Layer 1 structured cabling

The Main Distribution Frame (MDF) will be situated in location C of the Main Building - benefitting from its proximity to the Point of Presence, reducing latency and enhancing connectivity to provide a first-rate network experience. The absence of a dropped ceiling facilitates efficient and aesthetic cable management; the walls are coated in fire-retardant paint which adds security to the physical aspect of the networking system due to its ability to hinder the spread of a fire in its possible event. The lockable door provides security to the proposed system due to limiting unauthorised physical access to it. There is also an ample number of electrical outlets in the room, ensuring the high-quality networking equipment is effectively powered. This ideal choice of location provides a perfect foundation for a reliable, scalable and secure network infrastructure.

In order to deliver optimal network performance, the six Intermediate Distribution Frames (IDFs) have been positioned across all three buildings to support the Ethernet extended star topology design. In the Main Building, IDF 1 is at location A (first floor) and IDF 2 is at location B (first floor). In the East Building, IDF 3 is located at location N (first floor) whilst IDF 4 is at location P (second floor). In the third (West) building IDF 5 is at location R (first floor) with IDF 6 being situated at location W (second floor).
Each IDF will provide stable connectivity to nearby rooms, the robust backbone cabling linking the IDFs to the Main Distribution Frame in the Main Building. High-speed data transmission across all floors and buildings will be delivered due to the ideal choice of locations for situating the Intermediate Distribution Frames, which maximises not only performance but also high scalability for future network expansions in the future as necessary.

All six IDFs have been used as Horizontal Cross-Connects (HCCs), with each IDF serving as a primary distribution point for horizontal cabling connections, efficiently distributing connectivity to nearby rooms and workspaces across all three buildings whilst reducing latency. The strategic setup ensures the network is optimised, guaranteeing high-performance connectivity across each workspace in each building.

In order to even further enhance inter-building and inter-floor connectivity, certain IDFs have been designated as Intermediate Cross-Connects (ICCs), providing essential linkage between the MDF and other IDFS across the buildings, with the ICCS constituting IDFs 1 and 2 in the Main Building, 3 in the East Building, and IDF 5 in the West Building. These are configured to handle both the backbone cabling as well as the cross-building connections, providing seamless data flow and communication between the MDF and individual floors of the buildings. This configuration further augments the overall efficiency and scalability of the network.

In order to assure the highest-quality and highest speed connectivity across all locations, the backbone cabling has been tactically routed from the Main Distribution Frame to each designated IDF. The backbone cabling layout consists of cables connecting from MDF (location C) to IDF 1 at location A, the MDF to IDF 2 (location B), the MDF to IDF 3 (location N), MDF to IDF 4 (location P), MDF to IDF 5 (location R), as well as the MDF to IDF 6 at location W.

Each of these cabling runs employs high-capacity fibre optic media, with multimode fibre (MMF) being utilised for all internal building connections and single-mode fibre (SMF) being used for connections to the East and West buildings – this is the optimum solution is utilising optical fibre cabling for both backbone and horizontal connections. Multimode fibre is ideal for the horizontal cable runs due to its high data rate capabilities over these short distances, making it incredibly cost-effective and flexible. The backbone is proposed to employ single-mode fibre as it provides superior performance for longer-distance backbone connections, ensuring minimal signal degradation and much reduced latency. This choice not only delivers high bandwidth and complete immunity to interference, but also enhances security by increasing the difficulty of covert tapping without detection. The use of optical fibre cabling also positions the network for scalable growth in addition to its optimised performance, which is a benefit for a company willing to expand its network infrastructure with ease in the future.

There are also backbone cabling runs between individual IDFs; these consist of connections from IDF 1 (location A) to IDF 2 (location B) in the Main Building, IDF 3 (location N) to IDF 4 (location P) in the East Building, and IDF 5 (location R) to location W in the West Building. Each of these backbone connections is essential for maintaining top-speed connections across multiple distribution points within each individual building. The use of Multi-Mode Fibre warrants that the cabling runs are capable of handling the heightened bandwidth demands and minimising latency between IDFs.

