



SECR 1213 - 06
Network Communications

Lecturer: Dr. Ts. Raja Zahilah binti Raja Mohd Radzi

Task #3
LAN Device Selection and Optimization



Group 4: NetLink Solutions

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Task explanation

The goal of the project is to lay out a solid network solution capable of supporting the new Faculty of Computing building facility. Technologically equipped for 1 800 students and 140 staff, the building has four laboratories, a hybrid class, a video conference room, and a students' area.

The overarching proposal of the design focuses on the present and future needs of the institution and fast connection, increased security and flexibility in management. The incorporation of wireless access points, new generation routers, and large-scale storage systems will ensure that the network offers maximum efficiency that is expected in compliance with the Fourth Industrial Revolution (4IR).

This document also outlines the selection of devices and components in terms of the performance, reliability and cost. The solution put forward makes use of utensils from vendors like Cisco, Dell and Fortinet, with needed institutional endowments representing the sum of RM 2 million.

It clearly shows a lot of planning and good research and consultations before the layout of the infrastructure to support teaching, research and administrative activities. It also positions the institution's IT infrastructure for future growth and technological innovations by pointing out what should be done to add functionality or integrate with later or other systems.

Meeting minutes

Date/time	25/11/2024, 8:30 p.m.
Location	Google Meet (online)
Meeting discussion task	<ol style="list-style-type: none"> 1. The task. 2. The suggested idea. 3. Brand of the devices. 4. Task division.
Meeting MC	Abdalla Ali Abdalla Ali

Attendance

Name	Time	Reason of absence
1- Abdalla Ali Abdalla Ali	8:30	---
2- Nouredin Mamdouh	8:30	---
3- Mohammed abdelgawwad	8:31	---

Minutes

No	Item discussed	Result	Person in charge/Time
1.	The task.	Noureldin thoroughly read the task and explained each part in details, while explaining some terms, the team had a good understanding of the overall task.	Nouredin Mamdouh (8:32 pm – 8:55 pm)
2.	The suggested idea.	Mohammed suggested to briefly think about all the devices that should be included in the report, Abdalla named few devices that could be used in the labs	Mohammed abdelgawwad (8:55 pm – 9:17 pm)

3.	The brand of devices.	Nouredin discussed which companies are most suitable, Abdalla and Mohammed gave their opinions and options on which brands are suitable.	Mohammed abdelgawwad (9:18 pm – 9:33 pm)
4.	Task division.	Abdalla suggested that each part of the devices should be taken by a member with referencing from where did he get his information.	Nouredin Mamdouh (9:33 pm – 9:59 pm)
Meeting Ended		9:59 PM	

Devices

When planning and constructing the networking and lab structures under the allocated of RM 2.00 million of funding, great emphasis should be put on the choice of the devices in terms of offering good performance, reliability and that are relatively cheap in terms of the total budget. The following section includes the required devices, suitable companies, reasons for their choices, and their costs.

Network devices

- **Routers:** At least 2, considering redundancy for core networking.
- **Switches:** 1 per lab (4 labs), 1 for the video conferencing room, and 1 for the student lounge. Total: 6.
- **Wireless Access Points:** Minimum 2 per room for proper coverage (considering the size of 14m x 10m). Total: 12.
- **Cabling:** Approximate length per lab: 2 meters per computer + 20% tolerance, 72 meters for each lab but taking 1000 meters in total considering the size approximation and height, 1000 meters approximately for the network layout.
- **Patch Panels:** 1 per switch for organized cable management. Total: 6
- **Servers:** 1 or 2 for managing resources (mainly 2 considering the network traffic).
- **Firewalls:** 1 high-performance firewall for security

Lab Equipments and Devices

- **Desktop Computers:** 30 per lab, 120 total.
- **Monitors:** one for video conferencing rooms.
- **Keyboards and Mice :** 30 per lab, 120 total.
- **Printers (Networked):** 1 for the cisco lab.
- **Projector:** 1 for each lab, 1 for video conferencing room, and 1 for hybrid classroom.
- **IoT Devices:** Suggestion is Raspberry Pi 1 for each desk, 30 in total.
- **Cameras:** 2 cameras, 1 for hybrid classroom and another one for video conferencing room.

