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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A picture of a winding road and trees  CMPG315: Project Documentation  Group 17 | Abstract  This document presents the design and implementation of a robust network for a medium sized company using Cisco Packet Tracer. The solution balances performance, security and scalability whilst remaining cost-effective. The report outlines the team’s remote work collaboration, challenges encountered throughout the project, key lessons learnt, and a budget analysis based on current hardware pricing and installation considerations.  Group Members:   |  |  |  | | --- | --- | --- | | Name & Surname | Student Number | Email address | | Blessing Masemola | 37962574 | 37962574@mynwu.ac.za | | Muhle Mabunda | 39928454 | 39928454@mynwu.ac.za | | Siphokazi Malesa | 39212017 | 39212017@mynwu.ac.za | | Tokiso Malapane | 35672447 | 35672447@mynwu.ac.za | | Angel Maluleke | 42077117 | 42077117@mynwu.ac.za | | Forget Nukeri | 38535858 | 38535858@mynwu.ac.za | |

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# Group and Project Details

The following members participated in completing the project and it is the opinion of the members of this group that they all deserve to be included as equal contribution members:

|  |  |  |  |
| --- | --- | --- | --- |
| Role | Name | Student number | Participation |
| Project Manager | Blessing Masemola | 37962574 | 100% |
| Network Architect | Muhle Mabunda | 39928454 | 100% |
| Network Configuration Specialist | Siphokazi Malesa | 39212017 | 100% |
| Network Security Expert | Tokiso Malapane | 35672447 | 100% |
| Documentation & Support Specialist | Angel Maluleke | 42077117 | 100% |
| Network Devices Specialist | Forget Nukeri | 38535858 | 100% |

## Functions of roles:

1. Project Manager: Overseeing the project, ensuring tasks are completed, and coordinating between team members and the client.
2. Network Architect: Responsible for researching, selecting network devices, and designing the overall network layout in Cisco Packet Tracer.
3. Network Configuration Specialist: In charge of setting up network devices in Cisco Packet Tracer and ensuring proper connectivity.
4. Network Security Expert: In charge of setting up network devices in Cisco Packet Tracer and ensuring proper connectivity.
5. Network Devices Specialist: Responsible for setting up virtual computers in Cisco Packet Tracer and ensuring all devices are properly connected to the network.
6. Documentation & Support Specialist: Developing network documentation, user manuals, and troubleshooting guides, while also taking notes during meetings.

NB: Roles and responsibilities were interchanged throughout the project to ensure that each members gains a full-on experience of the project.

## Group internal work ethic:

The group reached an agreement as to this is how we will go about working on the project:

1. Collaboration: We will work together and support each other to ensure the project is successful. Help will be offered whenever needed, and communication will remain open and respectful.
2. Accountability: Each member is responsible for their assigned tasks. We will take ownership of our work and ensure deadlines are met.
3. Respect and Trust: We will respect each other's ideas, opinions, and time. Trust will be the foundation of our teamwork, with everyone contributing their best.
4. Proactive Communication: We will keep each other informed about progress and challenges. If a task is falling behind, we’ll address it early to avoid delays.
5. Meeting Participation: Every member is expected to actively contribute during meetings. Notes will be taken to ensure we don’t miss important details.
6. Problem-Solving: If issues arise, we will tackle them together, finding solutions as a team. Feedback will be constructive, and decisions will be made collaboratively.

## Methods of communication and collaboration:

The group used a WhatsApp group chat for instant updates and scheduling. Microsoft Teams was used occasionally for online meetings, though the group preferred face-to-face collaboration. A shared Word document on OneDrive allowed all members to contribute to the report in real time. GitHub was set up for code collaboration but was used minimally. Overall, physical meetings were prioritized, with digital tools supporting coordination and documentation.

## Major unresolved problems:

1. The first project file got corrupted, and we had to restart the project, we couldn’t expel the group member as it would be severely harsh to remove them for a technical error.
2. The project had to be halted during assessment week as members had to focus on their semester tests, this extremely impacted the progress of the project.
3. 1 Member had to be excluded from the project as they encountered module registration problems, this affected the group a lot as we worked with one man less on the project.

