BS3204: DISTRIBUTED SYSTEM

IMPROVEMENT PLAN

Figure 1:Troubleshooting illustration(Signa Tech, 2024)

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Introduction

This report contains an improvement strategy aimed at tackling connectivity, scalability, and performance challenges in a business network. It describes network upgrades such as the use of VLANs, backup routers, and centralised logs. The plan also focusses on sustainable IT practices to improve scalability, security, and environmental responsibility, which aligns with UN SDG 12.

Analysis of Case Study

The case study centres on a developing business with two locations that are dealing with problems like slow internet speeds, network congestion, and server accessibility issues. To improve communication, system dependability, and operational efficiency, the company needs better data protection, network scalability, and secure remote access.

Business Requirements

ID	Name	Description
1	Internet Speed Improvement	Enhance the corporate and regional offices' Internet access speeds, especially in the mornings and during busy periods when internal broadcasts cause a lot of network traffic.
2	Network Scalability	Create a scalable network design to handle future expansion, such as adding more terminals and users to the headquarters and regional offices.
3	Hq Web Server Accessibility	To guarantee constant availability for external clients, identify and fix irregular issues with Internet connectivity to the headquarters web server.
4	Network traffic management	Establish procedures in place to manage broadcast messages, improve bandwidth allocation, and reduce network congestion to optimise network traffic.
5	Data security and Backup	To stop breaches, illegal access, and the loss of business-critical data, strengthen data security by putting in place strong encryption, modern firewalls, and dependable backups.
6	Remote access and security	Give employees at both locations safe remote access options, making sure that private data is safeguarded by strong authentication, reliable encryption, and secure virtual private network connections.

Table 1: Business Requirement

Scalability problems, bandwidth conflict, and slower internet speeds during peak hours are caused by inadequate IP allocation and antiquated infrastructure. Operations are disrupted by intermittent web server failures and DNS resolution issues, which are probably caused by misconfigurations. Data breaches are more likely when communication security is inadequate. Upgrades to switches and routers, IP addressing optimisation, DNS administration enhancements, and the deployment of secure VPNs are examples of immediate fixes. By taking these steps, the business will be better positioned for future growth by improving scalability, security, and dependability (Abukari et al., 2024).

Improvement Design of the Case Study

Network Design

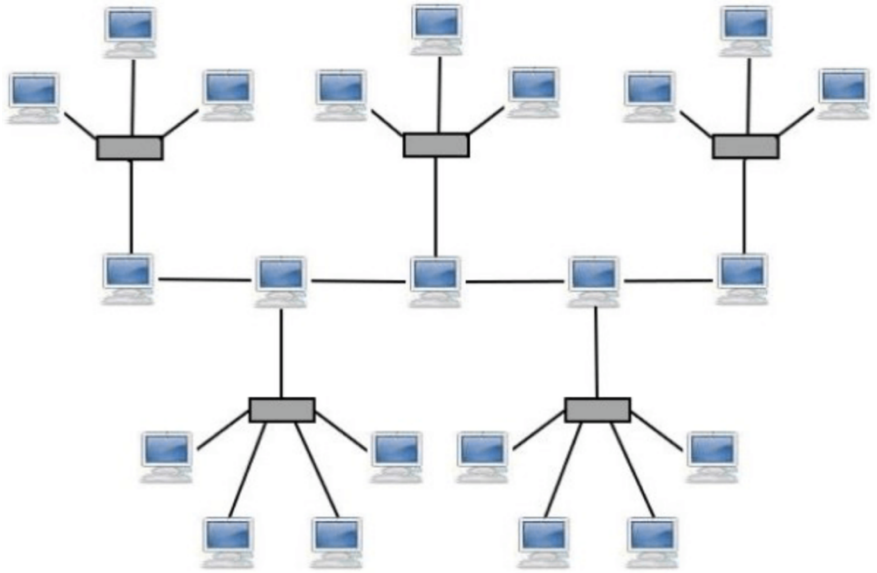

Figure 2: Diagram illustrating a hybrid network topology (Computer Hope, 2020).

A star-bus topology is used in the Cisco network diagram to provide scalability and dependability. Engineering, sales, administrative departmental switches and regional offices are connected via headquarters switches. The operational requirements of headquarters and regional offices are supported by this design, which provides effective communication, fault isolation, and redundancy via a central backbone (*Educational Wave Team*, 2024).

