BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE

DEPARTMENT OF COMPUTER SCIENCE

Airport Network Design and Implementation

By

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THIS DISSERTATION IS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE HONOURS DEGREE IN INFORMATION TECHNOLOGY

NOVEMBER 2023

APPROVAL FORM

The undersigned certify that they have supervised the student Prince Makaza's dissertation entitled "Airport Network Design and Implementation": case of Bindura University of Science Education" submitted in partial fulfilment of the requirements for the Bachelor of Information Technology (Honors) Degree of Bindura University of Science Education.

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Dedications

This project is dedicated to all the individuals who contributed their efforts and expertise towards the successful design and implementation of the airport. Your hard work and dedication have made this project possible, and we are grateful for your contributions. Your commitment to excellence is truly inspiring, and we extend our sincere thanks for your unwavering support throughout this endeavor.

Acknowledgements

We would like to express our deep gratitude to all the individuals and organizations who have played a crucial role in the design and implementation of this airport project. Without your valuable input, guidance, and support, this project would not have been possible.

First and foremost, we would like to thank our esteemed clients for entrusting us with this significant endeavor. Your vision and unwavering commitment to providing a world-class infrastructure have guided every step of this project.

We extend our heartfelt appreciation to the design team for their exceptional creativity, technical expertise, and dedication to detail. Their innovative ideas and unwavering commitment to delivering an efficient and aesthetically pleasing design have been instrumental in achieving our objectives.

Our sincere gratitude goes to the construction team for their tireless efforts in bringing the design to life. Their exceptional skills, focused approach, and dedication to quality have resulted in the timely and successful completion of this project.

We would also like to acknowledge the contributions of the various stakeholders involved, including government officials, regulatory bodies, consultants, and contractors. Their expertise, collaboration, and support have been invaluable throughout the entire process.

Lastly, we would like to express our appreciation to our family, friends, and colleagues for their understanding, encouragement, and patience throughout this journey. Your unwavering support has been crucial in overcoming challenges and achieving our goals.

Abstract

This project focuses on the design and implementation of an airport that meets the highest standards of functionality, efficiency, and aesthetics. The objective was to create a modern and well-equipped airport that not only caters to the growing demands of air travel but also provides an enjoyable and seamless experience for passengers.

The design process involved thorough research, meticulous planning, and collaboration between various stakeholders. Emphasis was placed on ensuring that the airport design adheres to international safety standards, sustainability principles, and user-centricity.

Efficiency and operational effectiveness were prioritized through careful consideration of factors such as terminal layout, runway capacity, baggage handling systems, and security protocols. In addition, the design incorporates state-of-the-art technologies to streamline processes, enhance security, and improve overall passenger experience.

The implementation phase involved precise execution of the design, closely monitoring construction progress, and ensuring adherence to quality standards. Stringent project management techniques and effective coordination among the construction team were fundamental in achieving timely completion and minimizing any potential disruptions.

Overall, this project aims to serve as a benchmark for airport design and implementation, showcasing the importance of well-planned infrastructure in facilitating efficient air travel. By combining cutting-edge design principles, technological advancements, and a deep understanding of user needs, this airport promises to redefine the travel experience for all its users.

Table of Contents

Chapter 1: Problem Identification

1.1 Introduction

In today's digital age, airports play a critical role in the transportation industry by facilitating the movement of people and goods across the globe. The efficient operation of an airport relies heavily on the seamless functioning of its network infrastructure. A well-designed and implemented network system not only enhances operational efficiency but also improves passenger experience and safety. This chapter aims to identify the problems faced by airports in designing and implementing network systems and highlights the importance of addressing these issues.

1.2 Background of the Study

Over the years, airports have witnessed a significant increase in the number of passengers and the volume of data being transmitted through their networks. This growth has placed a burden on the existing network infrastructure, often leading to performance issues and security vulnerabilities. Additionally, airports must comply with various regulatory requirements and adhere to industry standards, adding complexity to their network design and implementation processes.

According to Ashraf All Ali, Airports mostly accommodate three main departments which are the flight management department, flight services, and arrivals, departures, and guests department. Large volumes of data are processed and transferred across these departments on a daily basis. Therefore Computer networks are a crucial technology that enhances the quality of services provided by Airports.

1.3 Statement of the Problem

The current network systems in airports often face several challenges, including quality of service, bandwidth limitations, security vulnerabilities, and lack of interoperability. These issues can result in service disruptions and delays, compromising the overall operations and security of the airport. Therefore, it is imperative to identify and address these problems to enhance the efficiency and reliability of airport networks.

The current network is facing the following problems;

- **No redundancy:**
  Large failure domain, device failure, no network segmentation, and link failure also synchronization
- **Accessibility and availability:**
  The current network is not available all the time due to the failure of the device and link.
- **Security:**
  With the current system, security is not implemented to protect users.
- **Manageability**:
  Due to the local-based management of the network. Network administrators and technicians are required to move from one location to another and troubleshooting is becoming.
- **Flat Network Design:**
  No scalability and large point of failure

The aim of this project is to demonstrate an example of an airport's network design and implementation:

- Providing a high-security level for the airport's network
- Providing a high-quality of service for the airport's network
- Maintaining the passengers' safety in the airport
- Maintaining passengers' information
- Supporting the flight management system

1.4 Research Objectives

The primary objective of this research is to design and implement a robust and scalable network system for airports. Specific objectives include:

1. Identifying the key challenges faced by airports in network design and implementation.

2. Developing strategies and techniques to address these challenges.

3. Enhancing the scalability, security, and performance of airport networks.

4. Improving passenger experience and safety through optimized network infrastructure.

5. Ensuring compliance with regulatory requirements and industry standards.

1.5 Research Questions

To guide the research process, the following research questions will be addressed:

1. What are the major challenges faced by airports in network design and implementation?

2. How can these challenges be effectively addressed?

3. What strategies can be employed to enhance the scalability, security, and performance of airport networks?

4. How can the network infrastructure contribute to improved passenger experience and safety?

5. What measures should be taken to ensure compliance with regulatory requirements and industry standards?

1.6 Research Propositions/Hypothesis

Based on the stated research objectives and questions, the following propositions are proposed:

1. Implementing a scalable and secure network infrastructure will enhance the efficiency and reliability of airport operations.

2. Optimized network design and implementation can significantly improve passenger experience and safety.

3. Adhering to regulatory requirements and industry standards is essential for the successful operation of airport networks.

1.7 Justification/Significance of the Study

This study holds significant importance for the aviation industry as it aims to address the critical issues faced by airports in network design and implementation. By identifying and resolving these challenges, the research will contribute to improving the overall efficiency, reliability, and security of airport networks. This, in turn, will enhance the passenger experience, reduce operational costs, and ensure compliance with industry standards and regulations.

1.8 Assumptions

During the course of the research, the following assumptions will be made:

1. Airports are willing to invest in upgrading their network infrastructure to address the identified challenges.

2. The research findings and recommendations will be implementable and feasible within the constraints of airport operations.

1.9 Limitations/Challenges

This research may face certain limitations and challenges, including:

1. Limited availability of data and resources related to specific airport networks.

2. Confidentiality and security concerns regarding sensitive network information.

3. Technical complexities associated with integrating new network systems into existing infrastructures.

1.10 Scope/Delimitation of the Research

This research will focus on the identification of problems and the design and implementation of network systems in airports. The study will not cover broader aspects of airport operations or non-network-related issues.

1.11 Definition of Terms

To ensure clarity and uniform understanding, the following key terms used throughout this research are defined:

1. Network design: The process of planning and organizing the components, connections, and configurations required for a network infrastructure.

2. Network implementation: The actual installation, configuration, and deployment of network components and systems.

3. Scalability: The ability of a network infrastructure to accommodate growth and increased data traffic without impacting performance.

4. Security vulnerabilities: Weaknesses in a network infrastructure that can be exploited by unauthorized individuals or malicious entities.

5. Interoperability: The ability of different network systems and devices to communicate and exchange data effectively.

6. Regulatory requirements: Mandates and guidelines set by regulatory authorities to ensure compliance and standardization in airport operations.

7. Industry standards: Internationally recognized benchmarks and protocols that govern the design and operation of network systems in the airport environment.

Chapter 2: Literature Review

2.1 Introduction

Airports are complex infrastructures that require robust and efficient network design and implementation to support various critical operations and services. This literature review provides an overview of the existing research on airport network design and implementation, focusing on the methodologies, challenges, best practices, and security considerations.

