An Enterprise Network Design Report

FIT9137 Introduction to Computer Architecture and Networks-S1 2023 Assignment 2

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Summary of the Problem

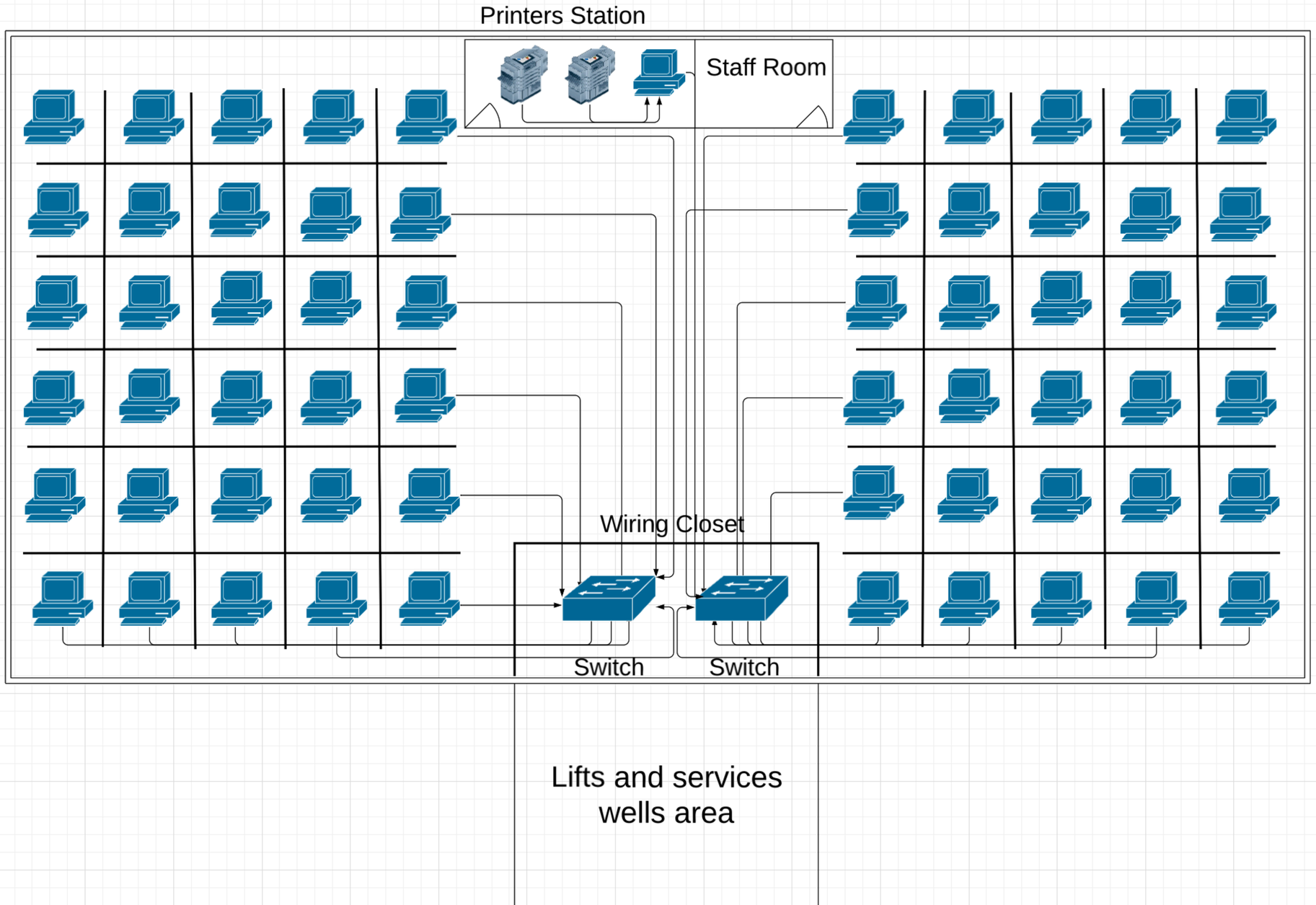
- A company is going to expand, and two new 2-storey buildings (East and West) need **the wired and wireless LAN infrastructure** to be installed on each floor. The wired LAN should support both the anticipated peak time data traffic as well as the wireless LAN.

- Two new buildings will accommodate **an additional 240 employees**, the 240 employees will evenly distributed to each floor of the new buildings, so **the seating arrangements** is needed.

- There will be **the backbone network interconnecting the LANs of each floor, and connecting new buildings to the existing main office network.** The main building network capacity should be increased to accommodate the increased traffic volume, and connectivity must always be maintained.

- **A wiring closet will be installed on each floor in each building**, which will have 4 fibre optic cables connecting to a dedicated server room in the basement.

Floor Plan



- **<u>60 computers</u>** / each floor
- A wiring closet with **<u>2 switches</u>**
- 30 computers connect to a switch.
- A printers station with **<u>2 printers and 1 printer server</u>**; the printer server also connects to the switch
- A staff room

Switch:

Cisco Meraki Access Switch MS390-48

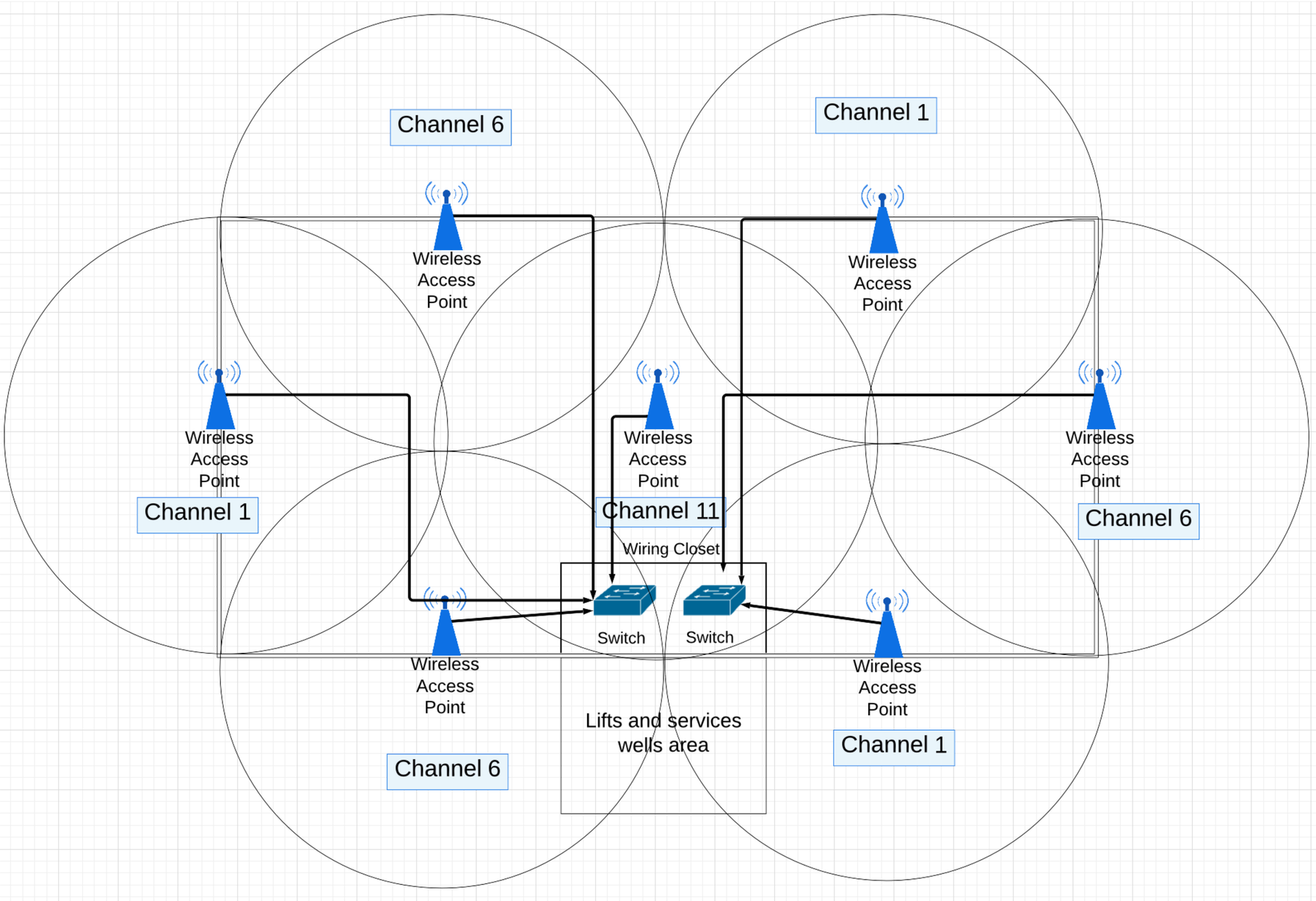
48 ports 1GbE

Cabling:

UTP 1000Base-T

1Gbps

Floor Plan



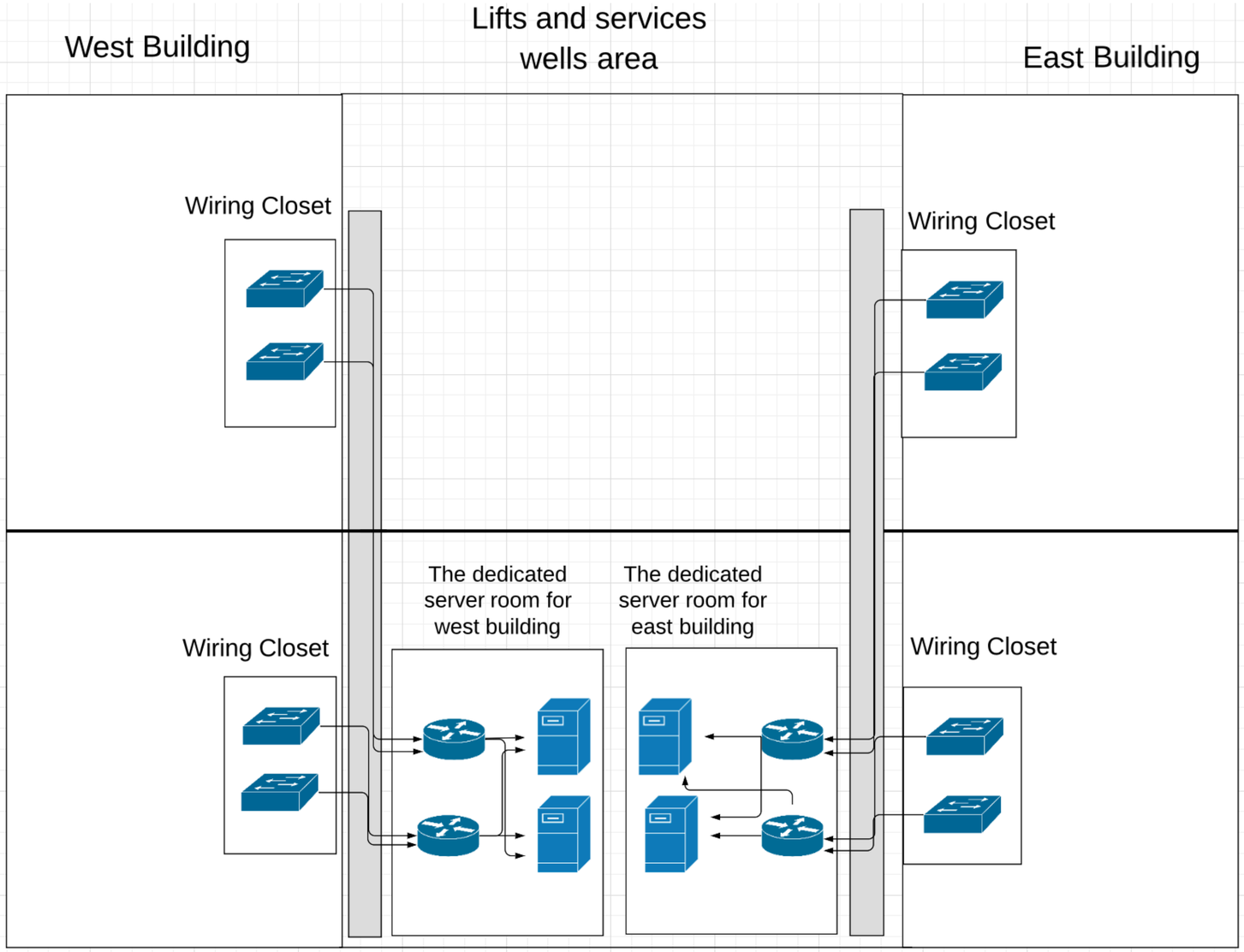
- **<u>7 access points</u>** (mount on the ceiling) /each floor
- The average coverage of an access point is about **2,000 square feet** (“AP placement and Channel Plan Best Practices,” n.d.).
- An access points can be used for **20 - 40 people** (Meraki, Inc., 2011)
- After calculation, the radius of the coverage is about 25 feet. There should be 7 access points to cover the whole space.
- Access points connect to the switch.