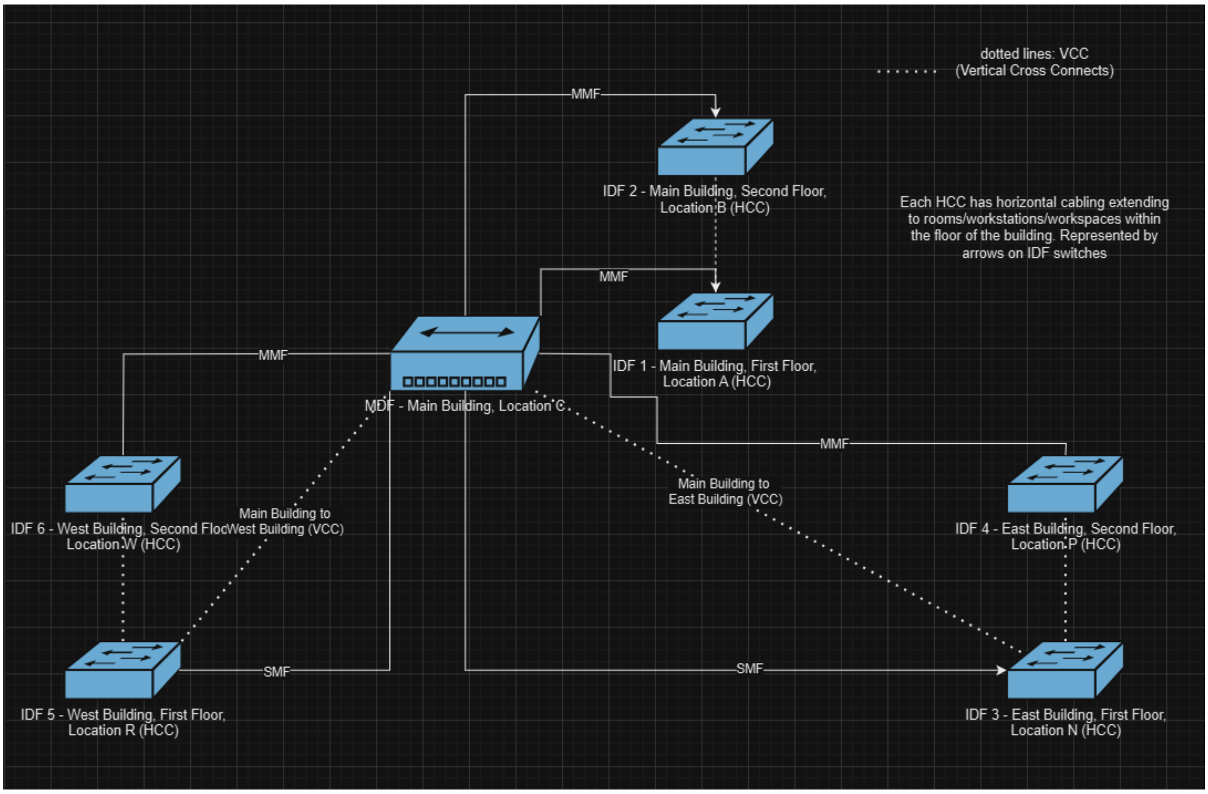
Likewise, connections from each IDF to the work areas within their proximity have been strategically employed to ensure the highest connection efficiency and minimal disruption. They have been designed to support the entire network's performance by delivering reliable connections to each room and workspace across each building.

In the Main Building, horizontal cabling will run from IDF (location A) to work areas on the first floor, and from IDF 2 (location B) it will run to work areas on the second floor. In the East Building, IDF 3 (location N) will have horizontal cabling running to work areas on the first floor, whilst IDF 4 (location P) will have horizontal cabling running to work areas on the second floor. Lastly, in the West Building, horizontal cabling will run from IDF 5 (location R) to work areas on the first floor, and from IDF 6 (location W) to work areas on the second floor.

Backbone cabling runs between IDFs are present in this topology; they consist of runs between IDF 1 (location A) and IDF 2 (location B) in the Main Building, IDF 3 (location N) to IDF 4 (location P) in the East Building, and IDF 5 (location R to IDF 6 (location W) in the West Building. These runs are all cabling between the first and second floors of the respective buildings.

Backbone cabling will also run between floors. It will run between the first and second floor of the Main Building in order to connect to the Main Distribution Frame in location C with the IDFs on both floors. In the East Building, cabling will also run between the first and second floors, connecting IDF 3 at location N on the first floor to IDF 4 at location P on the second floor. Within the West Building, a backbone connection will be present from IDF 5 (location R) on the first floor to IDF 6 (location W) on the second floor. As for backbone cabling connections between the individual buildings, fibre optic cabling in the form of Single-Mode Fibre will run between the East Building at location N to the main building at location C, and between the West Building at location R and the Main Building at location C, providing secure and fast data transfer between these buildings.

Logical Topology



Layer 2 LAN topology

The switch requirements for each building and floor are based on the room count below, with each room containing approximately two computers.