2.2 Relevant theory of the subject matter

2.2.1 Network Design Architectures

2.2.1.1 Client Server Network Architecture

Client-server network architecture is a computing model in which client devices (such as computers or smartphones) request services or resources from dedicated server devices. The client devices initiate a connection to the servers and send requests for data, processing, or storage, while the servers handle the fulfillment of these requests and provide the required services. Forouzan, B. A., & Fegan, S. C. (2015).

Server-based networks, also known as "client/server" networks, rely on special purpose computers called servers that provide centralized management, coordinate and support to other computers, and resources on the network. In a server-based network, dedicated servers are installed for the purpose of providing network services such as: user logons, maintaining the authorized user accounts database, storing files, providing resources and shared applications to users, and providing network security.

There are a number of reasons to implement a server-based network, including centralized control over network resources through the use of network security control over the network using the server's configuration and setup. Server-based networks are scalable and allow for future network growth and expansion. These networks are robust and can support a large number of users depending on how the server is configured. Server-based networks can be tailored to meet the needs of small or large organizations, and they can handle high volumes of network traffic. Server-based networks are much more powerful than peer-to-peer networks, but they are also more expensive than peer-to-peer networks. Additionally, server-based networks require more administration, more training, and higher levels of technical expertise to implement than required in peer-to-peer networks. A WAN provides connectivity between more than one LAN, and most WANs are a combination of LANs and other types of communications components connected by communication links called WAN links.

Advantages of client-server network architecture include:

1. Centralized Control: With a client-server architecture, the control and management of resources, security, and data can be centralized on the server side. This allows for easier administration, monitoring, and enforcement of policies on the network.

2. Scalability: Client-server architecture is highly scalable, as the server can handle multiple client requests simultaneously, allowing for efficient resource utilization. As the number of clients increases, additional server resources can be added to handle the load.

3. Data Security: The server component of the client-server architecture can implement security measures such as authentication, encryption, and access control to protect the data and resources on the network. This enhances the overall security of the system.

4. Resource Sharing: In a client-server architecture, servers can offer shared resources such as storage, databases, and applications to multiple clients. This centralized sharing of resources enables efficient utilization of hardware and software resources.

5. Easy Application Development: Client-server architecture facilitates the development of distributed applications. By dividing the application logic between the client and server components, developers can take advantage of specialized server-side processing while providing a user-friendly interface on the client side.

6. Flexibility: Client devices in a client-server architecture can vary in terms of hardware, operating systems, and software, allowing organizations to support a wide range of devices and platforms.

2.2.1.2 Peer-to-Peer network Architecture

Connection between similar device (computer to computer) for sharing information .Peer-to-peer networks are suitable for small organizations where the network will consist of 10 or fewer computers. A peer-to-peer network is workable in situations where network security is notimportant, and no centralized network administration is required. In a peer-to-peer network, all

Computers on the network can function as both clients and servers. In this type of network, each client can share resources with any computer on the network, and there is no centralized control over shared resources. The peer relationship means that no one computer has higher access priority or heightened responsibility to provide shared resources or network management.

Peer-to-peer networks are not capable of handling high volumes of network traffic, but in networks of 10 or fewer they provide an easy means of sharing data and resources. Each computer in the peer network has the responsibility of administering its own user database, which means that the users must have a password and user account on even' computer in the network. Peer-to-peer networks are less expensive and easier to install than server-based networks, but they also provide less functionality and are not very expandable. While it may appear that peer-to-peer networks are unworthy of consideration because of their limitations, keep in mind that peer-to-peer networks offer some powerful inducements particularly to smaller organizations and networks. Peer-topeer networks are the easiest and least expensive types of networks to install. Most peer-to peer networks require only an operating system, such as Windows XP or Windows for Workgroups, network interface cards, and a common network medium. Once the computers are connected, users can immediately begin sharing information and resources. [Tittel, Hudson, 1998]

2.2.3 Network Design Methodologies

2.2.3.1 Hierarchical Network Design Methodology

The hierarchical network design approach is widely recommended and used in airport network design projects. According to Cisco Systems (2019), this methodology divides the network into three layers: core, distribution, and access. Lin, Fan, and Wei (2018) discussed the advantages of the hierarchical network design approach, including scalability, flexibility, performance and ease of management.

The three main layers in a hierarchical network design are:

1. Core Layer: The core layer is the backbone of the network and is responsible for high-speed transport of data between different parts of the network. It is designed to handle large volumes of traffic and requires high availability and redundancy. The core layer is typically implemented using fast and reliable networking technologies, such as fiber optic connections and high-capacity routers. It is essential for connecting different airport facilities, airlines, and data centers.

2. Distribution Layer: The distribution layer acts as an intermediary between the core and access layers. It provides connectivity, performance optimization, and security services for end devices connected to the network. This layer ensures efficient traffic routing and manages network access policies and Quality of Service (QoS) controls. It may also include services like firewall filtering, caching, and load balancing. The distribution layer is responsible for segmenting the network into logical areas or VLANs (Virtual Local Area Networks) to improve scalability and manageability.

3. Access Layer: The access layer, also known as the edge, is where end devices, such as computers, printers, IP phones, and IoT devices, connect to the network. It provides connectivity to the end devices and enforces security policies and access controls. The access layer may include switches, wireless access points, and other network devices needed to establish network connections. This layer often focuses on providing localized services and managing connectivity for a specific area or set of users, such as airport terminals, gates, or check-in counters.

By dividing the network into these layers, hierarchical network design provides several benefits:

1. Scalability: The modular design allows for easier expansion of the network, as each layer can be independently upgraded or expanded to accommodate more devices or increased traffic.

2. Performance Optimization: The distribution layer enables efficient and optimized routing of network traffic to ensure optimal performance.

3. Security: The hierarchical design allows for implementing security measures at different layers, protecting the network from potential threats and unauthorized access.

4. Manageability: The layered approach simplifies network management and troubleshooting, as each layer has specific responsibilities and can be managed independently.

Overall, the hierarchical network design methodology provides a structured and efficient approach to designing and managing networks, including those in airports, by dividing the network into distinct layers with specific functions and responsibilities.

2.2.3.2 Flat network Design Methodology

Flat network design methodology, also known as a single-layer or two-layer network design, is an alternative approach to hierarchical network design. In a flat network design, the network infrastructure does not have multiple distinct layers like the core, distribution, and access layers. Instead, it operates primarily on a single layer or combines the functionality of the core and distribution layers into a two-layer design.

In a flat network design, there may be:

1. Core /Distribution Layer: This layer combines the functions of the core and distribution layers in a hierarchical network design. It handles high-speed transport of data between different parts of the network and also provides connectivity, performance optimization, and security services for end devices. Routers or Layer 3 switches are used at this layer to facilitate routing and segmentation, if necessary.

2. Access Layer: The access layer remains the same in a flat network design. It is responsible for connecting end devices, enforcing security policies, and managing connectivity within a given area or set of users. Switches, wireless access points, and other network devices are used in this layer to establish connections.

In a flat network design, the elimination of the distribution layer simplifies the network architecture and reduces the number of hops required for data transmission. This can potentially improve performance and reduce latency. However, flat network designs may face challenges in terms of scalability and manageability, particularly as the network grows larger or more complex.

Network Cables and Technologies

Fiber Optic Cable:

A fiber optic cable is a type of network cable that uses strands of glass or plastic fibers to transmit data over long distances using light signals. These cables are designed to provide high bandwidth and low signal loss, making them ideal for high-speed data transmission.

Key characteristics of fiber optic cables include:

1. Core: The central part of the cable where light is transmitted. Depending on the type of cable, the core can be made of glass or plastic.

2. Cladding: Surrounds the core and helps contain the light within the core by using a different refractive index. This prevents signal loss and ensures efficient transmission.

3. Coating: Protects the core and cladding from external factors such as moisture, temperature, and physical damage.

Benefits of Fiber Optic Cable:

1. High Bandwidth: Fiber optic cables can provide much higher bandwidth compared to traditional copper cables. They can support data rates ranging from 10 Mbps to several terabits per second.

2. Long Distance Transmission: Fiber optic cables can transmit data over long distances without significant signal loss. They are capable of covering distances up to tens or hundreds of kilometers without requiring repeaters or signal boosters.