Access point:

Cisco MR56 5.38 Gbps

Cabling:
UTP 1000Base-T

Backbone Connection in Two Buildings



- Two dedicated server rooms for each building are in common area.
- In each dedicated server room, there are **<u>two routers, and two servers</u>; one server is DHCP server, and the other is DNS server.**

Router:

Cisco C8500-20X6C

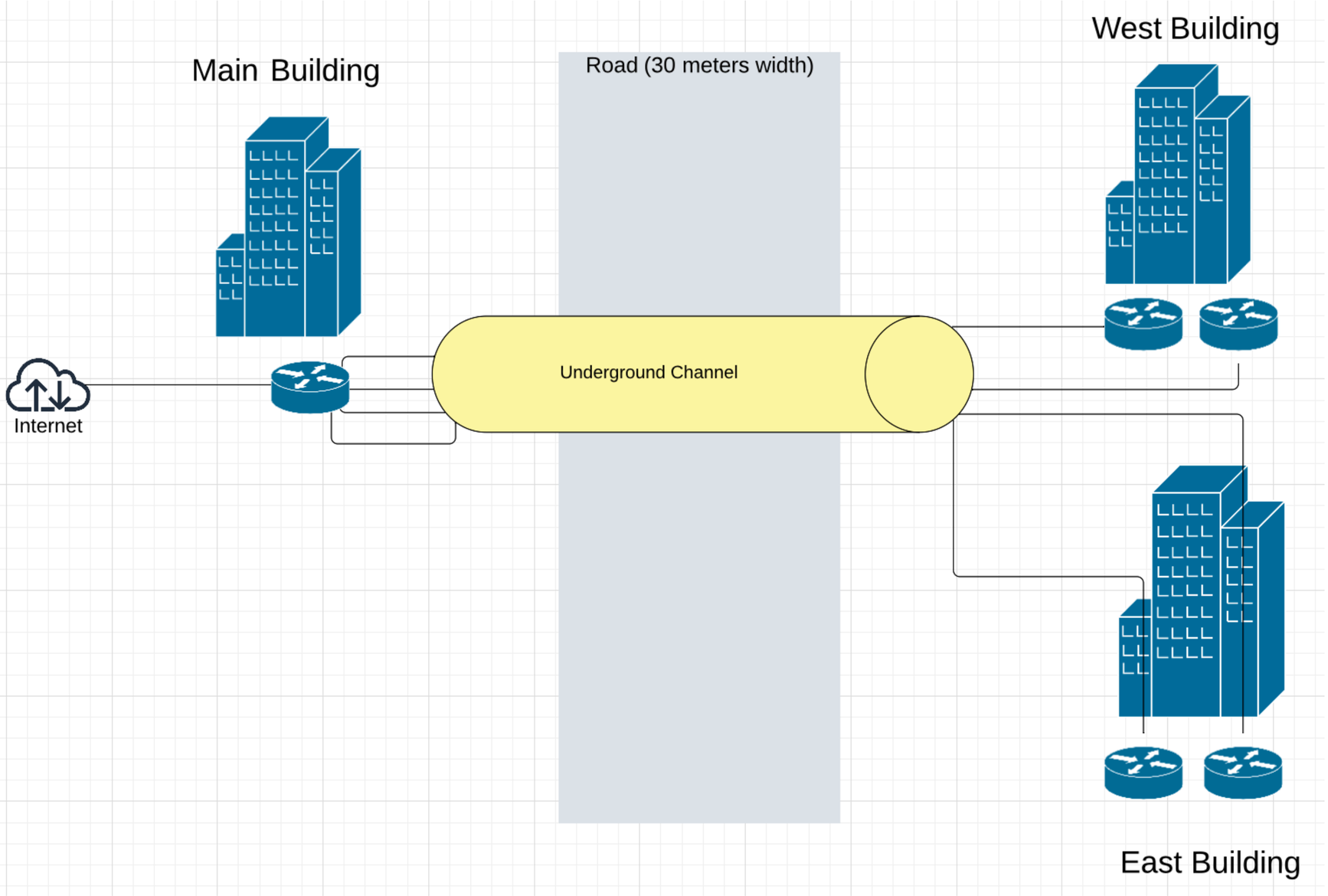
- 20 ports 1/10 GbE, 6 ports 40/100 GbE

Cabling:

Fiber Optic 10 GB Ethernet

*Multimode fiber supports distances up to 300 meters; single mode fiber supports distances up to 80 kilometers (Cosmo17, 2023).