## Group Reflection

Group members’ responsibilities, challenges faced per room and estimated completion dates for each task:

|  |  |  |  |
| --- | --- | --- | --- |
| **Room/Area** | **Challenges** | **Responsible Member(s)** | **Completion Date(s)** |
| **13 Offices** | Too many devices, Wi-Fi problems, long cables | M Mabunda - Plans where to place cables and Wi-Fi.  SD Malesa - Sets up the network so everything connects well.  VA Maluleke - Makes sure untrusted Wi-Fi devices don’t cause problems.  F Nukeri - Records how challenges are solved, creates diagrams/user guides, and captures issues in meetings. | 27 March – 01 April |
| **Technicians’ Office** | Lots of devices, direct link to server room, dual use (work + maintenance) | B Masemola - Designs this special room with direct access to servers.  F Nukeri - Implements connectivity and technician access to machine room.  T Malapane - Sets up secure technician-only access and isolates maintenance traffic.  VA Maluleke - Records how challenges are solved, creates diagrams/user guides, and captures issues in meetings. | 02 – 04 April |
| **Reception/Waiting** | Guest Wi-Fi needs to be separate, printer shared, small space with many users | VA Maluleke - Implements guest Wi-Fi isolation and staff/guest access policies.  T Malapane - Ensures smooth connection and access setup for staff and guests  M Mabunda - Designs layout to accommodate different users and devices.  SD Malesa - Records how challenges are solved, creates diagrams/user guides, and captures issues in meetings. | 04 – 06 April |
| **Kitchen** | IoT devices need internet, staff want safe Wi-Fi | B Masemola - Isolates IoT devices and controls access from public/staff Wi-Fi.  M Mabunda – Plans IoT and AP placement  VA Maluleke - Records how challenges are solved, creates diagrams/user guides, and captures issues in meetings. | 20 – 21 April |
| **Meeting Room** | Many users, video calls need stable and fast internet | T Malapane - Designs bandwidth and layout plan for teleconferencing + Wi-Fi users.  SD Malesa - Configures APs and prioritizes conferencing traffic.  F Nukeri – Security- Protects sensitive meeting data traffic.  M Mabunda - Records how challenges are solved, creates diagrams/user guides, and captures issues in meetings. | 22 – 24 April |
| **Machine Room** | All main devices here, needs to be safe and reliable | M Mabunda - Ensures logical topology and routing passes through here.  B Masemola - Sets up servers and routers  VA Maluleke - Locks down physical and remote access to core servers/switches.  SD Malesa - Records how challenges are solved, creates diagrams/user guides, and captures issues in meetings. | 26 – 28 April |
| **Open Floor Space** | Very crowded, many cables, Wi-Fi may slow down | M Mabunda - Plans modular switch and AP layout for dense use.  B Masemola - Connects 100+ wired points and manages large traffic volumes.  F Nukeri - Secures user/device access, manages subnet or VLAN segmentation.  T Malapane - Records how challenges are solved, creates diagrams/user guides, and captures issues in meetings. | 29 April – 04 May |
| **General Tasks** | Team coordination, device setup, documentation | B Masemola - Oversees everything, ensures deadlines are met, and coordinates between technical roles.  F Nukeri - Sets up all end-user devices across rooms; ensures they're connected and functional. | Throughout project (on a daily) |

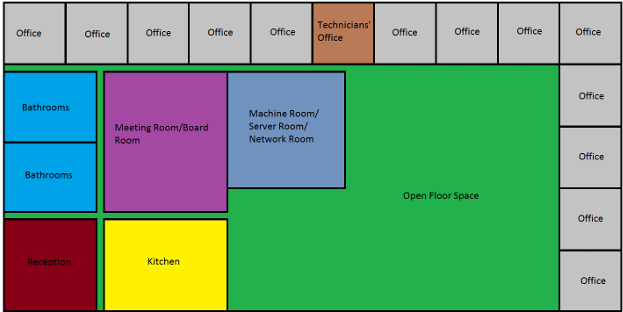
## Project Overview

The project involved the creation of a secure, high-performance LAN for a medium sized company.

* The network supports both wired and wireless connections.
* All devices must have internet access through a centralized network.
* The design accounts also for a segmentation of untrusted devices.