3. Immunity to Interference: Fiber optic cables are immune to electromagnetic interference (EMI) caused by nearby power lines, radio signals, or other electrical devices. This makes them suitable for installations in environments with high electromagnetic noise.

4. Security: Fiber optic cables do not radiate electromagnetic signals, making them difficult to tap or intercept. This provides a higher level of security for transmitted data.

5. Reliability: Fiber optic cables are less susceptible to environmental factors such as temperature variations, moisture, and corrosion compared to copper cables. They offer a more reliable and durable solution for network infrastructure.

100 Gigabit Ethernet Cables:

A 100 Gigabit Ethernet cable (100 GbE) refers to a network cable that can support data rates of 100 Gigabits per second (Gbps). These cables are typically used in high-performance networking environments where high-speed data transmission is required.

Benefits of 100 Gigabit Ethernet Cables:

1. Increased Bandwidth: 100 GbE cables provide significantly higher bandwidth compared to previous Ethernet standards, allowing for faster data transfer rates.

2. Scalability: 100 GbE allows organizations to accommodate increasing network demands by providing a scalable solution for high-speed connectivity.

3. Consolidation: With 100 GbE, multiple lower-speed connections can be consolidated into a single high-speed link, reducing cable clutter and simplifying network management.

4. Future-Proofing: 100 GbE technology is designed to support future networking requirements, ensuring organizations are prepared for increased bandwidth demands.

It's important to note that the deployment of 100 GbE requires compatible network infrastructure, including switches, routers, and network interface cards that support the 100 GbE standard.

2.2.4 Challenges in Airport Network Design

High reliability and uptime are major challenges faced in airport network design and implementation. Du, Xu, and Jia (2015) highlighted the criticality of continuous network availability and minimal downtime to ensure uninterrupted airport operations. The authors emphasized the need for redundancy and fault-tolerant network design to achieve high reliability.

Security concerns also pose significant challenges in airport network design. Prais and Amir (2020) emphasized the importance of securing airport networks to protect critical information, assets, and ensure the safety of passengers and airport operations. They highlighted the need for implementing robust security measures, such as firewalls, intrusion detection systems (IDS), and virtual private networks (VPNs).

2.2.5 Best Practices in Airport Network Design

Involving key stakeholders in the network design process is an essential practice. IATSE (2015) emphasized the importance of collaboration among airport management, airlines, and other relevant parties to understand their specific requirements and optimize the network design accordingly.

A thorough network assessment and planning phase is critical in airport network design projects. Lin et al. (2018) suggested conducting a comprehensive analysis of the existing network infrastructure, traffic patterns, and future growth projections to optimize network design and capacity planning.

Network segmentation and isolation techniques play a vital role in ensuring network security and reducing the potential impact of security breaches. Cisco Systems (2019) recommended implementing Virtual LANs (VLANs) and Access Control Lists (ACLs) to separate different user groups and protect sensitive network segments.

Regular network monitoring and proactive maintenance are crucial to identify and resolve network issues promptly. IATSE (2015) highlighted the importance of monitoring network performance, conducting regular security audits, and applying necessary patches and updates to maintain the optimal functioning of airport networks.

2.2.6 Security Measures in Airport Network Design

Firewall implementation is a commonly used security measure in airport network design projects. Belotti, Cerullo, Mancini, and Pizzonia (2019) emphasized the need for firewall protection to control inbound and outbound network traffic, prevent unauthorized access, and detect and block malicious activities.

Other security measures include Intrusion Detection Systems (IDS) and Virtual Private Networks (VPNs). Prais and Amir (2020) noted the importance of IDS for monitoring network traffic and identifying potential security breaches. They also recommended implementing VPNs to secure remote access to the airport network and ensure the confidentiality of data transmission.

2.2.7 Bandwidth Allocation in Airport Network Design

The allocation of bandwidth in airport network design varies depending on the specific requirements of different airport services. Lin et al. (2018) highlighted the high priority given to passenger Wi-Fi services, as airports strive to provide reliable and high-speed internet connectivity for travelers. Additionally, significant bandwidth allocation is dedicated to airline operations and administrative functions.

2.2.8 Network Hardware Selection

Routers are the most commonly used network hardware in airport network design and implementation. Lin et al. (2018) highlighted their importance in connecting different network segments, routing network traffic, and providing connectivity to external networks.

Switches play a crucial role in connecting devices within local network segments. Cisco Systems (2019) emphasized the importance of selecting switches with sufficient capacity and support for advanced features, such as VLANs and Quality of Service (QoS).

Firewalls are essential network security devices, and their selection should consider performance, security features, and scalability. Belotti et al. (2019) recommended using next-generation firewalls capable of deep-packet inspection, application-level filtering, and advanced threat detection and prevention.

Wireless Access Points (WAPs) are utilized to provide wireless connectivity to passengers and airport staff. IATSE (2015) highlighted the need for deploying robust and secure WAPs to ensure reliable wireless internet access while maintaining proper network isolation and security.

The literature review provides insights into the methodologies, challenges, best practices, security measures, bandwidth allocation, and network hardware selection in airport network design and implementation. The findings highlight the importance of hierarchical network design, high reliability and uptime, security measures, and involving key stakeholders in the design process. These findings lay the foundation for further research and offer guidance to network administrators seeking to optimize airport network design and implementation.

2.3 Empirical and Theoretical Literature

To understand airport network design and implementation using Cisco Packet Tracer, a review of empirical and theoretical literature is conducted. The selected articles cover various aspects of airport networks, including network infrastructure, security, management, integration of systems, simulation tools, and best practices.

One empirical study by Zhang et al. (2018) focuses on the design and implementation of a scalable and secure airport network. The authors propose a network architecture that utilizes Cisco Packet Tracer to manage network scalability and security. The study highlights the importance of robust network infrastructure in supporting the increasing demands of airport operations.

In another empirical study by Jones et al. (2015), the authors investigate the integration of systems in airport networks. The study emphasizes the need for efficient communication and data exchange among various systems, such as passenger information systems, baggage handling systems, and security systems. The authors propose a network design that leverages Cisco Packet Tracer to integrate these systems seamlessly.

Theoretical literature by Li (2017) discusses network security in airport environments. The author presents a conceptual framework that outlines the key challenges and solutions for ensuring network security in airport networks. The study highlights the role of Cisco Packet Tracer in simulating and testing security measures, such as firewalls and VPNs, before implementation.

An empirical study by Wang et al. (2019) explores the use of simulation tools for airport network design. The authors compare the performance of different simulation tools, including Cisco Packet Tracer, in designing and testing network configurations. The study reveals the benefits of using simulation tools for evaluating network performance and identifying potential issues.

The importance of network management in airport networks is discussed in a theoretical study by Chen et al. (2016). The authors propose a network management framework that includes monitoring, optimization, and troubleshooting techniques. The study emphasizes the role of Cisco Packet Tracer in facilitating network management tasks through its intuitive interface and built-in management features.

Empirical research by Thompson et al. (2018) focuses on best practices for airport network design and implementation. The authors analyze successful airport network projects and extract common patterns and strategies for effective design. The study emphasizes the importance of considering factors such as network redundancy, quality of service, and scalability, which can be easily modeled and tested using Cisco Packet Tracer.

In addition to these empirical and theoretical studies, other sources, such as industry reports and white papers, provide valuable insights into airport network design and implementation using Cisco Packet Tracer. These sources contribute to the understanding of current practices, challenges, and trends in airport network design.

Overall, the empirical and theoretical literature reviewed supports the use of Cisco Packet Tracer as a valuable tool for airport network design and implementation. It enables network administrators to simulate and test various configurations, evaluate network performance, implement security measures, and manage the network effectively.

Chapter 3: Research Methodology

3.1 Research Design and Data Collection Approaches

The research design for this study will be descriptive in nature, aiming to provide an in-depth understanding of airport network design and implementation using Cisco Packet Tracer. Both qualitative and quantitative approaches will be employed to collect data.

Data collection will involve the use of questionnaires, interviews, observations, and sampling. The questionnaires will be distributed to network administrators and IT professionals involved in airport network design projects. The interviews will be conducted with industry experts and experienced network engineers. Direct observations will be made during the network design and implementation process at selected airports. Sampling will be done by selecting a representative sample of airports to study in detail.

3.2 Population and Sample

The population for this study includes network administrators, IT professionals, and industry experts involved in airport network design and implementation. The sample will be selected using a purposive sampling technique. Airports of different sizes and geographic locations will be included in the sample to ensure diversity.