Backbone Connection between Buildings



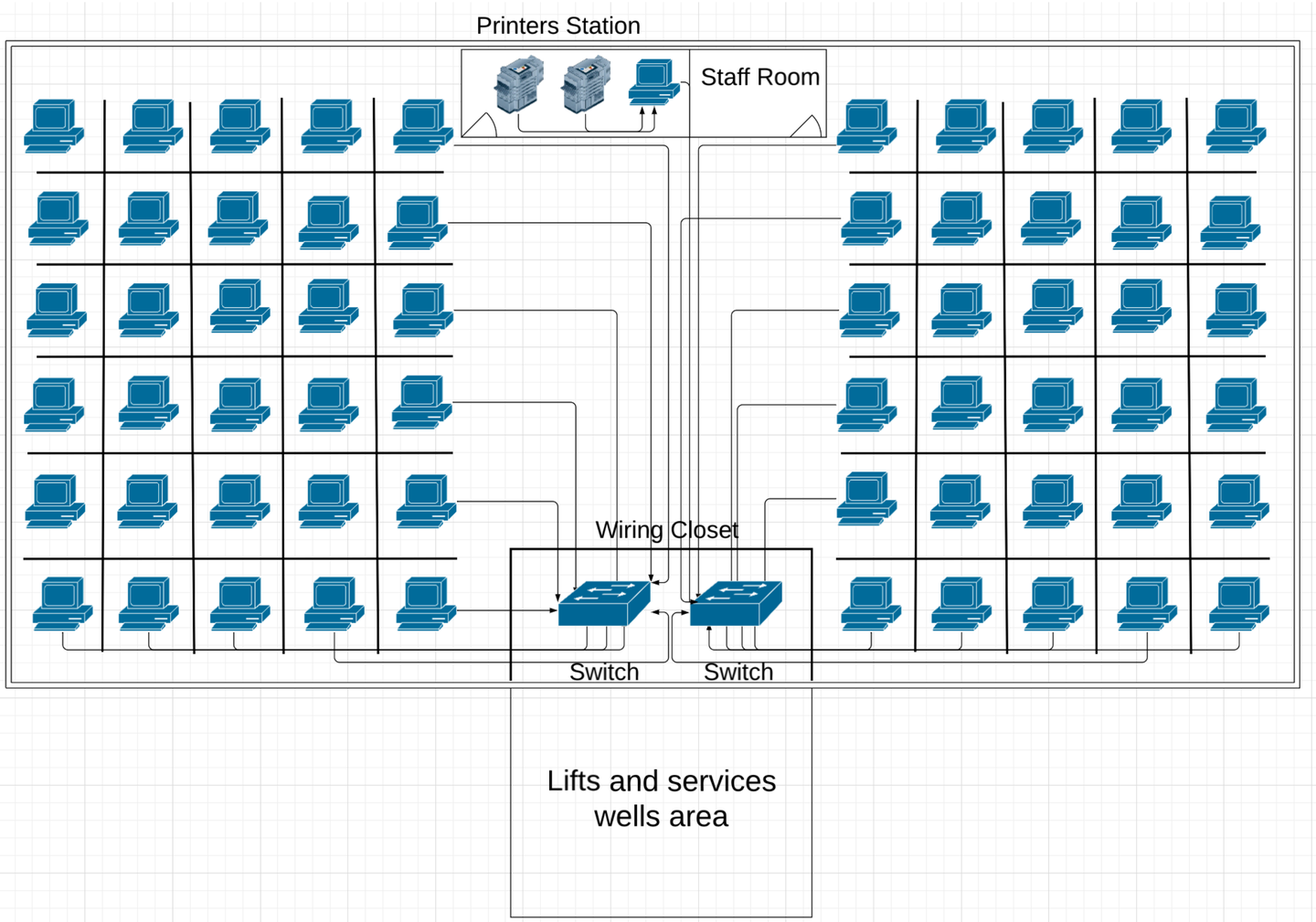
- The routers in west building and east building connect to the router in the main building.
- Assume the width of the road is 30 meters.

Cabling:

Fiber optic 10 Gb Ethernet

*Multimode fiber supports distances up to 300 meters; single mode fiber supports distances up to 80 kilometers (Cosmo17, 2023).