Topology Implementation

ID	Description of Change	Justification + Discussion
T.I 1	Added a backup router (ISR 4331) in HQ	Backup routers ensure high availability by taking over during primary router failures, minimising downtime and maintaining constant connectivity for enterprises.
T.I 2	Configured VLANs for Admin, Sales, and engineering departments	VLANs enhance security and performance by isolating traffic, reducing broadcast domains and enabling inter-VLAN routing via Layer 3 switches.
T.I 3	Added redundant links between key devices	Redundant lines between routers, ISPs, and switches prevent single points of failure, ensuring network availability, reliability, and backup routes during outages.
T.I 4	Configured EtherChannel for redundant links	EtherChannel improves bandwidth and redundancy by merging many physical links into a single logical link between access and Layer 3 switches (GeeksforGeeks, 2024).
T.I 5	Configured gateway redundancy using HSRP	High availability is achieved by implementing the Hot Standby Router Protocol (HSRP), which provides for automatic failover to a backup router when primary router isn't functioning, reducing network downtime and service disruption(GeeksforGeeks, 2024).

Table 2: Topology Implementations

The topology implementation ensures reliable communication, high availability, and redundancy among headquarters and regional offices. VLANs for security and performance, backup routers for fault tolerance, and redundant links for higher uptime are all included.

Logical configuration

Id	Changes	Justification + Discussion
L.C 1	Configured VLANs for Admin, Sales, and engineering departments	By dividing departmental traffic, VLANs improve security, decrease broadcast domains, boost performance, and facilitate seamless communication through Layer 3 inter-VLAN *routing (Basan, 2024).*
L.C 2	Implemented DHCP relay on Layer 3 switches	Devices in every VLAN can obtain IP addresses from the central server thanks to the DHCP relay configuration, which guarantees reliable and effective administration.
L.C 3	Configured static routes for leased line connectivity	Static routes improve connectivity between headquarters and regional offices by ensuring proper traffic routing across various networks.
L.C 4	Enabled inter-VLAN routing on Layer 3 switches	Layer 3 switches with inter-VLAN routing allow devices in various VLANs to communicate with one another while preserving logical traffic separation between offices.
L.C 5	Configured Syslog for centralized logging	Network security is *improved,* and real-time monitoring and problem identification are facilitated by centralised logging using a Syslog server (EITCA, 2024).

Table 3: Logical Configurations

Logical setups improve network performance by assuring secure traffic flow and efficient IP management. These include VLANs for traffic separation, DHCP relays for centralised IP distribution, inter-VLAN routing for smooth communication, and Syslog for centralised monitoring.

Distributed Services Implementation

Id	Changes	Justifications + Discussions
D.S 1	Implemented web-based paperless communication	Reduces inter-office delays and physical waste by using a digital communication system based on email and online services, improving collaboration and promoting sustainability goals such as UN SDG 12.
D.S 2	Set up DNS for hostname resolution	Provides effective hostname resolution, ensuring that devices within the network can rapidly and reliably convert domain names to IP addresses. This is crucial for seamless internal and external communication.
D.S 3	Configured centralized Syslog server	Aggregates logs from all network devices in a single location, allowing for real-time network monitoring, centralised logging, and speedier troubleshooting, hence boosting overall network security and operational efficiency.
D.S 4	Installed and configured a web server	Allows for web-based apps and internal communication, while also supporting operational needs and paperless operations. Ensures the availability of critical services and applications throughout the organisation.
D.S 5	Enabled paperless communication between HQ and Regional Office	Implementing a single web-based communication system ensures effective, paperless communication between headquarters and regional offices, hence improving collaboration.

Table 4: Distributed Services Implementations

Distributed services enable efficient hostname resolution, improved logging, and streamlined communication. DNS configuration, Syslog for centralised monitoring, web-based communication, and paperless collaboration are among the key modifications made to support corporate operations and sustainability.

VLAN configuration for Office Networks

Name	Network Address	Host Range
Admin	192.168.10.0	192.168.10.1 – 192.168.10.254
Sales	192.168.20.0	192.168.20.1 – 192.168.20.254
Engineering	192.168.30.0	192.168.30.1 – 192.168.30.254
Regional Admin	192.168.40.0	192.168.40.1 – 192.168.40.254
Regional Sales	192.168.50.0	192.168.50.1 – 192.168.50.254
Regional Engineering	192.168.60.0	192.168.60.1 – 192.168.60.254

Table 5: Vlan Configurations for Office Networks

VLAN segmentation improves security, performance, and communication by isolating departmental traffic for Admin, Sales, and Engineering, reducing broadcast domains and enhancing efficiency. Office networks are divided into subnets (e.g., Admin: 192.168.10.0/24), while regional VLANs (e.g., Regional Sales: 192.168.50.0/24) ensure effective traffic segregation, scalable communication, and simplified network management across locations.