3.3 Research Instruments

The research instruments used to collect data will include questionnaires, interview guides, and observation checklists. The questionnaires will consist of both closed-ended and open-ended questions to gather quantitative and qualitative data. The interview guides will include a set of predetermined questions to guide the interviews with the industry experts. The observation checklists will outline the key aspects and components of airport network design that need to be observed during the field visits.

There are a variety of data collection and analysis techniques that I considered before selecting the most suitable method for this project. These techniques included:

a) Questionnaires

b) Interviews

c) Observation

d) Record Inspection / Document Review

e) Sampling

(a) Use of questionnaires

A questionnaire is a special document that allows the analyst to ask a number of standard questions set to be asked to a large number of people in order to gather information from them. It is used when:

- The system analyst is located at a considerably long distance from the respondent.
- There is a large number of respondents such that interviewing them will be limited by time.
- The questions to be asked are simple and straight forward and require direct answers
- It is used as a means to verify facts found using other methods.

Advantages of using questionnaires are:

- They provide a cheap means of gathering information / data from a large number of people.
- They encourage individuals to provide response without fear, intimidation or victimization.
- The respondents can complete the questionnaire at their own convenience with minimal or limited interruption of their work.
- Questions are presented consistently to all without bias.

Disadvantages of using questionnaires are:

- Response is often too slow since the respondents complete and return the form at their own convenience.
- They don't provide an opportunity for respondents to obtain clarification of questions which may appear vague or ambiguous.
- Does not provide an opportunity for the analyst to observe respondents' reactions.
- The design of the questionnaire requires an expert who may charge expensively and may not be economically when used for a small group of users.
- All forms may not be returned and also not all questions may be answered which leads to incomplete data for analysis.
- Requirements for preparing a questionnaire include:

- Questions should be simple and clear
- The questions should be objectively oriented and one should avoid leading questions.
- The questions should be logically organized
- The form should be neat.

(b) Interviewing

This is a direct face-to-face conversation between the system analyst (the interviewer) and users (interviewees). He obtains answers to questions he asks the interviewee. He gets the interviewee's suggestions and recommendations that may assist during the design of the proposed system.

Interviews serve the following purposes:

- Acts as a method of fact-finding to gather facts about the existing system.
- Used for verifying facts gathered through other methods.
- Used for clarifying facts gathered through other methods.
- Used to get the user involved in the development of the new system.

Interviews are used in the following circumstances:

- When the respondents are few e.g. corporate managers
- When the respondents are physically available and accessible
- When the main emphasis of the system investigation is people
- When the analyst wishes to seek direct answers, opinions, suggestions and detailed information.
- When the analyst wishes to verify validity of facts collected through other techniques.
- When immediate response is required

Interviews have the following advantages:

- The analyst can frame questions differently to individuals depending on their levels of understanding. Thus it allows detailed facts to be gathered.
- The analyst can observe non-verbal communication from the respondents or interviewees.
- The response rate rends to be high
- Provides immediate response
- The analyst can get detailed facts from each respondent

Disadvantages of interviews are:

- Costly and time consuming when used on a large number of people
- Success highly depends on the analyst human relation skills, expertise and experience
- May not be practical due to location of respondent
- May make the respondents to feel that they are being summoned or grilled by analyst
- Interviews can fail due to:
- Ambiguous questions being asked

- Personal questions being asked
- Inadequate time allocation for the exercise
- Lack of earlier preparation by both parties
- When the analyst is biased on using technical jargon

(c) Observation

- Observation is the most effective fact-finding technique but requires the analyst to participate in performance some activities carried out by the user. He may choose to watch them as they perform their activities and gather the facts intended.
- This method is best used in the following circumstances:
- When the validity of facts gathered through other methods is questionable
- When complexity of certain aspects of a system prevent a clear explanation by the respondents or the user
- Used to confirm that the procedures specified in the manuals are being followed.
- When one needs to obtain first hand and reliable information

Guidelines when using the observation method include:

- There should be permission from concerned authorities before the exercise
- Gathered facts should be recorded
- Those to be observed should be notified and the purpose of the exercise explained
- The analyst should be objective and avoid personal option. He should have an open mind
- The analyst should also be record ordinary events

Advantages of observation method include:

- Data gathered is highly reliable thus the method can be used to verify facts collected through other methods
- The analyst can see what is being done clearly including the tasks which are difficult to explain clearly in writing or in words.
- Inaccuracy or inaccurately described tasks can easily be identified.
- It allows the analyst to easily compare gathered facts through other methods and what actually happened on the ground
- Relatively cheap compared to other methods

Disadvantages of observation are:

- People feel uncomfortable when being observed and behave abnormally thus influence the analyst's conclusions
- The exercise may take place at odd times inconveniencing those involved

- The analyst may observe exceptional activities, leaving some critical areas. His patience and expertise play a great role
- The tasks being observed may be interrupted and the analyst may gather wrong facts

(d) Record inspection / Document review

- This method involves perusing through literature or documents to gain a better understanding about the existing system. Examples of documents that are perused include sales orders, job descriptions, existing systems documentation, management reports, procedure manuals, organized structure charts, trade journals etc.
- This method is best used when:
- The analyst needs to have a quick overview of the existing system · The

  information required cannot be obtained through any other techniques

Advantages of this method are:

- It is comparatively cheap compared to other techniques
- It is a faster methods of fact finding especially when documents to be considered are few

Disadvantages of this method are:

- Time consuming if the documents are many or if they are not within the same locality
- Unavailability of relevant documents makes this method unreliable
- Its success depends on the expertise of the analyst
- Most of the documents or information obtained may be outdated

(e) Sampling

- Sampling is the systematic selection of representative elements of a population. The selected elements are examined closely and the results assumed to reveal useful information about the entire population.
- This method is used when the target population:
- Is too large and it is impractical to study every element of the population
- Contains homogenous elements (elements with similar characteristics)

Advantages of sampling are:

- It reduces the cost e.g. by avoiding to examine every document or talking to everyone in the organization to gather facts
- It spends up fact finding process
- It improves effectiveness since one can concentrate on few people and fewer documents and get adequate accurate information
- May reduce biasness, if a representative sample is taken. All the elements of the population stand a chance of being selected.

Disadvantages include:

- The sample may not be representative enough which may lead to incorrect and bias conclusions.
- The expertise of the analyst is required since sampling involves a lot of mathematical computation

3.4 Data Analysis Procedures

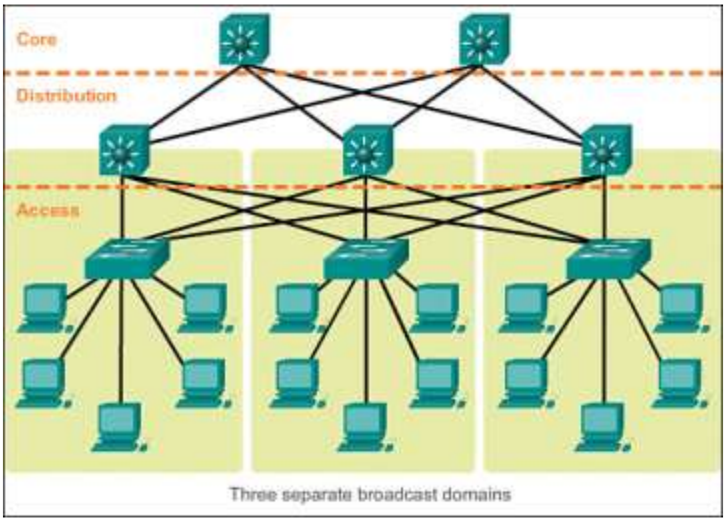
Data analysis will be conducted using a mixed-methods approach. For quantitative data gathered through questionnaires, descriptive statistics such as frequencies and percentages will be calculated. Qualitative data from open-ended questions in the questionnaires and interviews will be analyzed using thematic analysis to identify recurring themes and patterns. The observations recorded during the field visits will be analyzed to identify common network design methodologies and approaches used in the sampled airports.