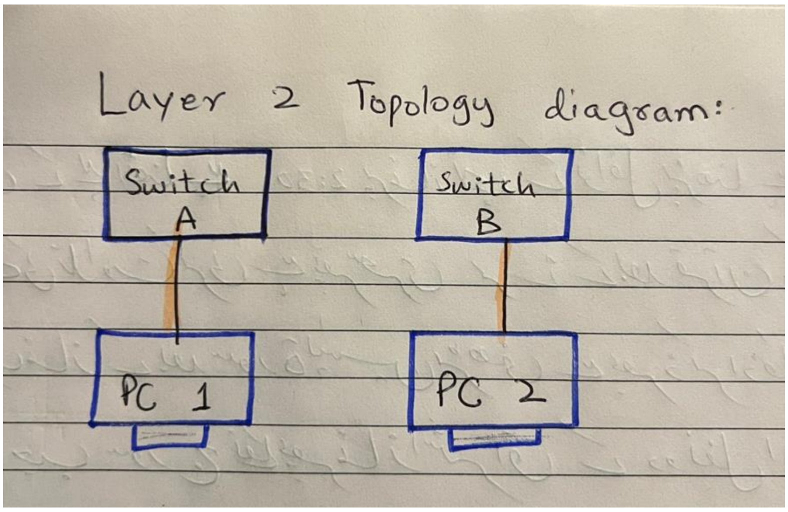
- Main Building, First Floor: 23 rooms × 2 devices = 46 devices
- Main Building, Second Floor: 20 rooms × 2 devices = 40 devices
- East Building, First Floor: 15 rooms × 2 devices = 30 devices
- East Building, Second Floor: 15 rooms × 2 devices = 30 devices
- West Building, First Floor: 15 rooms × 2 devices = 30 devices
- West Building, Second Floor: 14 rooms × 2 devices = 28 devices

For the **Main Building**, the first floor, which has 23 rooms, requires 46 ports to connect all devices. A single 48-port switch will be deployed on this floor, providing two spare ports for potential future connections. On the second floor, with 20 rooms and 40 devices, a 48-port switch will also be deployed, leaving eight ports available for future expansion.

In the **East Building**, each floor contains 15 rooms, totalling 30 devices per floor. A 48-port switch will be used on both the first and second floors, leaving 18 spare ports per floor; this will support additional devices or potential expansion. Similarly, in the **West Building**, the first floor has 15 rooms, also requiring 30 ports, and will use a 48-port switch, allowing for 18 extra ports. The second floor, with 14 rooms and 28 devices, will be outfitted with a 48-port switch as well, leaving 20 spare ports for future use. This design ensures that each floor has sufficient ports to meet current needs and allows for potential growth, as each switch configuration includes some spare capacity.

Uplink and trunk ports will be configured using the spare ports on each switch, enabling connections to the MDF and facilitating inter-floor and inter-building communications. These uplinks will be configured as trunk links to carry VLAN traffic between switches, ensuring efficient and secure data transfer across the network. To improve performance and maintain security, VLANs will be set up for each floor or department, which will reduce broadcast traffic and prevent unnecessary data sharing between departments.

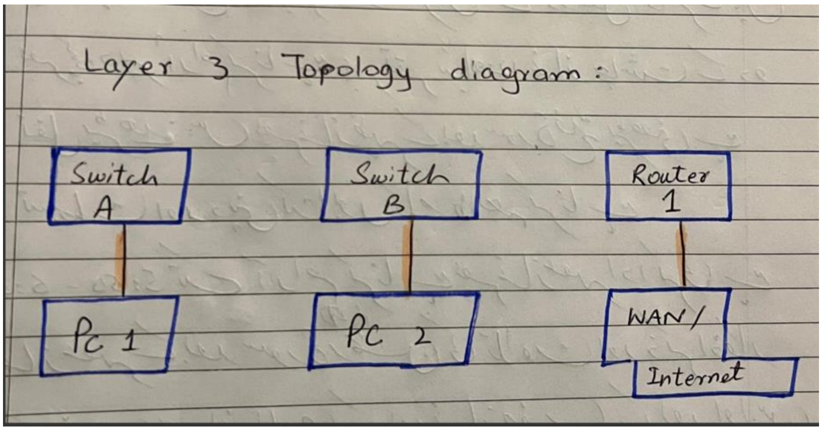
This switch and port configuration allows for scalability and adaptability while keeping the infrastructure streamlined. The extra ports available on each switch make it easy to add additional devices as the company expands, without needing to overhaul the existing infrastructure.