The network consists of:

* Server Room/Machine room:
  + All core networking equipment(routers,switches,servers).
  + DHCP, NAT, DNS, file storage, and intranet services.
* 13 Offices:
  + 2–4 people each, wired and Wi-Fi; 1 office used as storage (no connectivity needed).
* Technicians’ Office:
  + 2 technicians wired and Wi-Fi, with direct communication to machine room.
* Reception Area:
  + 2 staff, printer, wired and staff/guest Wi-Fi.
* Kitchen:
  + 4 IoT wired devices, Wi-Fi for staff
* Meeting Room:
  + 20–30 people, wired for conferencing, staff Wi-Fi
* Open Floor Space:
  + 75–120 people, 100 wired access points, Wi-Fi, 5 printers
* Remote work is supported via access to internet services(VPN).
* Network includes a hybrid topology(structured wired core and wireless coverage).



# Network Topology and Setup

In this section the minimum requirements for the system will be discussed. The discussion will follow the order as they are mentioned in the project description document, namely: OS requirement, data transmission, message display, message encryption, emailing, user friendliness, and communication through a network proxy.

## Overview of topology

The hybrid topology was selected for this project because it combines the strengths of both wired and wireless network architectures, enabling the organization to balance performance, reliability, and flexibility. This topology has several advantages over other topology designs, as it allows for high-speed, secure, and stable connections in the wired core for essential devices, while also supporting mobility and easy scalability through wireless access for portable devices and guest users. Additionally, it enables better network segmentation and management by integrating VLANs and centralized control. This approach does, however, require that a few issues be kept in mind, namely the proper placement of wireless access points to ensure full coverage, potential interference in wireless communication, and ensuring secure integration between wired and wireless segments to prevent vulnerabilities and unauthorized access.

## Design considerations per section

In the following section the design considerations for each section will be discussed. Each will be constructed in the following way: firstly, the overview of the function and purpose of each section will be considered, followed by…

### Reception

* Function: Entry point for staff and visitors, handles administrative tasks.
* Design Considerations:
  + 2 wired access points (1 per workstation).
  + Full Wi-Fi for staff: 2-4 devices per person.
  + Guest Wi-Fi must be isolated to prevent access to internal systems.
  + 1 network printer.

### Meeting Room

* Function: Host meetings, presentations and teleconferencing.
* Design Considerations:
  + 2 wired ports dedicated to conferencing hardware (camera, screen-sharing systems).
  + Wi-Fi access for 20-30 participants, segmented from the core network for security.
  + Prioritize traffic for VoIP.

### Machine Room

* Function: Core of the network as it hosts servers, routers and switches.
* Design Considerations:
  + No Wi-Fi; wired connections only.
  + Access limited to technicians; physically secured.
  + Centralized location for the main router and switches.

### Technicians’ Office

* Function: Workspace for IT support and network maintenance staff.
* Design Considerations:
  + 2 wired ports for technician workstations.
  + 4 wired ports for equipment testing.
  + Wi-Fi for up to 8 devices per technician.

### 13 Offices

* Function: Individual or shared workspace for employees.
* Design Considerations:
  + 4 wired access points per office.
  + Wi-Fi for 2-4 devices per user
  + 1 office is used for storage therefore no networking requirements needed.

### Open Floor Space

* Function: Dynamic working area for 75-120 staff.
* Design Considerations:
  + 100 wired access points.
  + Wi-Fi for all users.
  + 5 networked printers placed

# Network Design

In this section the physical network design, produced using Packet Tracer version 8.2.2, will be introduced. The presentation in this section builds on the contents of Section 2.1, and the way the design considerations were addressed will also be discussed. The section will conclude with a discussion on how the network will handle remote connections, with a focus on the application of remote work principles.

## Design of Reception Network

Consists of:

* 2 Personal Computers
* A Switch
* 2 Access Points
* Printer

2 Personal Computers are connected to the Switch via FastEthernet.

PC IP address configuration: DHCP, with same default gateway.

2 Wired Access Points connected to the Switch via FastEthernet cable.

Printer connected to the Switch via FastEthernet cable.

Printer IP address configuration: DHCP.

## Design of Meeting Room Network

Consists of:

* 2 IP Phones
* Switch

2 IP Phones connected to the Switch via FastEthernet cables.

Reason for using IP Phones:

* Supports PoE(Power over Ethernet).
* Combines voice, video, messaging, and data into a single platform.
* IP phones can be configured and managed **remotely** via a central system or VoIP server.