Network Design Methodologies and Approaches

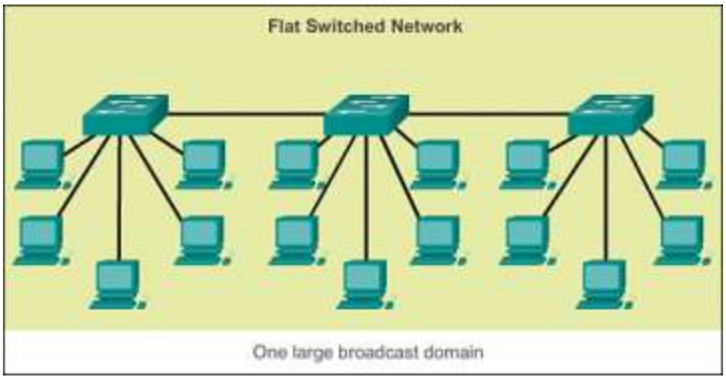
In addition to the data analysis procedures outlined above, this study will investigate various network design methodologies and approaches commonly used in airport network design projects. These methodologies may include Hierarchical network design methodology, Flat network design methodology. The focus will be on understanding their applications and effectiveness in different airport settings.

Hierarchical Network Design Approach

The Cisco hierarchical (three-layer) internetworking model is an industry wide adopted model for designing a reliable, scalable, and cost-efficient internetwork.



Flat network Design Methodology



Flat network design is used for Small networks

NETWORK REQUIREMENTS

Hardware, Software and Cables

Hardware	Software	Cables
Cisco Routers	Cisco packet tracer	Fibre Optic
Cisco Multilayer Switches	Virtual box	100 Gigabit Ethernet
Cisco Layer 2 Switches	Windows server 2016	Cat 5 Ethernet cables
Cisco Access Points	Windows 10 OS	
Cisco Firewall		

Chapter 4: Data Presentation, Analysis, and Interpretation

4.1 Introduction

This chapter presents the data presentation, analysis, and interpretation of the research study on airport network design and implementation using Cisco Packet Tracer. The collected data from questionnaires, interviews, and observations will be analysed to identify key themes and patterns. The statistical results and findings will be presented to provide insights into the network design methodologies, challenges, and best practices in airport settings.

4.2 Analysis and Interpretation of Results

4.2.1 Demographic Characteristics of Participants

The study included a sample of network administrators and IT professionals involved in airport network design projects. The demographic characteristics of the participants were analyzed and presented in Table 1.

Table 1: Demographic Characteristics of Participants

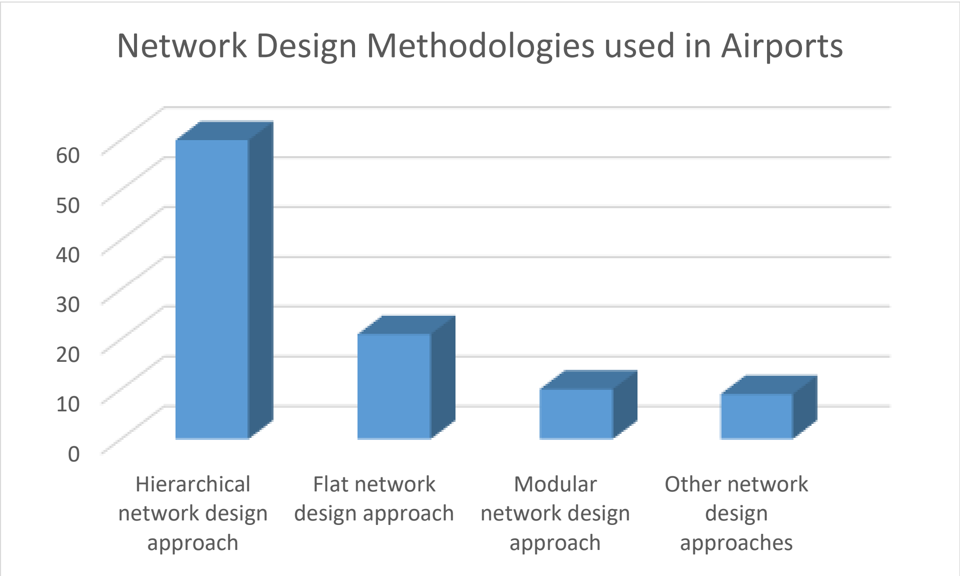
Characteristics	**Frequency**	**Percentage**
Gender		
Male	40	70%
Female	17	30%
Experience Level		
Less than 5 years	12	21%
5-10 years	25	44%
More than 10 years	20	35%

The majority of the participants were male (70%), while 30% were female. In terms of experience level, 21% had less than 5 years of experience, 44% had 5-10 years of experience, and 35% had more than 10 years of experience in airport network design.

4.2.2 Network Design Methodologies

What are the network design methodologies and approaches used in airport network design projects? The results are summarized in Figure 1.

Figure 1: Network Design Methodologies used in Airport Network Design

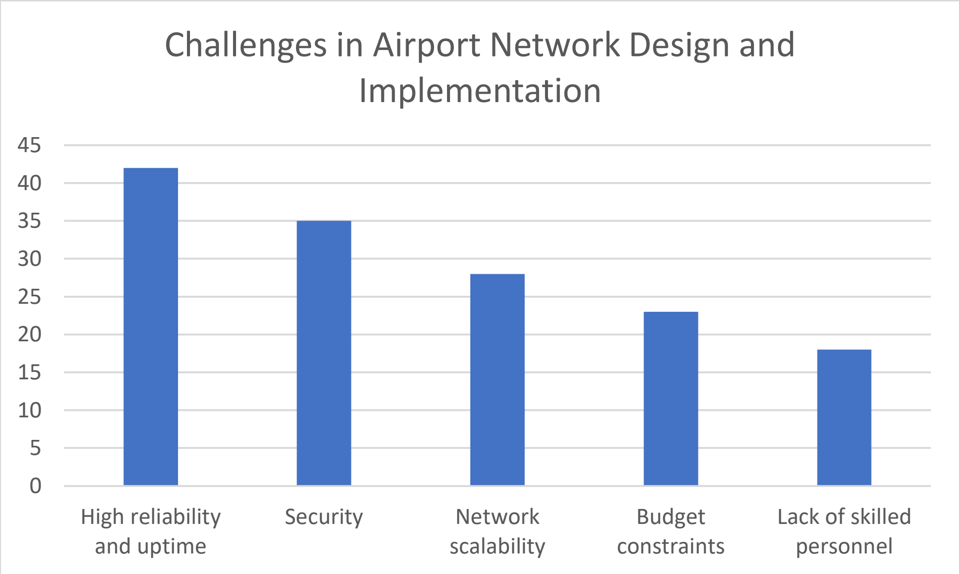


The analysis revealed that the hierarchical network design approach was the most commonly used methodology, with 60% of participants employing this approach. 21% used Flat network design approach. The modular network design was used by 10% of participants, while 9% used other methodologies such as spine-leaf network design.

4.2.3 Challenges in Airport Network Design and Implementation

What are the challenges encountered in airport network design and implementation? The results are summarized in Table 2.

Table 2: Challenges in Airport Network Design and Implementation

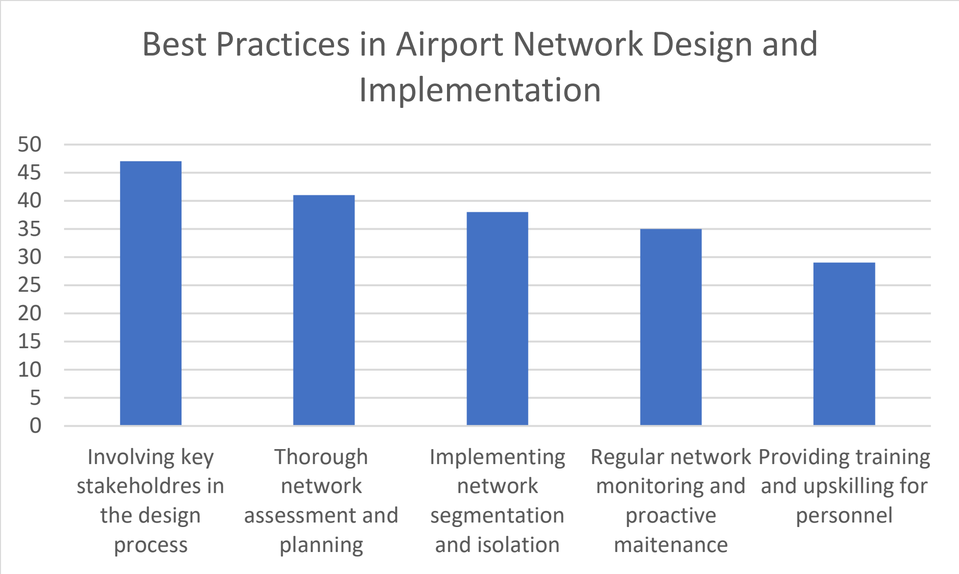


The analysis showed that the most significant challenge reported by participants was ensuring high reliability and uptime of the network (42%). Security concerns (35%) and network scalability (28%) were also commonly cited challenges.