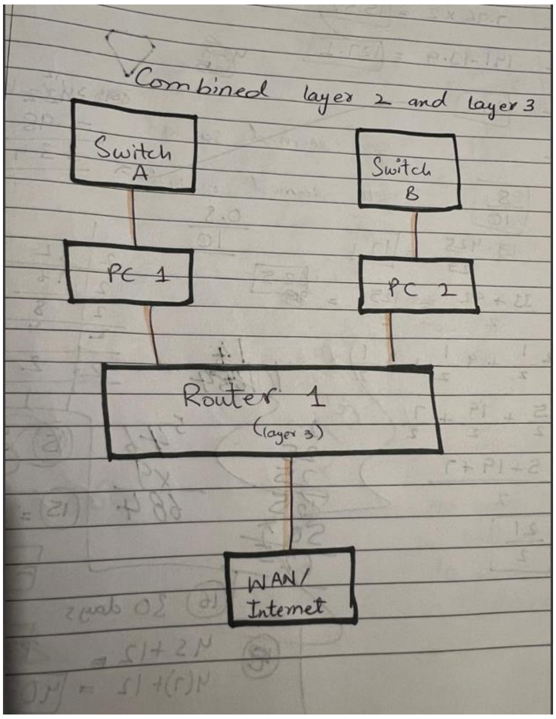
The switches in the layer 2 topology diagram above connect various devices within the LAN. The end-user devices (PCs, printers, etc.) are connnected to the switches.

Routers will be used to add Layer 3 capability to this Layer 2 topology. To connect the LAN to WANs and the Internet, the routers will divide the network into various subnets and offer routing capabilities.

Layer 3 topology



Router 1 connects the Local Area Network (LAN) to the Wide Area Network (WAN). Router 2 connects different segments of the LAN and provides inter-VLAN routing if VLANS are implemented. Each segment of the LAN can be assigned a different subnet (e.g. 192.168.1.0/24 for Switch A and 192.168.2.0/24 for Switch B).



In the combined Layer 2 and Layer 3 devices diagram, both Layer 2 switches and Layer 3 routers are included. The LAN switches (A and B) and the WAN/Internet are separated by Router 1. All routing between the internal and external networks is managed by it. For redundancy or to link to other WANs, more routers can be installed if needed. Each switch can have devices on different subnets. Router 1 will be responsible for routing between these subnets and the WAN. By establishing distinct broadcast domains, routers lower broadcast traffic and enhance network efficiency.

To control traffic between several parts and the Internet, this Layer 3 design adds routers to the Layer 2 structure. The logical diagram shows how switches, which are Layer 2 devices, link to routers, which are Layer 3 devices, to form an organised network that can effectively route data.