## Design of Machine Room Network

Consists of:

* 4 Servers
* 5 Switches
* 2 Routers (1 Main Router & 1 ISP Router)
* DSL Modems
* Clouds

Connections explained:

* 1st Server: Used for file storage, internal hosting and internal services.
* DNS Server: Connected to the ISP router, responsible for resolving domain names.
* Google Server: Simulated server to represent external access.
* Server: Another internal server, connected to the same switch as DNS and Google servers.
* All servers are connected to switches (via Ethernet) and routed through the ISP and main router for both internal and external access.
* Technicians Office Switch: Connects the Server and PC, distributing traffic locally and to the rest of the network.
* Office Main Switch: Central aggregation point for most endpoints in the office.
* Switch: Acts as an intermediary between the HR PC switch and the Main Router.
* Open Floor Switch: Connected to the Office Main Switch for workstation or VoIP endpoints.
* Other Switches: Likely distributes connections to more PCs or other departments.
* Switches interconnect to form a LAN and link endpoints to routers and servers.
* Main Router: Central router managing internal LAN routing and forwarding traffic to the ISP router.
* ISP Router: Connects to the DSL Modem and to Cloud, simulating connection to the wider internet.
* The Main Router handles local routing (VLANs).
* The ISP Router acts as the gateway to the outside world.
* The DSL Modem connects the Main Router to the ISP Router, simulating a DSL broadband connection.
* This is the middle ground between internal network and external services, handling data conversion from DSL lines.
* Cloud– Represents the internet connectivity.
* Connected to the ISP Router to simulate public internet access.
* DNS– Simulated external servers to test DNS resolution and web traffic.

## Design of Kitchen Network

Consists of:

* Switch
* IoT: Smoke Detector, Webcam, Light, Appliance

## Design of Technicians’ Office Network

Consists of:

* End Devices: Laptops and Desktop PCs.
* 3 Switches
  + 1st Switch - Access Switch: All laptops and PCs are directly connected here.
  + 2nd Switch – Distributed Switch: Connects Switch to the rest of the network infrastructure.
  + 3rd - Technicians Office Switch: links multiple departmental switches to the main switch and servers.

Key features:

* Scalability: Easy to add more PCs for testing and diagnostics.
* Segmentation Potential: Can implement VLANs to separate traffic by departments.
* Centralized Management: All access traffic can be monitored or filtered at the Switch.

## Design of 13 Offices Network

Consists of:

* 2 to 4 devices
* Switch

Connections explained:

* Devices connected to switch via FastEthernet cables.
* IP configurations: Static

## Design of Open Floor Space Network

Consists of:

* 5 Printers
* Switch
* 9 Hubs
* Laptops
* Wireless Router

Connections explained:

* All printers connect to the switch, providing centralized access.
* The switch is the backbone of the network, feeding into a set of 9 hubs.
* Each hub distributes the network connection to 2–3 laptops.
* Laptops rely on hub-based Ethernet connections, meaning:
  + More collisions (since hubs broadcast),
  + Slower compared to switch-based setups,
  + Cheaper, simple design (possibly for educational or low-traffic environments).

## Handling of remote connections

Handling remote connections in our corporate network design required creating a secure, efficient, and well-managed environment that allows off-site employees to access necessary internal resources without compromising network security. Our approach emphasized strong network segmentation, secure wireless communication, and clearly defined server roles to ensure both accessibility and protection. By using VLANs to segment traffic, implementing WPA2 encryption for wireless access, and assigning dedicated servers for specific services, we designed a system that supports flexible work while safeguarding sensitive data and maintaining smooth network performance.

Ultimately, handling remote connections is about balancing accessibility with security, ensuring that employees can remain productive without exposing the network to unnecessary risks. As the company may support a bring-your-own-device (BYOD) policy, additional safeguards such as device compliance checks or network segmentation may be needed to isolate untrusted devices while still allowing them access to necessary resources.

### Use of VLANs

* Purpose: VLANs (Virtual Local Area Networks) were used to logically separate traffic between departments. This segmentation limits unnecessary communication between unrelated parts of the network, reduces broadcast traffic, and enhances security by isolating sensitive resources from general user access.
* Implementation:
  + VLANs were configured at the main router to handle traffic and direct it to specific destinations. A trunk switch was employed to forward VLAN traffic between devices while maintaining the VLAN structure. This trunk switch allows the assignment of VLANs to specific interfaces, ensuring that different network segments are properly isolated and routed according to their respective VLAN configuration.