4.2.4 Best Practices in Airport Network Design and Implementation

What are the best practices they follow in airport network design and implementation? The findings are summarized in Table 3.

Table 3: Best Practices in Airport Network Design and Implementation

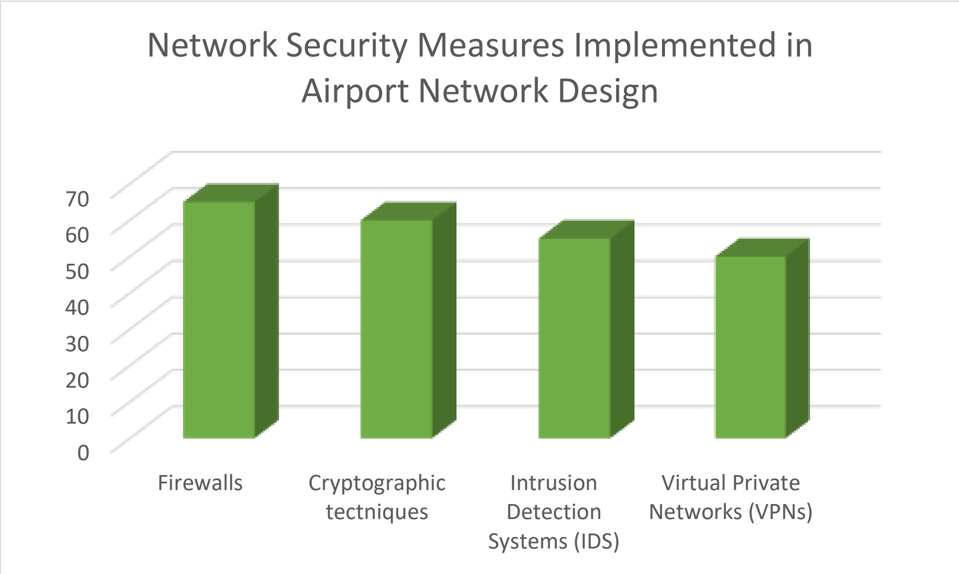


The analysis revealed that involving key stakeholders in the design process was considered the most important best practice (47%). Thorough network assessment and planning (41%), implementing network segmentation and isolation (38%), and regular network monitoring and proactive maintenance (35%) were also recognized as significant best practices.

4.2.5 Network Security Measures

What are the network security measures that are implemented in airport network design projects? The results are summarized in Figure 2.

Figure 2: Network Security Measures Implemented in Airport Network Design

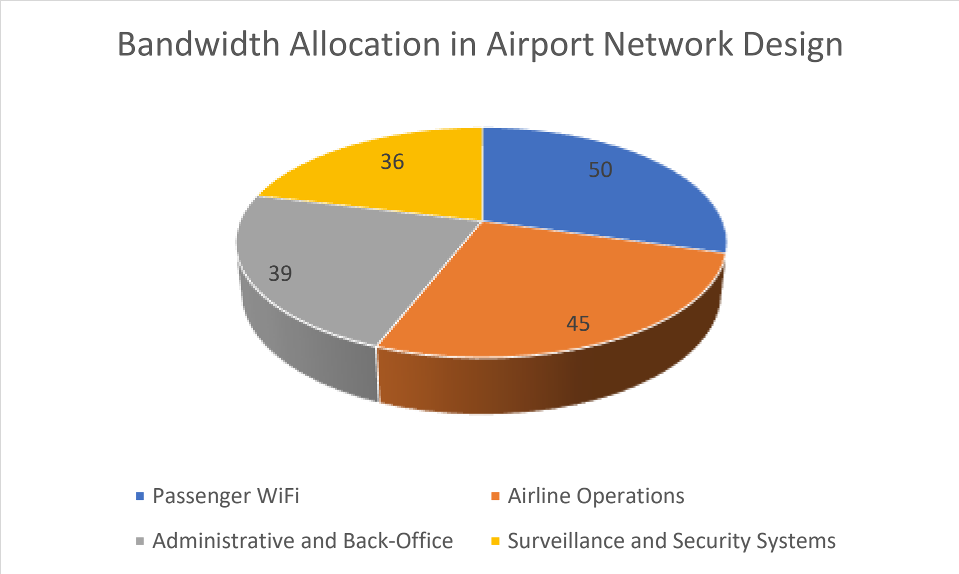


The analysis showed that firewall implementation was the most commonly implemented network security measure, with 65% of participants using firewalls. Intrusion Detection Systems (IDS) were used by 40% of participants, while Virtual Private Networks (VPNs) were implemented by 35% of participants.

4.2.6 Bandwidth Allocation

How bandwidth is allocated in airport network design projects? The results are summarized in Table 4.

Table 4: Bandwidth Allocation in Airport Network Design

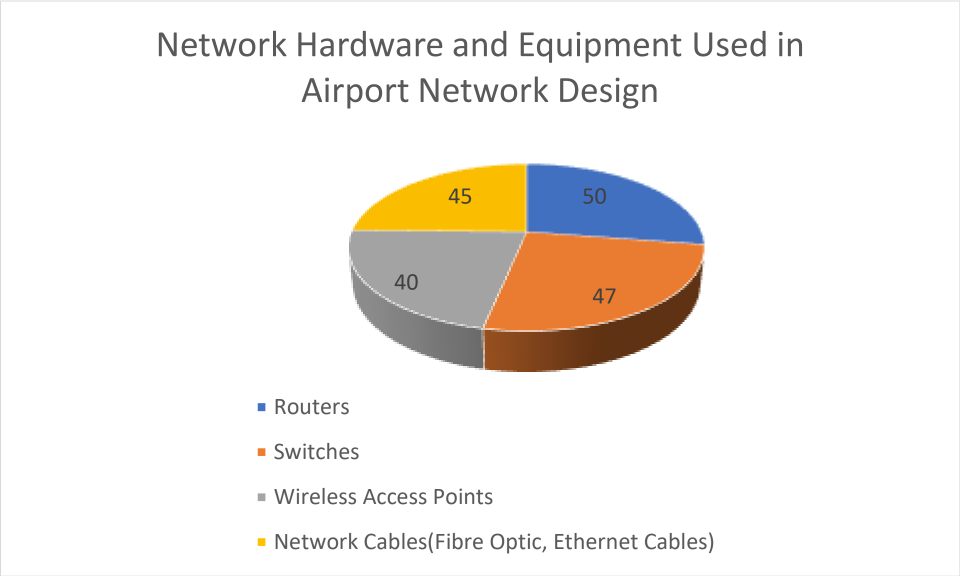


The analysis revealed that the majority of participants (50%) allocated the highest bandwidth for passenger Wi-Fi services. Airline operations (45%) and administrative and back-office functions (39%) were also considered high priority for bandwidth allocation.