- **Hard drive storage:** 1 for each of the classes, video conferencing room and hybrid classroom. Total: 6.
 - **Central storage:** 1 for the whole facility.
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Device comparison

Network devices

1. Routers

Feature	Chosen (Cisco ISR 4331)	Alternative 1 (Huawei AR2220E)	Alternative 2 (TP-Link TL-ER6120)
Throughput	Up to 2 Gbps	1.6 Gbps	1.2 Gbps
WAN Options	MPLS, LTE, broadband	MPLS, broadband	Dual-WAN, broadband
Scalability	Modular design for growth	Modular interfaces	Fixed architecture
Security	Cisco IOS Security Suite	Integrated firewall, VPN	VPN support, basic firewall
Energy Efficiency	Moderate	High	Moderate
Price (RM)	25,000	20,000	1,500

Reason for Selection:

The Cisco ISR 4331 was chosen for its modular design, allowing scalability as the institution's requirements grow. Its advanced security and high throughput make it a reliable choice for managing large-scale networks.

Comparison:

While the Huawei AR2220E is a more cost-effective option with decent performance, it lacks the level of modularity and enterprise-grade features offered by Cisco. TP-Link is budget-friendly but suitable only for smaller setups or secondary networks.

2. Switches

Feature	Chosen (Cisco Catalyst 2960-X)	Alternative 1 (Huawei S5700 Series)	Alternative 2 (TP-Link T2600G-28TS)
Ports	24/48 Gigabit Ethernet	24/48 Gigabit Ethernet	24 Gigabit Ethernet
Layer	Layer 2/3	Layer 2/3	Layer 2+
Energy Efficiency	Advanced	Advanced	Basic
Management	Secure, scalable options	Intelligent stacking	Centralized
Price (RM)	15,000	12,000	2,000

Reason for Selection:

Cisco Catalyst 2960-X provides advanced Layer 3 capabilities, enabling more efficient routing and VLAN support, which are critical for the institution's network infrastructure.

Comparison:

Huawei S5700 offers similar features at a lower price, but its management capabilities are less robust. TP-Link is significantly cheaper but lacks advanced

Layer 3 functions, making it less suitable for a demanding network.

3. Wireless Access Points

Feature	Chosen (Ubiquiti UniFi UAP-AC-PRO)	Alternative 1 (Cisco Aironet 1850 Series)	Alternative 2 (TP-Link EAP245)
Wi-Fi Standard	802.11ac	802.11ac Wave 2	802.11ac
Speed	Up to 1300 Mbps	Up to 1.73 Gbps	Up to 1200 Mbps
Management	UniFi Controller Software	Cisco Mobility Express	Omada Controller
MU-MIMO Support	No	Yes	No
Price (RM)	1,000	3,000	600

Reason for Selection:

The Ubiquiti UniFi UAP-AC-PRO was selected for its balance of cost-effectiveness and performance. Its centralized management software and good coverage make it suitable for large spaces like labs and lounges.

Comparison:

Cisco Aironet 1850 offers higher speeds and MU-MIMO support but comes at a much higher cost. TP-Link EAP245 is affordable but lacks advanced features like MU-MIMO, making it less future-proof.

4. Firewall

Feature	Chosen (Fortinet FortiGate 100E)	Alternative 1 (Cisco Firepower 1010)	Alternative 2 (SonicWall TZ400)
Throughput	7 Gbps	6 Gbps	1.5 Gbps
Security Features	UTM, IPS, antivirus	Advanced threat protection	VPN, intrusion prevention
VPN Support	Comprehensive	Comprehensive	Standard
Price (RM)	20,000	15,000	10,000

Reason for Selection:

Fortinet FortiGate 100E offers comprehensive security features, including Unified Threat Management (UTM) and high throughput, making it ideal for securing the institution's network.

Comparison:

Cisco Firepower 1010 integrates well with other Cisco devices but has a slightly lower throughput. SonicWall TZ400 is a more affordable option but lacks advanced UTM capabilities.

5. Patch Panels

Feature	Chosen (Panduit DP245E88TGY)	Alternative 1 (Leviton 69586-U24)	Alternative 2 (Netgear JNP24C)
Ports	24-port, Cat6 compatible	24-port, universal wiring	24-port, fully shielded

Compatibility	Cat6 cabling	Universal compatibility	Cat6 compatibility
Design	Color-coded labeling for easy management	Secure cable retention	Compact design
Durability	High-quality materials	Reliable build	Shielded for reduced interference
Price (RM)	500	400	500

Reason for Selection:

The Panduit DP245E88TGY was chosen for its reliability and ease of cable management, making it ideal for an academic setup where structured cabling is critical. Its color-coded labeling simplifies organization, which is especially useful during installation and maintenance.

Comparison:

The Leviton 69586-U24 is slightly cheaper and offers universal compatibility but lacks advanced features like shielding for interference reduction. The Netgear JNP24C, while similarly priced, focuses on compact design and shielding but does not offer as much ease of management as Panduit's color-coded labeling.