### Encryption

* Purpose: WPA2 encryption was applied to all wireless access points to secure wireless communications and protect data transmitted over the air from interception or unauthorized access.
* Implementation: The guest Wi-Fi was isolated from the internal network using VLAN segmentation to prevent unauthorized access to internal resources, even if credentials were compromised.

### Dedicated Servers

* Purpose: Instead of using one centralized server, we deployed multiple dedicated servers, each responsible for a specific function, this reduces dependency on a single server and limits the impact of failures or breaches.
* Implementation: Each server was assigned a defined role and placed within its appropriate VLAN.

## Reflection on network design

Our network design project provided a valuable opportunity to apply theoretical concepts in a practical setting, strengthening our technical skills and teamwork. Implementing VLANs was central to our approach, as it allowed us to logically segment the network, improving traffic management, enhancing security, and isolating guest access from internal systems. This taught us how thoughtful network segmentation supports both performance and protection.

By selecting a hybrid topology, we balanced the reliability of wired connections with the flexibility of wireless access. Our careful integration of both elements, along with strategic placement of access points and VLAN structuring, ensured robust connectivity and secure network boundaries.

Building and testing the network in Packet Tracer improved our ability to configure switches, manage IP schemes, and troubleshoot complex systems. It also helped us understand how physical layouts and logical designs interact to create efficient, functional infrastructures.

The collaborative nature of the project allowed each team member to contribute to different aspects, including architecture planning, configuration, documentation, and security. By rotating roles and working together to solve challenges—like device segmentation, resource allocation, and scalability—we strengthened both our technical competence and our ability to work effectively as a team.

Overall, this project enhanced our confidence and capability to design, implement, and manage secure and scalable networks. It reinforced how careful planning, logical segmentation, and collaboration are key to building a reliable and efficient network infrastructure.

The project faced numerous major challenges, but our capacity to adapt, assist each other, and implement solid network strategies led to a positive result.

# Budget

In this section the budget for the project will be discussed. The basic considerations and assumptions will be explained first, followed by an overview of the budget. The section will conclude with the full budget, and a discussion of any factors that may impact the budget but have not been considered.