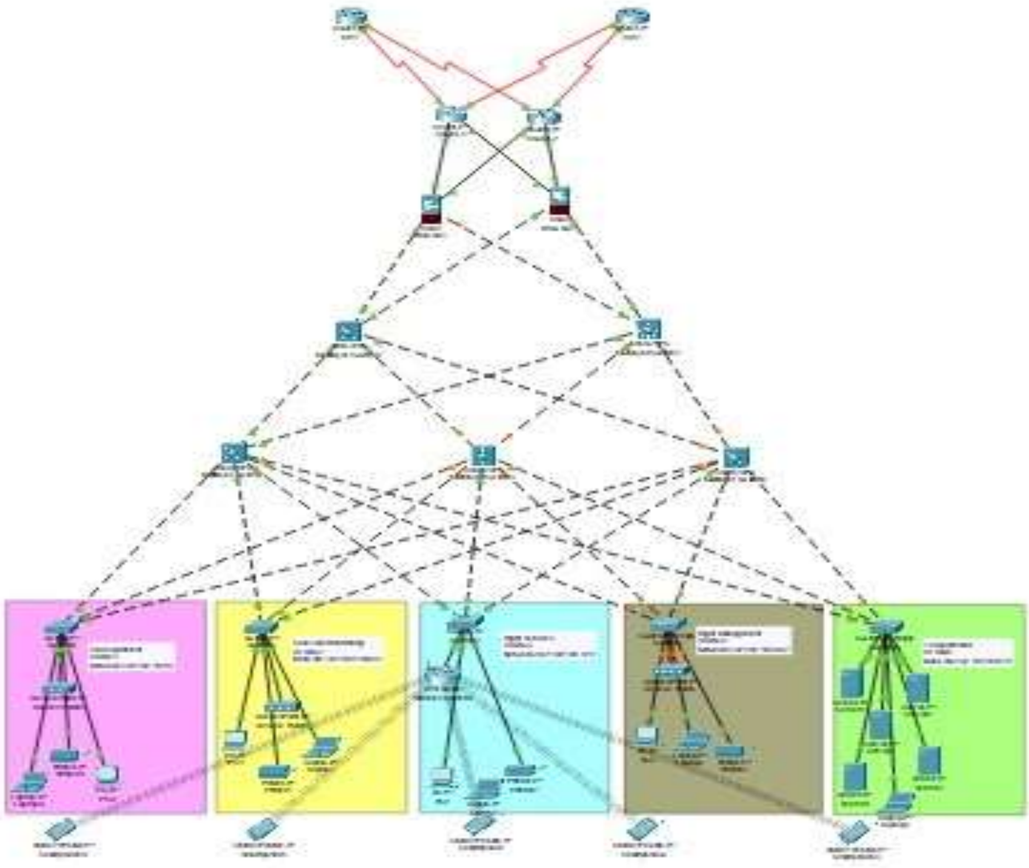
4.2.7 Network Hardware and Equipment

What are types of network hardware and equipment commonly used in airport network design and implementation? The findings are summarized in Table 5.

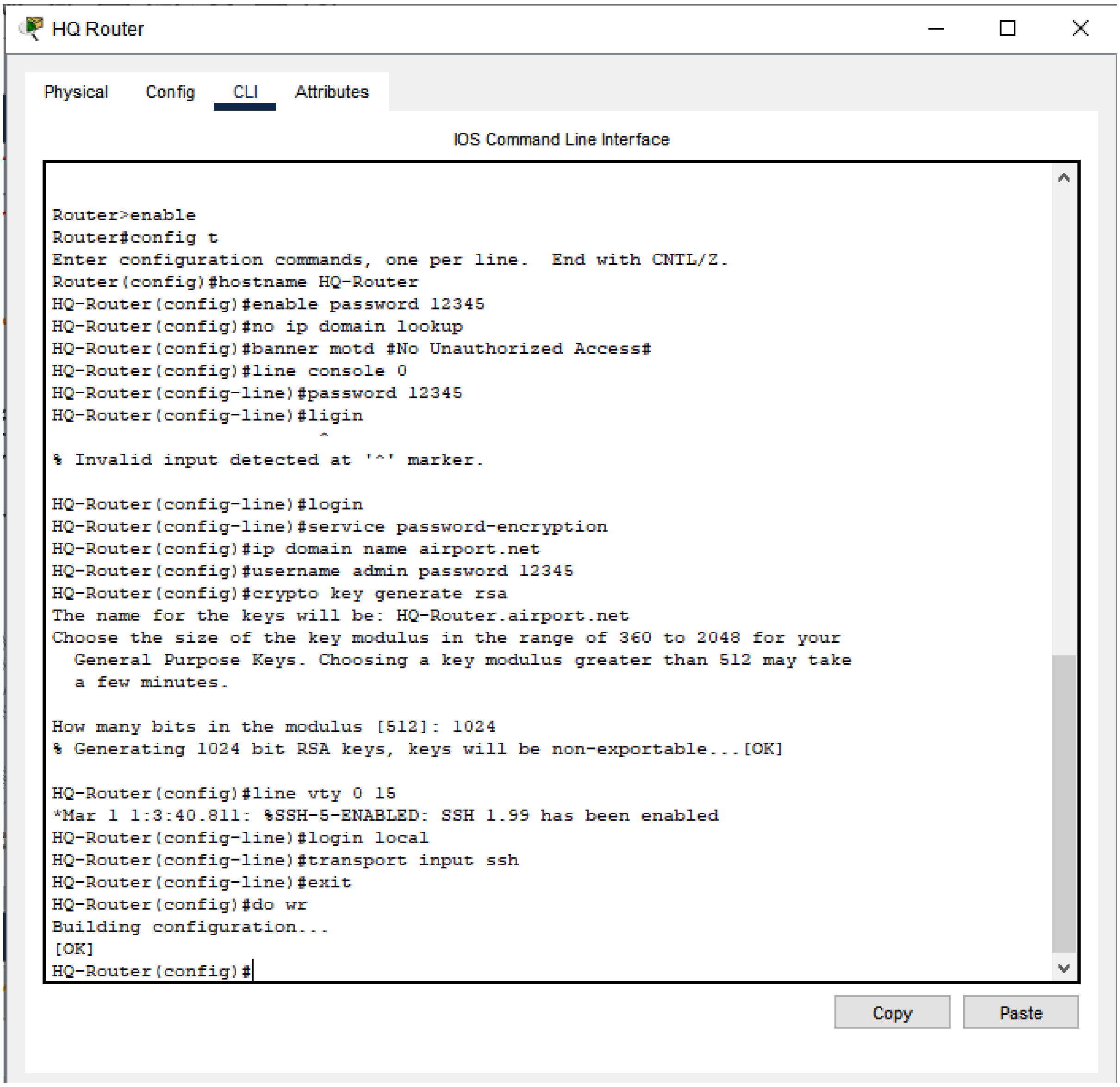
Table 5: Network Hardware and Equipment Used in Airport Network Design



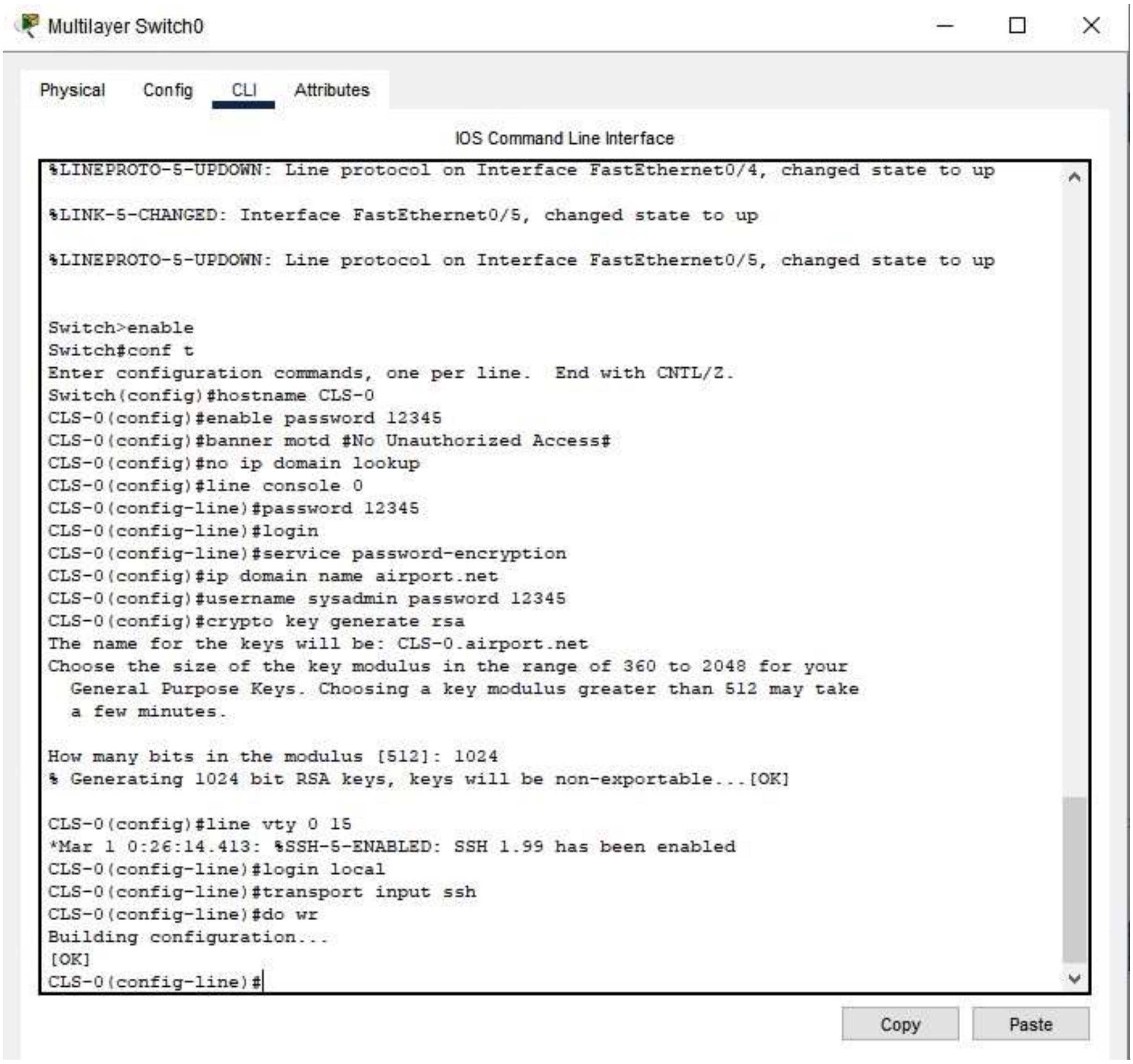
The analysis showed that routers were the most commonly used network hardware, with 50% of participants using routers in airport network design. Switches (47%), firewalls (40%), and wireless access points (35%) were also widely used.