Traffic Throughput for Each Floor



Switch:

Cisco Meraki Access Switch MS390-48

48 ports 1GbE

Access point:

Cisco MR56

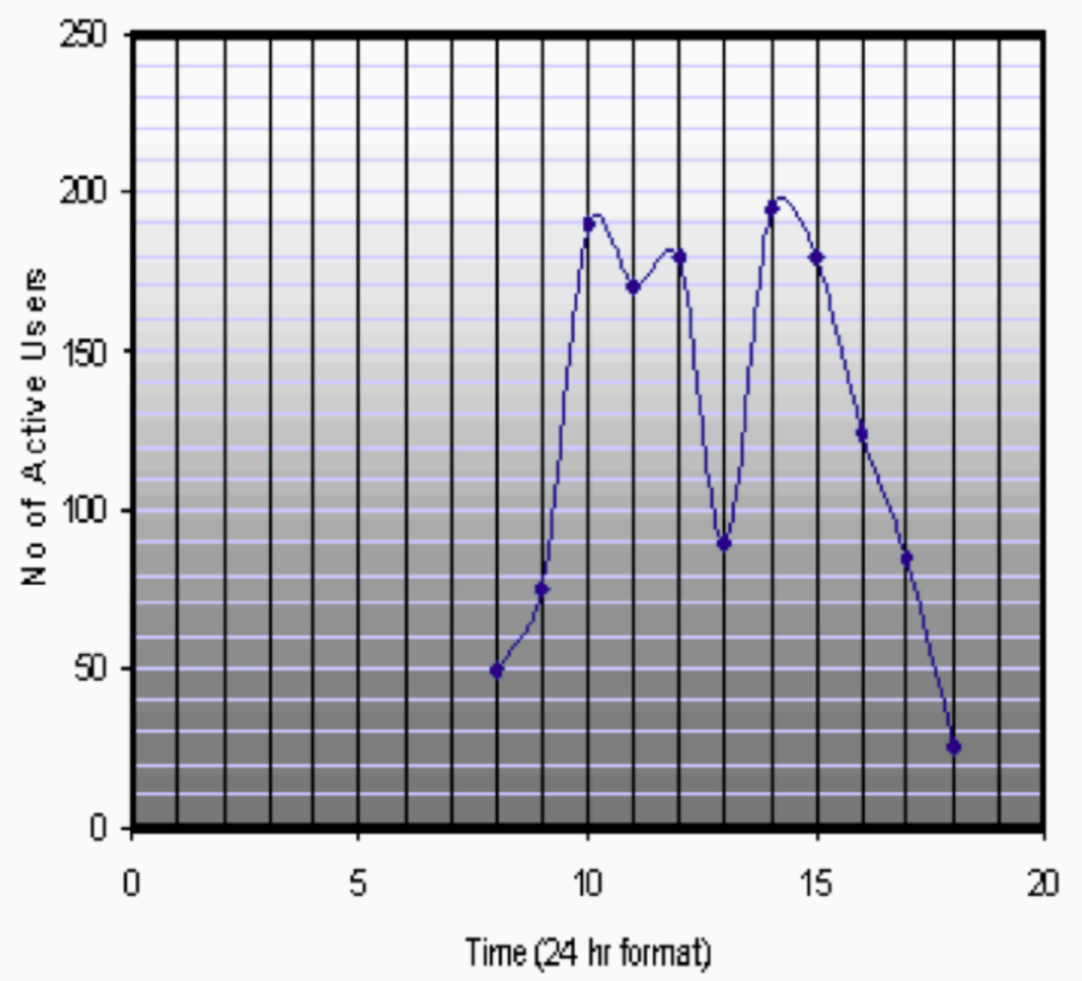
5.38 Gbps

Cabling:

UTP 1000Base-T

If each employee uses both wired and wireless network, it would be 30 (wired) + 30 * 0.3 (wireless) = **39 Mbps**

Traffic Throughput for Each Floor



Switch: 48 ports 1GbE

Cabling: UTP 1000Base-T

During peak time, there are 200 active users.

(1) If 200 active users evenly distributed to every floor,

then there are 50 users each floor:

39 * 50 = **1950 Mbps (about 1.91 Gbps)**

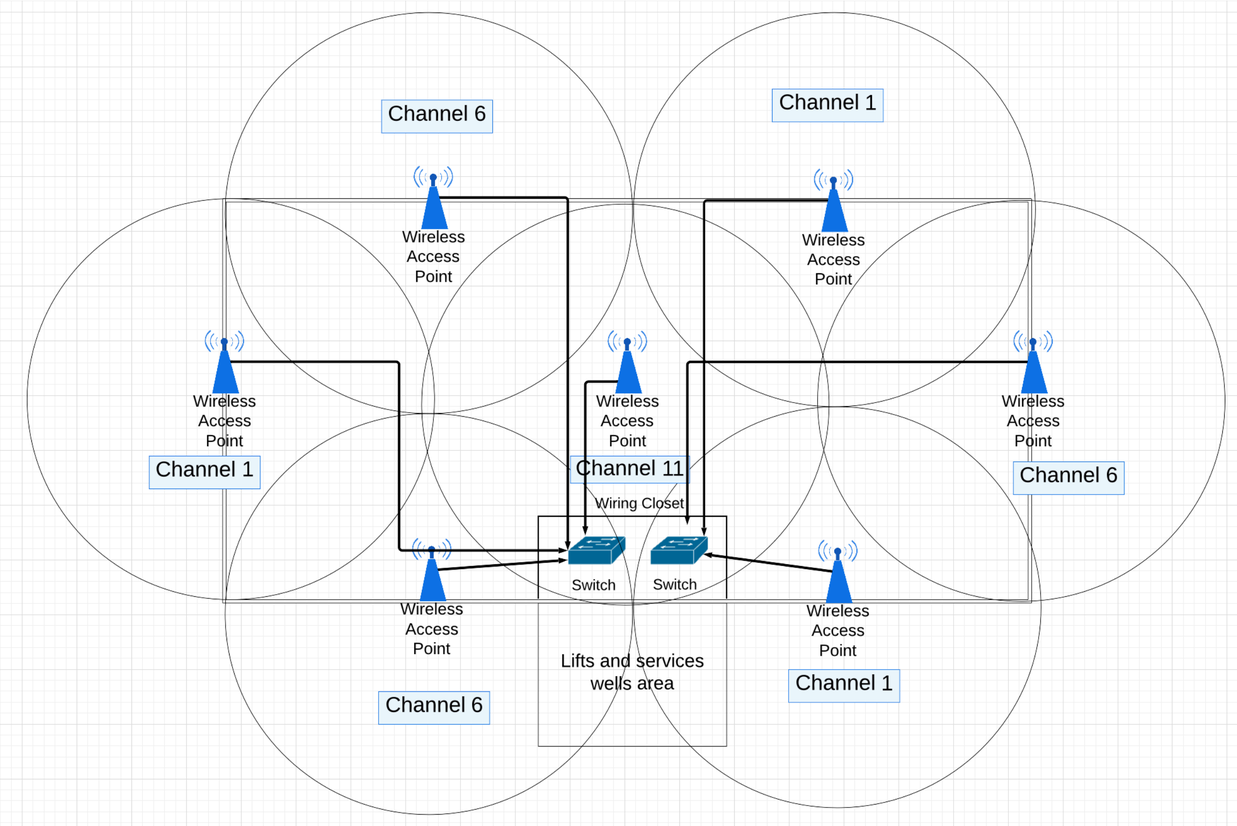
—> Minimum throughput

(2) If 60 employees on a floor are all active users:

39 * 60 = **2340 Mbps (about 2.29 Gbps)**

—> Maximum throughput

Traffic Throughput for Each Floor (WLAN)



Access point: Cisco MR56 5.38 Gbps

Each employee generates 9 Mbps.

During peak time, there are 200 active users.

(1) If 200 active users evenly distributed to every floor,

then there are 50 users each floor:

9 * 50 = **450 Mbps (about 0.44 Gbps)**

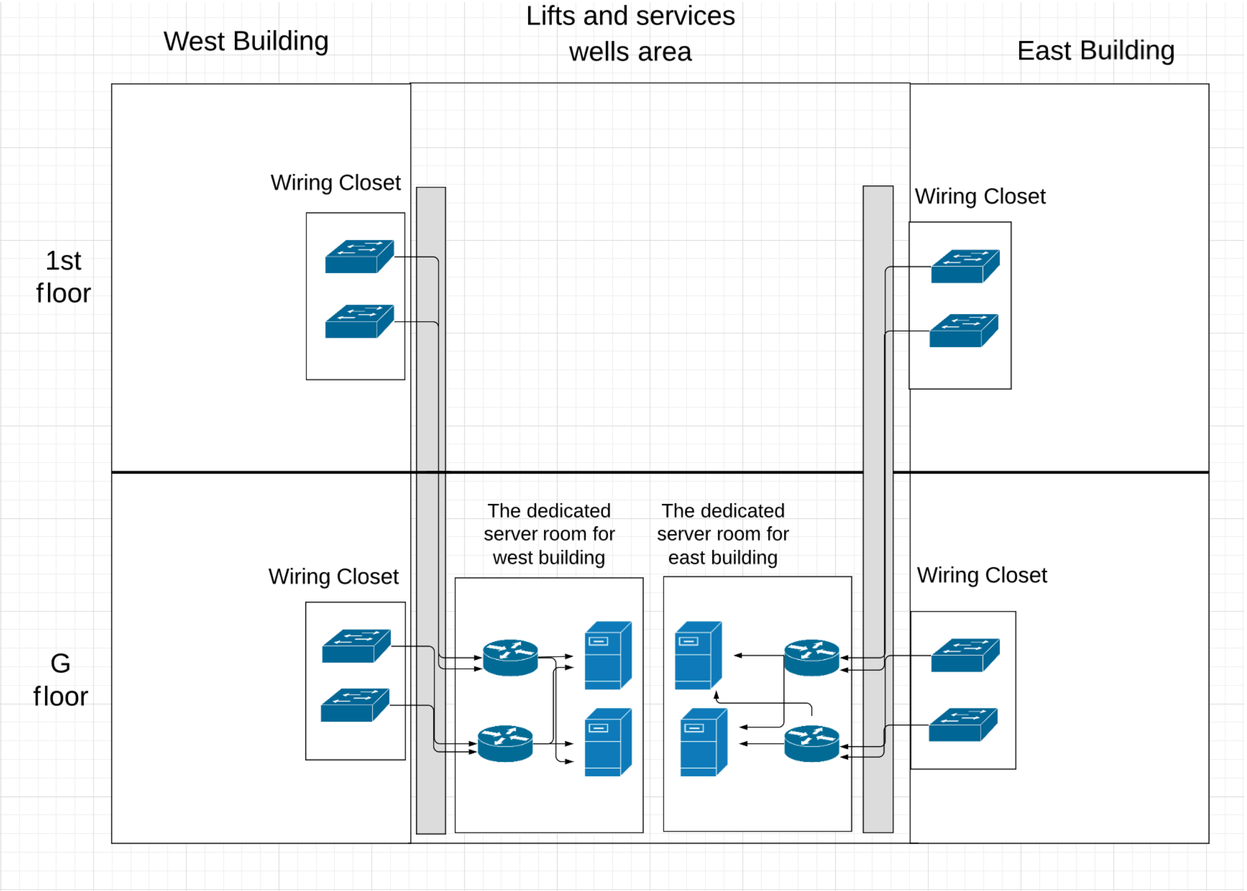
—> Minimum throughput

(2) If 60 employees on a floor are all active users:

9 * 60 = **540 Mbps (about 0.53 Gbps)**

—> Maximum throughput

Traffic Throughput for Each Building



Router: 20 ports 1/10 GbE, 6 ports 40/100 GbE

Cabling: Fiber Optic 10 Gb Ethernet

During peak time, there are 200 active users.