6. Servers

Feature	Chosen (Dell PowerEdge R650)	Alternative 1 (HPE ProLiant DL360 Gen10)	Alternative 2 (Lenovo ThinkSystem SR630)
Processor	Dual Intel Xeon Silver (16 cores each)	Intel Xeon Scalable	Intel Xeon Scalable
RAM	64GB DDR4, expandable	64GB, expandable	64GB, expandable

Storage	4TB NVMe SSD	SSD/HDD options	SSD/HDD options
Price (RM)	50,000	45,000	40,000

Reason for Selection:

Dell PowerEdge R650 was chosen for its high scalability, reliability, and support for NVMe SSDs, which offer superior performance.

Comparison:

HPE ProLiant DL360 Gen10 is a competitive alternative with robust security features but slightly lower storage performance. Lenovo ThinkSystem SR630 is the most cost-effective but may not offer the same level of enterprise support.

Lab Equipments and Devices

1. Desktop Computers

Feature	Chosen (Dell OptiPlex 7080)	Alternative 1 (HP EliteDesk 800 G6)	Alternative 2 (Lenovo ThinkCentre M720)
Processor	Intel Core i7	Intel Core i7	Intel Core i7
RAM	16GB DDR4	16GB DDR4	16GB DDR4
Storage	512GB SSD	512GB SSD	512GB SSD
Ports	Multiple USB, DisplayPorts	Multiple USB, DisplayPorts	Multiple USB, DisplayPorts
Price (RM)	4,500	4,200	4,000

Reason for Selection:

The Dell OptiPlex 7080 was selected for its robust build, enterprise reliability, and excellent after-sales support, making it a long-lasting investment for lab environments.

Comparison:

The HP EliteDesk 800 G6 offers similar performance and slightly enhanced security features at a lower price. The Lenovo ThinkCentre M720 is the most cost-effective but lacks the premium build quality and support Dell provides.

2. Monitors

Feature	Chosen (Dell UltraSharp U2419H)	Alternative 1 (HP Z24n G2)	Alternative 2 (Lenovo ThinkVision P24h)
Screen Size	24 inches	24 inches	24 inches
Resolution	Full HD	Full HD	QHD
Panel Type	IPS	IPS	IPS
Ergonomics	Adjustable stand	Adjustable stand	Adjustable stand
Price (RM)	1,200	1,100	1,300

Reason for Selection:

The Dell UltraSharp U2419H was chosen for its superior display quality, ergonomic design, and long-standing reputation for durability in professional setups.

Comparison:

The HP Z24n G2 is slightly cheaper and offers comparable color accuracy. The Lenovo ThinkVision P24h provides higher resolution (QHD) but is more expensive.

3. Cameras

Feature	 Chosen (Hikvision DS-2CD2387G2-L)	 Alternative 1 (Axis P3245-LVE)	 Alternative 2 (Dahua IPC-HDW2431T-ZS)
Resolution	4K	HDTV 1080p	4MP
AI Features	Motion detection	Forensic WDR	Night vision IR
Weatherproof	Yes	Yes	Yes
Price (RM)	1,500	2,500	1,200

Reason for Selection:

The Hikvision DS-2CD2387G2-L offers 4K resolution and AI-based motion detection at a competitive price, making it ideal for monitoring classrooms and conference rooms.

Comparison:

The Axis P3245-LVE is premium and better in low-light conditions but much more expensive. The Dahua IPC-HDW2431T-ZS provides basic functionality at a lower cost but lacks advanced features.

4. Projectors

Feature	 Chosen (Epson EB-X41)	 Alternative 1 (BenQ MS560)	 Alternative 2 (Sony VPL-EX430)
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Brightness	3,600 lumens	4,000 lumens	3,600 lumens
Resolution	Full HD	Full HD	WXGA
Lamp Life	12,000 hours	10,000 hours	8,000 hours
Price (RM)	2,500	2,200	3,200

Reason for Selection:

The Epson EB-X41 was chosen for its excellent balance of brightness, resolution, and durability, making it ideal for classrooms and conference rooms.

Comparison:

The BenQ MS560 is a more affordable option with higher brightness but shorter lamp life. The Sony VPL-EX430 offers premium features but at a higher price.