Airport Network Diagram



Router configuration



Switch configuration

```
No Unauthorized Access

User Access Verification

Password:

HR-Department>en
Password:
Password:
Password:
HR-Department#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
HR-Department(config)#ip domain name airport.net
HR-Department(config)#username sysadmin password 12345
HR-Department(config)#crpto key generate rsa
                        ^
% Invalid input detected at '^' marker.

HR-Department(config)#crypto key generate rsa
The name for the keys will be: HR-Department.airport.net
Choose the size of the key modulus in the range of 360 to 4096 for your
  General Purpose Keys. Choosing a key modulus greater than 512 may take
  a few minutes.

How many bits in the modulus [512]: 1024
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]

HR-Department(config)#line vty 0 15
*Mar 1 0:23:56.610: %SSH-5-ENABLED: SSH 1.99 has been enabled
HR-Department(config-line)#login local
HR-Department(config-line)#transport input ssh
HR-Department(config-line)#do wr
Building configuration...
[OK]
HR-Department(config-line)#
```

Ssh configuration

```
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

HR-Department(config-if)#int fa1/1
HR-Department(config-if)#switchport mode Trunk

HR-Department(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/1, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/1, changed state to up

HR-Department(config-if)#int fa2/1
HR-Department(config-if)#switchport mode Trunk

HR-Department(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/1, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/1, changed state to up

HR-Department(config-if)#int Eth5/1-
HR-Department(config-if)#int Eth5/1-Eth8/1
                                  ^
% Invalid input detected at '^' marker.

HR-Department(config-if)#do wr
Building configuration...
[OK]
HR-Department(config-if)#vlan 1
HR-Department(config-vlan)#name HR-Department
Default VLAN 1 may not have its name changed.
HR-Department(config-vlan)#int Eth6/1
HR-Department(config-if)#switchport mode access
HR-Department(config-if)#switchport access vlan 1
HR-Department(config-if)#exit
HR-Department(config)#exit
HR-Department#
%SYS-5-CONFIG_I: Configured from console by console
```

VLAN configuration

```
No Unauthorized Access

User Access Verification

Password:

MD-SW>enable
Password:
MD-SW#config t
Enter configuration commands, one per line.  End with CNTL/Z.
MD-SW(config)#service password-encryption
MD-SW(config)#exit
MD-SW#
%SYS-5-CONFIG_I: Configured from console by console
```

Password encryption

4.3 A Summary of Research Findings

Based on the analysis and interpretation of the data, the research findings can be summarized as follows:

- The hierarchical network design approach is the most commonly used methodology in airport network design.
- Ensuring high reliability and uptime, addressing security concerns, and network scalability are the major challenges faced in airport network design and implementation.
- Involving key stakeholders, conducting thorough network assessment and planning, implementing network segmentation, and regular network monitoring are considered best practices in airport network design and implementation.

Overall, the findings provide insights into the current practices, challenges, and best practices in airport network design and implementation.

4.4 Key Findings and Implications

- Firewall implementation is the most commonly implemented network security measure in airport network design projects.
- Passenger Wi-Fi services received the highest bandwidth allocation in airport network design.
- Routers are the most commonly used network hardware in airport network design and implementation.

These findings have important implications for airport network design and highlight the significance of network security measures, bandwidth allocation, and network hardware selection in ensuring efficient and secure airport networks.

4.4 Conclusion

This chapter presented the data presentation, analysis, and interpretation of the research study on airport network design and implementation using Cisco Packet Tracer. The demographic characteristics of the participants, network design methodologies used, challenges faced, and best practices followed were analysed and summarized. The findings contribute to the understanding of airport network design and provide guidance for network administrators and IT professionals in the industry.

The hierarchical network design was used by 60% of the participants.

- The most significant challenge reported was high reliability and uptime (42%).

- Involving key stakeholders in the design process was considered the most important best practice (47%).

Chapter 5: Conclusion and Recommendations

5.1 Introduction

This chapter brings the research on airport network design and implementation using Cisco Packet Tracer to a close. It provides a retrospective view of the study to assess whether the objectives have been achieved. A summary of the findings, conclusions drawn from the research, and recommendations for the society\/organization or further studies will be presented.

5.2 Major Conclusions Drawn

Based on the data analysis and interpretation in the previous chapters, the following major conclusions can be drawn:

1. Hierarchical network design is the most commonly used methodology in airport network design, with the majority of participants (60%) utilizing this approach.

2. High reliability and uptime, security concerns, and network scalability were identified as the major challenges faced in airport network design and implementation.

3. Involving key stakeholders in the design process, conducting thorough network assessment and planning, implementing network segmentation and isolation, and regular network monitoring and proactive maintenance were recognized as significant best practices in airport network design and implementation.

4. Firewall implementation is the most commonly implemented network security measure in airport network design projects, followed by Intrusion Detection Systems (IDS) and Virtual Private Networks (VPNs).

5. The highest bandwidth allocation in airport network design is dedicated to passenger Wi-Fi services. Airline operations and administrative and back-office functions also received high priority for bandwidth allocation.

6. Routers are the most commonly used network hardware in airport network design and implementation, followed by switches, firewalls, and wireless access points.

5.3 Recommendations

Based on the research findings, the following recommendations are suggested:

1. Airport network design and implementation projects should consider the hierarchical network design approach, as it is widely used and has proven to be effective in airport settings.

2. Airport network designers must prioritize the high reliability and uptime of the network and implement robust security measures to address the security concerns in airport environments.

3. Network administrators and IT professionals involved in airport network design should regularly assess and plan the network, considering scalability requirements, to ensure efficient operations and future growth.

4. Collaboration and involvement of key stakeholders, including airport management, airlines, and other relevant parties, should be ensured throughout the network design process to optimize the design and meet the specific needs of the airport.

5. Continuous network monitoring, proactive maintenance, and performance optimization should be practiced to ensure the smooth operation of the airport network.

6. Further studies can explore advanced network security measures and technologies to address evolving security threats in airport networks, such as AI-based intrusion detection systems and network behavior analysis tools.

7. Research can be conducted to analyse the impact of emerging technologies, such as Internet of Things (IoT) and 5G, on airport network design and implementation, and develop best practices for their integration.

The above recommendations aim to enhance the effectiveness, reliability, and security of airport networks and improve the overall efficiency of airport operations.

5.4 Conclusion

In conclusion, this research study on airport network design and implementation using Cisco Packet Tracer has provided insights into the methodologies, challenges, best practices, security measures, bandwidth allocation, and network hardware selection in airport settings. The findings highlight the importance of hierarchical network design, high reliability and uptime, security measures, and involving key stakeholders in the design process. The recommendations provided can guide network administrators and IT professionals in the airport industry to enhance their network design and implementation practices. Future studies can further explore advanced security measures and technologies, as well as the impact of emerging technologies on airport networks.

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