Network Architecture Upgrade for Business Expansion

The Cisco Packet Tracer network was enhanced to decrease communication bottlenecks and increase scalability and dependability. While VLANs improve security and performance, a star-bus topology links departments and regional offices. IP allocation is managed via DHCP relays, and failures are avoided, and uptime is guaranteed by backup routers with redundant lines.

Web servers and DNS improve communication, and paperless systems cut down on delays. Proactive monitoring is made possible via centralised Syslog logging. These enhancements assist corporate expansion and UN SDG 12 by establishing a scalable, dependable, and sustainable network.

Reflection

This reflection is structured using Gibbs' Reflective Cycle (Gibbs, 1988).

Description
The enhanced network guarantees performance, scalability, and dependability thanks to its hierarchical models and VLAN segmentation. Security is improved and broadcast domains are decreased with VLANs and star-bus topology. The use of backup routers and redundant connections addressed fault tolerance. Paper-based systems were replaced by cloud alternatives, which aided UN SDG 12. Service continuity and dependability are guaranteed via centralised monitoring with Syslog support.

Feelings
The design process was challenging, but it was also enjoyable. The application of theoretical concepts was interesting, but there were unexpected difficulties resolving one problem, like VLANs, which frequently resulted in small, preventable errors that caused other components, like routers, to malfunction. It was enjoyable to address the wider influence on sustainability regardless of the challenges. The importance of IT infrastructure in coordinating corporate objectives with social and environmental obligations was highlighted by observing how network optimisation and paperless communication might help achieve SDG12.

Evaluation
The improvements significantly lowered the network's technological limitations. VLANs reduced broadcast traffic and increased efficiency, while DHCP relay and static routing optimised resource allocation. Link aggregation was used to solve bandwidth problems and guarantee scalability for future expansion. Concerns over e-waste and energy usage were brought up by hardware improvements. Cloud communication decreased paper waste, but data centre environmental impact management presented a new difficulty.

Analysis
The enhancements focus attention on the conflict between environmental impact and technological performance. Backup routers and redundant links improved dependability, while VLANs guaranteed balanced IP management and traffic flow. To counteract the intricacy of subnetting and the dependence on energy-intensive cloud platforms, SDG12 targets must be achieved by environmentally friendly measures including the adoption of energy-efficient hardware and data centres powered by renewable energy.

Conclusion
The enhancements demonstrated the need to include sustainable practices in IT infrastructure while meeting performance, scalability, and reliability goals. Reducing environmental effects in addition to improving operations, with a focus on sustainable consumption, efficient technologies, and renewable energy, is necessary to meet SDG 12.

Action
Sustainability measures will be incorporated into future deployments to better line with SDG12. Cloud services powered by renewable energy sources and ENERGY STAR-certified energy-efficient hardware will lessen their impact on the environment (Hegab et al., 2023). Long-term sustainability will be guaranteed by e-waste recycling policies and resource-efficient improvements, all the while upholding high network infrastructure performance standards.

Planned Actions for Sustainable and Efficient IT Infrastructure

Id	Description of change	Justification and discussion
1	Cloud services that are fuelled by renewable energy.	By lowering the carbon footprint of IT operations, this measure contributes to UN SDG 12. Renewable energy-powered cloud services reduce the environmental effect of data centres, increasing the sustainability of IT infrastructure while guaranteeing good service availability and scalability (*Industry Trends*, 2024).
2	Adopt ENERGY STAR-certified hardware	Reducing overall energy usage through the use of energy-efficient technology directly advances sustainability objectives. By reducing energy consumption without sacrificing functionality, this strategy aids in striking a balance between environmental responsibility and network performance.
3	Implement e-waste recycling policies	IT equipment is managed responsibly for the environment when outdated gear is disposed away and recycled. This promotes a circular economy by sustainability principles, recovers valuable resources, and lessens landfill waste.
4	Optimize data centre cooling and energy management	Energy consumption in data centres is substantial. The environmental effect of IT operations can be further decreased by optimising energy efficiency through the use of sophisticated cooling systems and energy management procedures, such as temperature monitoring and precision cooling (Whitehead et al., 2014).
5	Regular sustainability audits for IT infrastructure	Frequent audits will assist in identifying areas for improvement and monitor the effectiveness of sustainability measures that have been put into place (Hoare, 2025). This guarantees that the company keeps its IT operations in line with sustainability objectives while preserving the network infrastructure's high performance and dependability.

Conclusion

The improvement plan efficiently enhances network performance, scalability, and reliability by using sophisticated settings such as VLANs, redundant lines, and secure VPNs. These enhancements address important operating issues and reduce delays. Furthermore, sustainable initiatives such as cloud services powered by renewable energy and energy-efficient hardware encourage long-term sustainability, ensuring the company's future readiness.

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