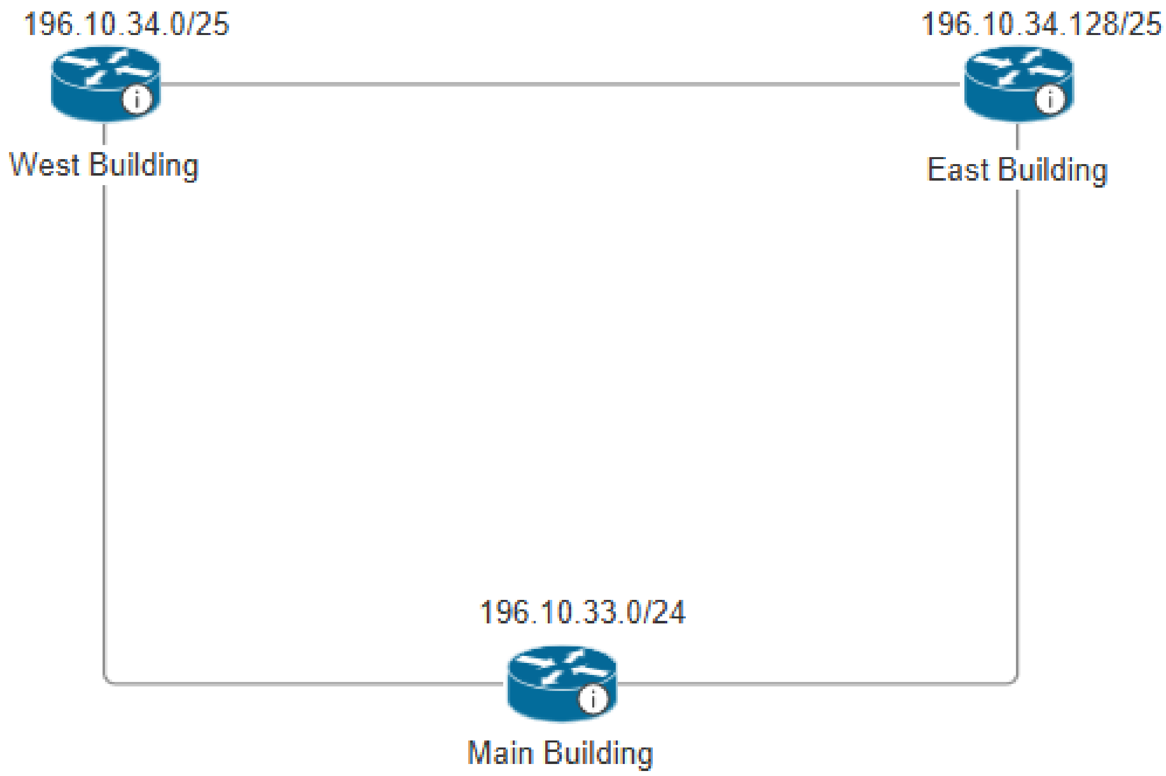
IP Addressing scheme

The public IP Addresses 196.10.33.0 and 196.10.34.0 are available, 196.10.33.0 will be used entirely by the Main Building due to it being the larger building. This means there will be 254 IP addresses available for the Main Building with the /24 (255.255.255.0) subnet. 196.10.33.1 will be used by the router in the Main Building and the next 9 IP addresses will be reserved for use by servers, such as the email server and the web server; due to this there will be 244 usable IPs available for general workstations and other connected devices in the Main Building.

The second public IP address block, 196.10.34.0, will be split equally between the East and West buildings, using the /25 subnet mask (255.255.255.128). This means that there will be two subnets available, with 126 usable hosts. The router in the West Building will have the 196.10.34.0 subnet, the router will be 196.10.34.1. The East Building will have the network address 196.10.34.128, and the router in this building will be 196.10.34.129.

For internal private IP addresses on the network, these will all have a non-public address that is only visible with the private network. Server will be separated from workstations using VLANS; these allow for the ability to virtually split networks giving the impression of multiple networks on one switch. If the IP Address is 10.1.10.0 this means that it belongs to a server, the routers will also have their own private default gateway within the network, this is on the VLAN 10.1.1.0. Lastly, the workstations will belong to the VLAN 10.1.20.0 in the Main Building, 10.1.30.0 in the West Building and 10.1.40.0 in the East Building. Separating all the devices this way ensures that each device that is on the network is separated, and security is upheld. Having an individual VLAN for each building also ensures that there are enough IP addresses for all the devices and have space for potential growth in the future. (Mehdizadeh, et al., 2017)

Network Address Translation, or NAT, is used to allow multiple private IP addresses to share a single public IP address for internet access. This ensures efficient use of public IPs and enhances security by keeping internal devices hidden from external networks.



Executive Summary

This proposal has been designed to even further enhance the company's growth and success, thus helping it achieve peak excellence. Delivery excellent quality reminiscent of and worth its cost, the proposal outlines a dependable and scalable network solution tailored to both meet and exceed the company's current as well as future business needs. The network infrastructure is centered around a strategically placed Main Distribution Frame (MDF) and six Intermediate Distribution Frames (IDFs) across three buildings, ensuring optimal performance and minimal delays. Top-grade, high-speed fibre optic cabling links the IDFs to the MDF, providing incredibly high-speed, secure and efficient data transmission both within and between each individual building due to being the best quality cabling media possible. Each floor is equipped with 48-port switches, offering plenty of capacity for future expansion and growth. In order to provide high-calibre security and exceptional network efficiency, the system divides the network into separate groups for different types of traffic, isolating traffic and reducing congestion; this makes it easier to manage and prevents unnecessary interference between departments or teams. This design not only addresses present requirements but also allows for seamless, swift expansion as the company grows, positioning both the network and the company for long-term success and prosperity.

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Appendix

Contributions of group members

Natalia Dragon (100%)

- All of Layer 1 Structured Cabling
- Logical topology diagram
- Executive summary
- Edited whole document, e.g. mostly grammar/wording/sentence structure to fit the tone + physical layout of the document/appendix
- Planning/discussing each proposal section

Jake Cunningham (100%)

- All of IP addressing scheme
- IP addressing scheme diagram
- Small contributions to other parts of proposal
- Planning/discussing each proposal section
- Setting up references

Sophie Hughes (100%)

- All of Layer 2 LAN topology written work
- Calculations for device numbers per floor
- Small contributions to other parts of proposal
- Planning/discussing each proposal section

Fatima Laraib (100%)

- All of Layer 3 topology
- Layer 2 topology diagram (including written work underneath this diagram)
- Small contributions to other parts of proposal
- Planning/discussing each proposal section