## Hardware Budget

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Category | Device | Quantity | Price per unit | Subtotal |
| Switches | TP-Link 24 Port Gigabit Ethernet Switch Desktop/ Rackmount Plug & Play Shielded Ports Sturdy Metal Fanless Quiet Traffic Optimization Unmanaged (TL-SG1024S) | 30 | R1326  [Price to Switch](https://www.amazon.com/TP-Link-24-Port-Gigabit-Rackmount-TL-SG1024S/dp/B0779R9LJ3?currency=ZAR&dib=eyJ2IjoiMSJ9.gyMAr6oJYSIpHbmtsT-1wnRy_oEh8DAZbjditxUEDLiHTvK0EgfN1LkbkIvn6_aapStfutPayBgEsdYhYwPRwvIfE0s9npQJOyHJmULXfsegQNQ9pM4c_DWiqYi04s7YlGWsQQIZg4oioYyjKmibhnPA5kQEy2f5ZKtgpZ6As8PjPb0skSWNlQMlxknOOV7oWyJ7iLgFG7Bon4qgoWD2R5Z1sn0RRS563np4kYqXuu4.taVUkFEMUOuLNZSdSpiD0gOxgZsR3IefKkdiG5m4Ahw&dib_tag=se&keywords=cisco%2B24%2Bport%2Bgigabit%2Bswitch&qid=1746385004&sr=8-4&th=1) | R39780 |
| Routers | TP-Link ER605 V2 Wired Gigabit VPN Router, Up to 3 WAN Ethernet Ports + 1 USB WAN, SPI Firewall SMB Router, Omada SDN Integrated, Load Balance, Lightning Protection | 3 | R1105  [Price to Router](https://www.amazon.com/TP-Link-Integrated-Lightening-Protection-TL-R605/dp/B08QTXNWZ1?dib=eyJ2IjoiMSJ9.lNgJwPMw17aTloMV1nfGEaYYi65QuHaIuuQ9SWyiCLE5BW9xl1B-wQ6cr7gLA0U-qRLujqUhi3dtQuE4votky_vVxouqO_cfKB1Xr2rPeCoFqdHVqBse7vm9R2l1UpDAjPdsbnGPJsCjoYT974MUsgZWiqsg6DSM_MMq_PMqQt8EhhZrvzHVl9EuRu7UHHV1hpUNzpslWCUzlX3fU70NCROdIeV9xyaDcQUG3jCvQja6RtnjivQNr0PUmulaNqM39nT6XK5-H2_2VX7Uzk3ylkwJWthJdvQT5zOSMI_1PZg.cbZL5OAtzzmL-hS6q4Gd5XD7_mWLCo5JpqMUPQSVhR4&dib_tag=se&keywords=Business-Class%2BRouter&qid=1746386122&s=pc&sr=1-5&th=1) | R3315 |
| Modems | NETGEAR High-Speed Broadband DSL Modem (DM200-100NAS). Compatible with CenturyLink, Verizon, and Frontier) | 2 | R5618  [Price to Modems](https://www.amazon.com/NETGEAR-High-Speed-DM200-100NAS-Compatible-CenturyLink/dp/B01HTAPPJE?crid=3ABAO7G9YCPFR&dib=eyJ2IjoiMSJ9.C-CRzwvMVh7iFbMEiNDAxfjgNtUTbCycKBDQofOxSZjwYVHN-VUK1ztsFqgNJSxQ9Ks2mSA-lJe286jJULEvcp48nKH9TfnidKTZTV4tD7-4Krpuqf_ntQ4DErOM570vRZDiDL8KyFozthzlGhQ3zTb-6uNktCjA7_zhpNLoMSSDbrzvqlYccW3A-RzfSp7yAjKF4PMkYn3a19tCf4dCFin0l2P122Dfq7y1seW_-vU.YM_4zZvuk0_d6WWIbgRu-uqkou1_AmoL9Xw2TGgE4sM&dib_tag=se&keywords=DSL%2BModem%2BTP%2BLInk&qid=1746386638&sprefix=dsl%2Bmodem%2Btp%2Blink%2Caps%2C915&sr=8-10&th=1) | R11236 |
| Access Points | TP-Link EAP610 Ultra-Slim Wireless Access Point for Business | Omada True Wi-Fi 6 AX1800 | DC Adapter Included | Mesh, Seamless Roaming, WPA3, MU-MIMO | Remote & App Control | PoE+ Powered | 17 | R1842  [Pricee for Access Points](https://www.amazon.com/TP-Link-EAP610-Ultra-Slim-Wireless-Business/dp/B09XM74VQL?th=1) | R31314 |
| Servers | Dell EMC PowerEdge R250 1U Rack Mount Server, Xeon E-2314 2.8GHz, 16GB RAM, 2TB HDD, No OS, 4x 3.5" bays | 7 | R36590  [Price for Server](https://dell.laptopdirect.co.za/Dell-EMEA_PER250SPL3-p-302267.php) | R256130 |
| IoT Devices(Smoke detector; Webcam ;Light; Appliance) | - | Bulk | R8000  [Price Check Iot](https://www.pricecheck.co.za/search?search=Webcam) | R8000 |
| Cabling & Accessories(Cables,Panels,Racks,Adapters) | - | Bulk Estimate | R12000 | R12000 |
| Hardware Total |  |  |  | R361775 |

## Labour & Services

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Role | Task Description | Estimated Hours | Rate | Total |
| Network Technician | Install switches, routers, cabling, testing | 40 | R250/hr | R10000 |
| System Administrator | Server setup, configuration, remote services | 25 | R380/hr | R9500 |
| Access Point Setup | Configure IoT & APs | 10 | R260/hr | R2600 |
| Labour & Services Total |  |  |  | R22100 |

## Contingency (20%)

|  |  |  |
| --- | --- | --- |
| Item | Base Cost | Contingency (20%) |
| Hardware + Labour Total | R383875 | R76775 |

## Budget considerations and overview

The following assumptions were made with regards to the budget:

* A 20% contingency on the final cost is included;
* Labour hours assume no significant site delays; unexpected site constraints could extend labour time.
* Exchange rate fluctuations could impact server/modem costs
* Prices exclude VAT and possible shipping/import costs.
* A network engineer wasn’t needed for the project as the scale and complexity of the project could be handles and managed by a network technician.

The total of the budget is **R 460650** and includes the use of the best-value equipment that could be sourced by comparing prices across platforms such as Takealot, Amazon, and various local suppliers. This careful market research ensured a balance between affordability, quality, and availability. We prioritised hardware that offered proven reliability, ease of integration, and long-term value while avoiding unnecessarily high-end or proprietary solutions that would inflate costs without proportional benefit. Given the scope of the project and the quality of the components selected, this is believed to be a reasonable and competitive price that aligns with current market rates and the technical requirements of the network infrastructure.