(1) If 200 active users evenly distributed to two buildings,

then there are 100 users in a building:

39 * 100 = **3900 Mbps (about 3.81 Gbps)**

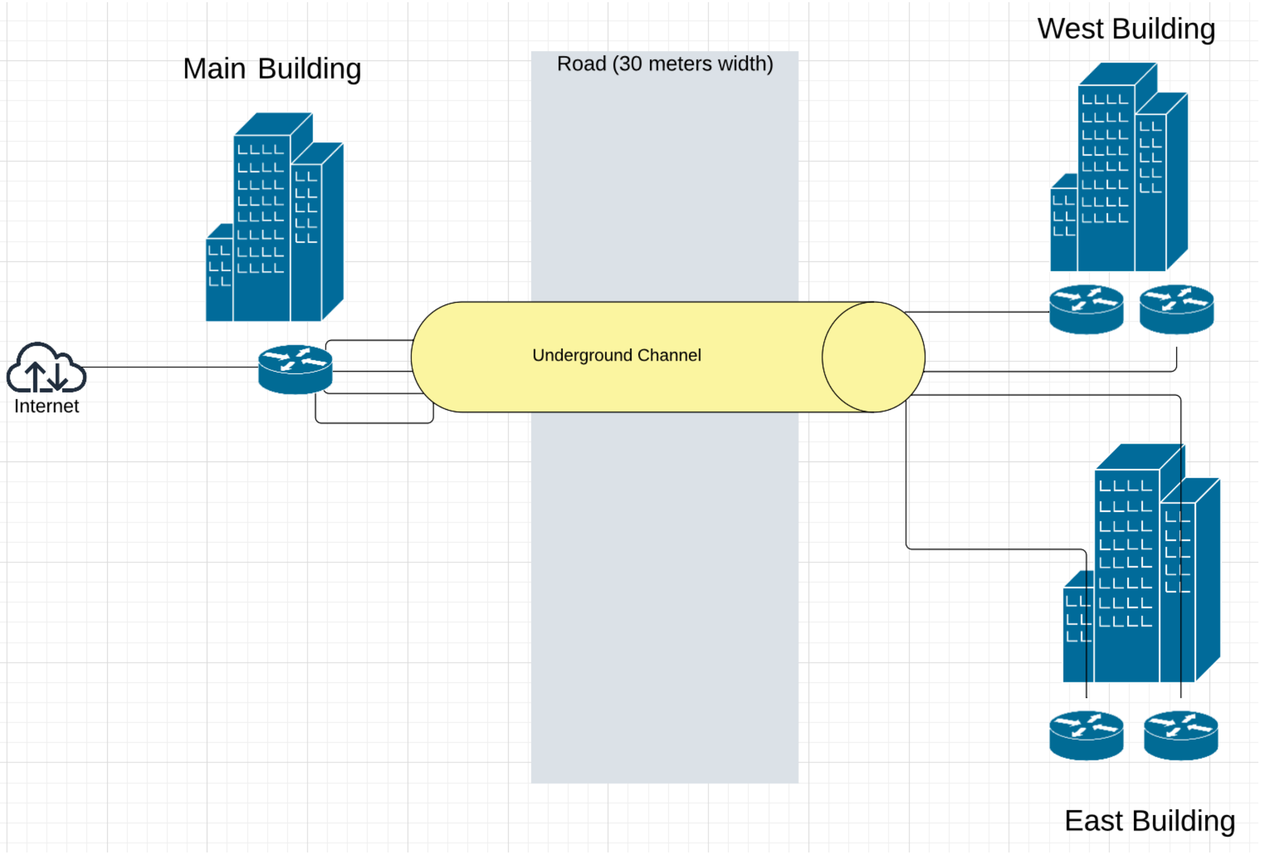
—> Minimum throughput

(2) If 120 employees in a building are all active users:

39 * 120 = **2340 Mbps (about 4.58 Gbps)**

—> Maximum throughput

Traffic Throughput for Backbone Network



Router: 20 ports 1/10 GbE, 6 ports 40/100 GbE

Cabling: Fiber optic 10 Gb Ethernet

(1) During peak time, there are 200 active users.

39 * 200 = **7800 Mbps (about 7.62 Gbps)**

—> Minimum throughput

(2) If all employees are all active users:

39 * 240 = **9360 Mbps (about 9.15 Gbps)**

—> Maximum throughput

Estimation of Future Load

- Assume that every year the employee increase 4% (Australian Bureau of Statistics, 2023,).
- This estimation focuses on the future load for the upcoming 5 years.
- After five years,

  The total number of employees: 240 * $(1.04)^5$ —> about 292 employees

  Each building: 146 employees

  Each floor: 73 employees

  Peak time: 200 * $(1.04)^5$ —> about 244 employees

Number of Employees	Total	Peak time
Floor	73	61
Building	146	122
Total	292	244

Estimation of Future Load

Number of Employees	Total	Peak time
Floor	73	61
Building	146	122
Total	292	244

- Spec of Switches, Routers, Access points, and Cables:

Switch: 48 ports 1GbE
Access point: 5.38 Gbps
Horizontal Cabling: UTP 1000Base-T
Router: 20 ports 1/10 GbE, 6 ports 40/100 GbE
Backbone Cabling: Fiber Optic 10 Gb Ethernet

- **Each Floor:**

  Minimum: 39 * 61 = 2379 Mbps (about 2.33 Gbps)

  Maximum: 39 * 73 = 2847 Mbps (about 2.79 Gbps)

- **Access Point:**

  Minimum: 9 * 61 = 549 Mbps (about 0.57 Gbps)

  Maximum: 9 * 73 = 657 Mbps (about 0.65 Gbps)

- **Each Building:**

  Minimum: 39 * 122 = 4758 Mbps (about 4.65 Gbps)

  Maximum: 39 * 146 = 5694 Mbps (about 5.57 Gbps)

- **Two Buildings:**

  Minimum: 39 * 244 = 9516 Mbps (about 9.30 Gbps)

  Maximum: 39 * 292 = 11338 Mbps (about 11.12 Gbps)

Conclusions

- This network topology design meets all the requirement of the company. In addition, the design is estimated to work well even if the number of employees increases in the following five years.