5. Printers

Feature	 Chosen (HP LaserJet Pro M404dn)	 Alternative 1 (Canon imageCLASS LBP226dw)	 Alternative 2 (Brother HL-L6200DW)
Speed	40 ppm	38 ppm	48 ppm
Duplex Printing	Yes	Yes	Yes
Energy Efficiency	High	High	Moderate
Price (RM)	1,500	1,200	1,800

Reason for Selection:

The HP LaserJet Pro M404dn was selected for its high-speed printing, energy efficiency, and reliability, which are critical for a Cisco lab's daily operations.

Comparison:

The Canon imageCLASS LBP226dw is more budget-friendly but offers slightly lower speed.

The Brother HL-L6200DW has the fastest speed but is more expensive and less energy-efficient.

6. Hard Drives

Feature	Chosen (Seagate Backup Plus Hub 8TB)	Alternative 1 (WD My Book 8TB)	Alternative 2 (Toshiba Canvio Advance 8TB)
Storage Capacity	8TB	8TB	8TB
Connectivity	USB 3.0	USB 3.0	USB 3.0
Portability	Yes	Yes	Yes
Price (RM)	1,200	1,000	1,100

Reason for Selection:

The Seagate Backup Plus Hub 8TB offers fast transfer speeds and reliability, ideal for frequent backups in a lab environment.

Comparison:

The WD My Book is cheaper but lacks additional features like the integrated USB hub. The Toshiba Canvio Advance provides similar performance but does not match Seagate's durability.

7. Central Storage (Class Central Facility Storage)

Feature	Chosen (Synology DS920+)	Alternative 1 (QNAP TS-453D)	Alternative 2 (Asustor AS6604T)
Storage Bays	4	4	4
RAID Support	Yes	Yes	Yes
Network Support	1GbE	10GbE	10GbE
Price (RM)	7,500	7,000	8,000

Reason for Selection:

The Synology DS920+ is reliable, easy to manage, and offers excellent backup and file-sharing capabilities, making it perfect for an academic environment.

Comparison:

The QNAP TS-453D is slightly cheaper and supports 10GbE connections for faster networking. The Asustor AS6604T offers NVMe caching but is more expensive and may exceed the project's needs.

8. IOT devices

Feature	Chosen (Raspberry Pi 4)	Alternative 1 (ODROID-XU4)	Alternative 2 (BeagleBone Black)
			

Processor	Quad-core ARM Cortex-A72	Octa-core Samsung Exynos 5422	1GHz ARM Cortex-A8
RAM	2GB/4GB/8GB	2GB	512MB
Storage	MicroSD, USB 3.0 support	eMMC, USB 3.0 support	eMMC, USB 2.0 support
Connectivity	Gigabit Ethernet, Wi-Fi	Gigabit Ethernet	10/100 Ethernet
Price (RM)	300–450	400	350

Reason for Selection:

The Raspberry Pi 4 is chosen for its balance of performance, connectivity, and affordability, making it suitable for IoT-focused educational activities.

Comparison:

The ODROID-XU4 offers higher performance with an octa-core processor but comes at a slightly higher cost. The BeagleBone Black is more affordable but less powerful and less suited for intensive tasks.

9. Keyboard and Mice

Feature	 Chosen (MK120 Corded Keyboard and Mouse Combo)	 Alternative 1 (HP 150 Wired Combo)	 Alternative 2 (Lenovo Essential Wired Combo)
Design	Full-size keyboard and ambidextrous mouse	Full-size keyboard and mouse	Full-size keyboard and ambidextrous mouse
DPI (Mouse)	1600 DPI	1200 DPI	1200 DPI
Price (RM)	90	260	130

Reason for Selection:

The MK120 Combo is affordable, durable, and offers adequate functionality for daily use in a lab environment.

Comparison:

The HP 150 Combo is more expensive but offers a slightly better build. The Lenovo Combo is moderately priced but lacks additional features such as higher DPI.

10. Cables

Feature	 Chosen (Cable Matters Cat6 and Fiber Optic)	 Alternative 1 (Mogami Cat6 and Fiber Optic)	 Alternative 2 (Mediabridge Cat6 and Fiber Optic)
Cat6 Bandwidth	Up to 550 MHz	Up to 550 MHz	Up to 550 MHz
Fiber Optic Bandwidth	Up to 10 Gbps	Up to 40 Gbps	Up to 10 Gbps
Jacket Material	Durable PVC	Durable PVC	Flexible PVC
Price (RM)	Cat6: 200/100m, Fiber Optic: 300/100m	Cat6: 280/100m, Fiber Optic: 400/100m	Cat6: 250/100m, Fiber Optic: 350/100m

Reason for Selection:

The Cable Matters cables are cost-effective and provide high performance, suitable for both short-range (Cat6) and long-range (fiber optic) connections.