# Remote group work

This section contains details on the project group’s experiences with conduction the work for this project remotely. The section will start with a discussion of the working procedures/habits/philosophies/assumptions/etc. use/followed/applied by the group, followed by a reflection of the experience.

## Group modus operandi when working remotely

When working remotely, the group established clear guidelines to ensure effective communication, collaboration, and task management. These practices helped maintain productivity and alignment even when face-to-face meetings were not possible:

1. **Primary Communication**
   * WhatsApp group chat remained the main platform for quick updates, questions, and scheduling.
2. **Scheduled Virtual Meetings**
   * Microsoft Teams and Group Calls were designated for structured online meetings, including progress reviews, brainstorming sessions, and task planning.
   * Meetings were scheduled in advance, with agreed start and end times to respect members’ availability.
3. **Document Collaboration**
   * Shared documents were maintained on OneDrive, allowing real-time co-editing and version control.
   * Team members committed to updating their assigned sections ahead of meetings to streamline reviews and feedback.
4. **Code Collaboration**
   * GitHub was used as the central repository for any shared code, with clear guidelines for commits and versioning, even if used sparingly.
   * Team members agreed to notify the group when major changes were pushed to avoid conflicts.
5. **Task Management and Accountability**
   * Each member was responsible for updating the group on their task progress during weekly check-ins.
6. **Availability and Responsiveness**
   * Group members communicated their availability in advance when possible and aimed to respond to messages within 24 hours on working days.
   * Flexibility and understanding were encouraged, recognising different personal schedules and workloads.

## Reflection on remote group work experiences

Working remotely as a group presented both advantages and challenges. One of the biggest benefits was flexibility — being able to communicate and collaborate from different locations made scheduling more adaptable around individual commitments. Tools like WhatsApp and OneDrive allowed us to share updates and documents quickly, and when used well, these platforms helped keep everyone on the same page.

However, remote work also highlighted some difficulties. Communication could sometimes be slower or less clear compared to face-to-face discussions, especially when relying on text messages for complex topics. It was also harder to maintain momentum and stay engaged during online meetings, and technical issues (like unstable internet connections) occasionally disrupted discussions.

Overall, while remote collaboration worked reasonably well with the right tools and clear communication, we found that in-person meetings were more efficient for brainstorming, problem-solving, and building group cohesion. The experience emphasized the importance of proactive communication, clear task division, and mutual accountability when working remotely. Going forward, a hybrid approach — blending digital tools with regular face-to-face interaction — would likely offer the best balance.

# Addressing Issues with Multiple Solutions

When the group encountered issues that had more than one possible solution, we followed a structured, collaborative approach to reach a consensus. First, we ensured the problem was clearly defined so everyone understood the core issue. Then, team members proposed different solutions, often drawing on personal preference, research, or prior experience. These options were openly discussed in meetings — whether in person or virtually — weighing the pros and cons of each in terms of feasibility, cost, efficiency, and alignment with project goals.

Where necessary, we divided tasks to quickly gather more information or test small prototypes to compare potential outcomes. The group aimed to make decisions based on evidence and practicality rather than personal preference. In cases where opinions were split, we used a majority vote after discussion to ensure everyone’s input was considered. Once a decision was made, it was clearly documented, and responsibilities were assigned to implement the chosen solution efficiently.

This method helped ensure that all viewpoints were heard, and the final decisions were well-informed and broadly supported by the team.

# How all additional features not required in the PT simulation can be implemented

* Easier Troubleshooting:
  + Problem: Hard to find issues when something breaks
  + Fix: Add monitoring systems
  + How: Make devices save error messages to one computer

Set all devices to use the same clock time

* Stronger Security:
  + Problem: Anyone can connect to any device
  + Fix: Add basic protection rules
  + How: Set passwords on devices(switches, routers)
* More Reliable Connections:
  + Problem: If one cable fails, connection is lost
  + Fix: Add backup connections
  + How: Connect switches with two cables instead of one

Set up a backup router that takes over if main one fails

* Regular Backups and Disaster Recovery:  
  Configuration backups of network devices can be automated and stored securely using TFTP/FTP servers or dedicated backup software. A comprehensive Disaster Recovery Plan (DRP) should also be established, including backup internet connections and data recovery procedures.

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