ports	72 Fiber Ports
Cable Compatibility	Cat5e, Cat6	Fiber Optic
Installation Method	1U Rack Mount	1U or 2U Rack Mount
Connector Type	RJ45 (Keystone Coupler)	LC, MPO/MTP Fiber

For Ethernet-based networks that use the Cat6 cabling as stated above, **QuickNet™ Shielded Patch Pane** are selected. It is cost effective and uses RJ45 (Keystone Coupler), allowing flexibility in port configurations and easy cable replacements.

For Fiber Optic cabling, **Leviton OPT-X™ UHDX Fiber Panels** are selected. It is essential for modern networking, making it much more scalable. 72 fiber ports allow more connections in the rack space, maximizing space and cost efficiency.

6. Firewall

Firewall is a network security system that monitors and controls incoming and outgoing network traffic based on predetermined security rules. This helps block malicious traffic, unauthorized access attempts, and other threats that could compromise the network.

	Fortinet FortiGate 200F [28]	Cisco Firepower 1010 [30]	Palo Alto Networks PA-820 [31]
Price	RM 18,444.88 [29]	RM 3,841.00	RM 27,316.13
IPS Throughput	5 Gbps	900 Mbps	1.3 Gbps
Threat Protection Throughput	3 Gbps	890 Mbps	790/840 Mbps
Maximum Concurrent Session	3,000,000	100,000	128,000
New Session Per Second	280,000	6,000	8,600

Based on the comparison, the **Fortinet FortiGate 200F** seems to be the best option for our case. Although it may be more expensive compared to the Cisco Firepower 1010, it has a higher throughput and can accommodate more sessions.

Conclusion

Item	Quantity	Unit Price (RM)	Total Price (RM)
Cisco RV345 Dual WAN Gigabit VPN Router	2	1400.00	2800.00
TP-Link Archer AX73	4	499.00	1996.00
Cisco C9200-48T-A Catalyst 9200	8	18,039.88	144319.04
Aruba Networking CX 6400	1	56135.00	56135.00
S PRO 12-way TB Fibre Optic Cable	3	2340.00	7020.00
RJ 45 2996AS-1GY (1m)	60	32.86	1971.60
D-LINK NW-D-C6UF (1m)	40	16.00	640.00
Adoreen B093K9SX9F (15m)	30	44.76	1342.80
Omada EAP783	2	5899.00	11798.00
QuickNet Shielded Patch Panel	3	930.31	2790.93
Leviton OPT-X™ UHDX Fiber Panels	3	470.40	1411.20
Fortinet FortiGate 200F	1	18,444.88	18444.88
		Total	250669.40

Reflection

1. Are you surprised by the prices? How were you surprised?
   Yes. For some of the devices, we may expect it to be expensive but it turns out to be a little bit cheaper than expected while others may cost a fortune.

2. Have you ever considered cost as a factor for choosing networking devices?
   Yes. It is obvious that the devices that have a better specification would be more expensive. Thus, we need to trade-off with the price and specification of the devices.

3. What are the major differences between the same devices from different brands? For example, Cisco and Huawei Routers.
   The pricing and the specifications offered. Despite some of them having similar specifications, the price may vary.

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Meeting Minutes

DATE/TIME	3 Nov 2024 7.00pm
LOCATION	M19, Kolej Tun Dr. Ismail
AGENDA	Discussion for Task 2
MEETING MC	Lam Yoke Yu

ATTENDANCE		
NAME	**TIME**	**REASON FOR ABSENCE**
Goe Jie Ying	7.00 pm	-
Lam Yoke Yu	7.00 pm	-
Tan Yi Ya	7.00 pm	-
Teh Ru Qian	7.00 pm	-

MINUTES			
NO.	**ITEM DISCUSSED**	**IDEA/SUGGESTIONS AND PERSON GIVING IT**	**PERSON IN CHARGE & DATE**
1	Discuss the questions.	- Discuss the kinds of questions to be asked.	All 4/11/2024
2	Search the questions online.	- Use the keywords related to our task and search in the browser.	All 13/11/2024
3	Next Meeting	8/11 - Progress Checking	All
4	Meeting Ended	9.00 pm	All

DATE/TIME	12 Nov 2024 9.00pm
LOCATION	Physical, Family Mart
AGENDA	Discussion for Task 3
MEETING MC	Teh Ru Qian

ATTENDANCE		
NAME	**TIME**	**REASON FOR ABSENCE**
Goe Jie Ying	9.00 pm	-
Lam Yoke Yu	9.00 pm	-
Tan Yi Ya	9.00 pm	-
Teh Ru Qian	9.00 pm	-

MINUTES			
NO.	**ITEM DISCUSSED**	**IDEA/SUGGESTIONS AND PERSON GIVING IT**	**PERSON IN CHARGE & DATE**
1	Discuss the devices	- Discuss devices and quantity	All 13/11/2024
2	Do research about the devices	- Find out the devices through internet - Search for prices on internet using shopee and lazada - Find the specifications of devices	All 13/11/2024
3	Next Meeting	9/11 - Progress Checking	All
4	Meeting Ended	10.15 pm	All