Recommendations

- It is recommended to put one more switch in each wiring closet in case for some unexpected events happen; likely, more routers should be prepared in the each server room if the original one breaks down. For each wiring closet, there are two unused fibre optic cables which can connect to a buffer router. (Appendix 1)

- For the main building, there should be the capacity increase to connect the two new buildings to the main building. (Appendix 2)

References

AP placement and Channel Plan Best Practices. (n.d.). Retrieved April 24, 2023, from https://www.watchguard.com/help/docs/help-center/en-US/Content/en-US/Wi-Fi-Cloud/deploy/deployment_best-practices_device-channel.html

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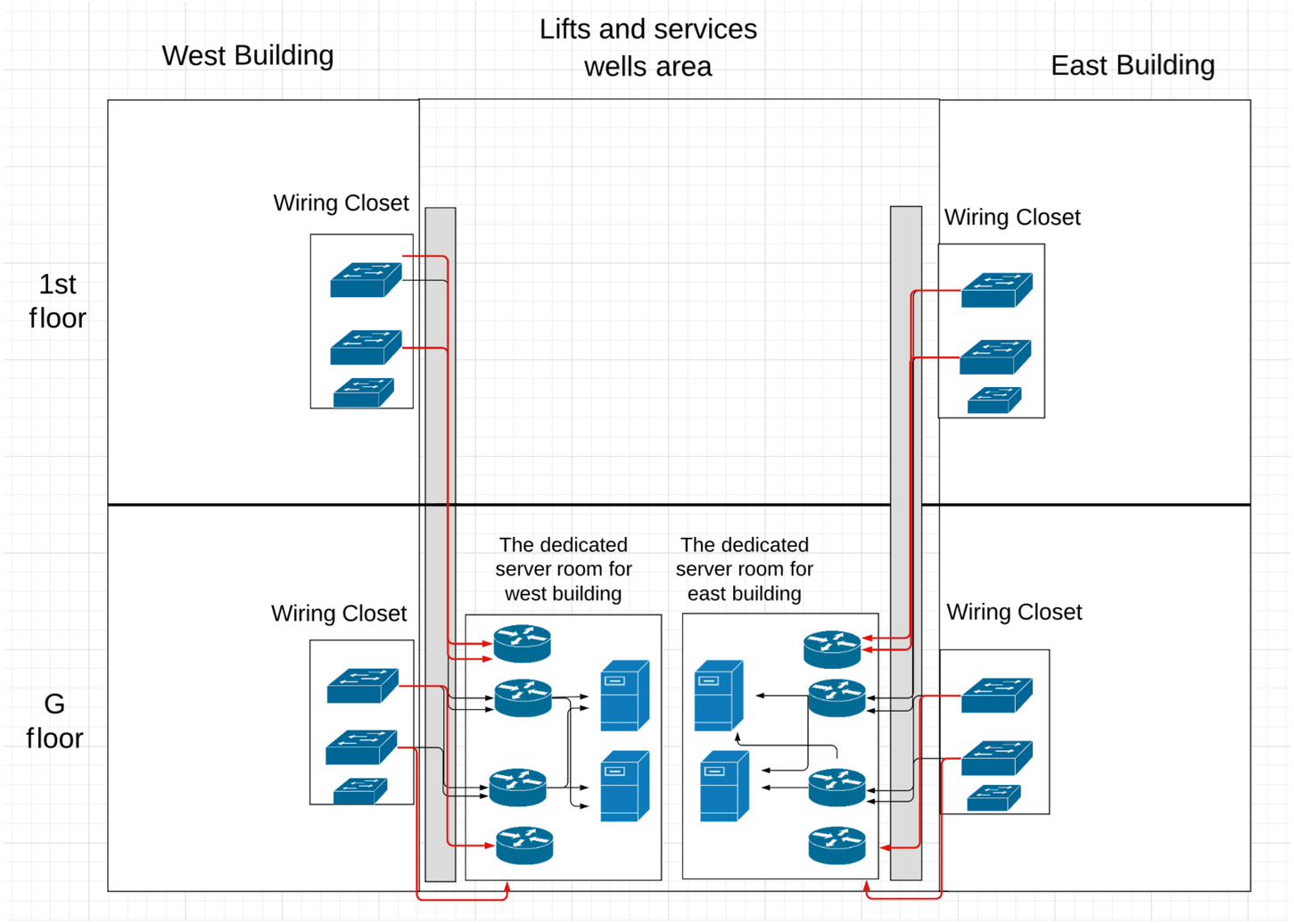
Labour Account Australia, December 2022. Australian Bureau of Statistics. (2023, March 3). Retrieved April 24, 2023, from https://www.abs.gov.au/statistics/labour/labour-accounts/labour-account-australia/dec-2022

Appendix 1

- The diagram for the recommendation 1 is as follows:



Appendix 2

—The current maximum throughput of the two buildings is **9360 Mbps (about 9.15 Gbps).**

—The future (in 5 years) maximum throughput of the two buildings is **11338 Mbps (about 11.12 Gbps).**

— It is suggested to add two **more router in** the main building to connect to the two new buildings; one is for the capacity increase, and if this one breaks down, the other one can be used immediately to prevent the loss of connection.

Appendix 3

A conceptual high-level diagram for a typical floor plan and backbone connection