Comparison:

The Mogami cables have higher bandwidth for fiber optics but are significantly more expensive. The Mediabridge cables are moderately priced but offer similar performance to Cable Matters.

Device and Cost Breakdown

Category	Selected Devices	Unit Cost (RM)	Quantity	Total Cost (RM)
Router	Cisco ISR 4331	25000	2	50000
Switch	Cisco Catalyst 2960-X Series	15000	6	90000
Wireless AP	Ubiquiti UniFi UAP-AC-PRO	1000	12	12000
Firewall	Fortinet FortiGate 100E	20000	1	20000
Desktop Computers	Dell OptiPlex 7080	4500	120	540000
Monitors	Dell UltraSharp U2419H	1200	120	144000
Keyboard and mice	MK120 Corded Keyboard and Mouse Combo	90	120	10800
IoT Devices	Raspberry Pi 4	300	30	9000
Printers	HP LaserJet Pro M404dn	1500	1	1500
Servers	Dell PowerEdge R650	50000	2	100000
Patch panels	Panduit DP245E88TGY	500	6	3000
Cables	Cat6 Ethernet + Fiber Optic Cable Matters	-	-	5000
Cameras	Hikvision DS-2CD2387G2-L	1500	2	3000
Projectors	Epson EB-X41	2500	6	15000
Screen	Elite Screens Manual Series	1000	1	1000
Hard Drives	Seagate Backup Plus Hub 8TB	1200	6	7200
Central Storage (NAS)	Synology DS920+	7500	1	7500
Overall Total				RM 1,019,000

Budget Justification

The cost incurred sums up to RM 1,019,000, which is lower than the allocated budget of RM 2,000,000 for the expansion and the contingencies. Spend was kept to bearable levels in order to be able to achieve the desired reliability and performance. Key points include:

1. Critical Infrastructure (Routers, Switches, Firewall):

Using Cisco brand superior models was done deliberately due to the following reasons namely reliability, scalability and durability of the branded devices. Though slightly expensive, they masterfully maintain operations and are essential in future expansion.

2. Wireless Access Points and IoT Devices:

Ubiquiti UniFi APs were selected for its cost-sensitivity and technical compatibility, and the Raspberry Pi \$4 BTO costs significantly less while delivering high performance, although at a slightly reduced technical compatibility level.

3. Storage and Servers:

Central storage from Synology and Dell PowerEdge were chosen for their effectiveness in resource management and for their scalability. Although they are a little costly because of their custom-made attributes, they guarantee long spans free from data loss.

4. Lab Equipment and End-User Devices:

Simple yet rugged products that are more affordable were sought out and include the Dell OptiPlex for Desktops and the MK120 products for Keyboard and Mouse.

5. Cost Savings in Peripheral Devices:

There was a deliberate choice of cost-effective materials such as Cable Matters cables for wires and Epson projectors.

In this context, the proposed plan spreads the budget divided and raises as many resources as possible in cost-effective solutions to provide a high-quality, adjusted, and functional network to the institution

Reflection

Are you surprised by the prices? How were you surprised?

Yes, the prices were surprising, especially for premium brands like Cisco, which were significantly higher than alternatives like TP-Link or Huawei. For example, Cisco routers cost RM 25,000, compared to Huawei (RM 20,000) and TP-Link (RM 1,500). Similarly, Cisco switches were RM 15,000, whereas TP-Link was only RM 2,000. While expected for enterprise-grade devices, the stark differences highlighted the trade-offs between cost and advanced features.

Have you ever considered cost as a factor for choosing networking devices?

Cost is always an essential factor, particularly for academic institutions with limited budgets. In this project:

- We prioritized affordable yet reliable devices, such as Ubiquiti APs over Cisco Aironet.
- However, for critical devices like routers and switches, reliability and scalability took precedence over cost, ensuring a robust network infrastructure.

What are the major differences between the same devices from different brands?

The primary differences are in performance, features, and cost:

- **Routers:** Cisco offers modularity and enterprise-grade features, Huawei balances cost and performance, and TP-Link focuses on affordability for smaller setups.
- **Switches:** Cisco provides advanced Layer 3 features, Huawei offers similar performance at a lower price, and TP-Link is best for basic setups.
- **Wireless APs:** Ubiquiti balances affordability and performance, Cisco excels in speed and advanced features, and TP-Link suits smaller environments.
- **Storage and IoT:** Seagate and Raspberry Pi provide excellent cost-performance ratios, while QNAP and ODROID offer premium features at higher costs.

These differences reflect trade-offs between cost-efficiency and advanced capabilities.

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