“Design and Implementation of a VoIP-Based IP Telephony Network for Service Provider “

Case study: -

This project focuses on designing and implementing a scalable, secure, and efficient VoIP (Voice over Internet Protocol) IP telephony network for **Etisalat Masr**, one of the leading telecommunications companies in Egypt. With the company's continuous growth and acquisition of new branches, a reliable and integrated communication system is essential. This project proposes a complete network infrastructure that supports voice and data services while ensuring high availability, security, and manageability.

The network includes three departments—Finance, HR, and ICT—interconnected with a robust infrastructure. Each department is equipped with VoIP-enabled routers (Cisco 2811) and access layer switches (Cisco 2960). PCs are connected through IP phones, with each phone acting as a bridge between the PC and the switch.

The voice traffic is isolated in **VLAN 100**, while data traffic is assigned separate VLANs per department. DHCP services are segmented: voice IPs are dynamically assigned by each router, and data IPs are assigned from a centralized DHCP server at the server-side site. Inter-VLAN communication is enabled through **router-on-a-stick** configuration.

OSPF is used as the dynamic routing protocol between departments, ensuring fast convergence and scalability. To facilitate remote management, **SSH** is enabled on all routers. VoIP dial plans are configured with distinct number ranges per department. The system also incorporates **dial peer** configurations to ensure seamless voice communication across departments.

Packet Tracer is used for network simulation, configuration, and testing to ensure all components function as expected. The final design guarantees secure, efficient,

and cost-effective internal communications for the newly integrated branch of Etisalat Masr.

Business Requirements: -

- Integration of a new branch with internal communication aligned with corporate infrastructure.
- Unified voice and data system with scalability and high availability.
- Centralized services (DNS, DHCP for data, Mail, Web) accessible to all users.
- Departmental separation for security, management, and performance.
- Secure remote access for network administrators.
- Support for future expansion without re-architecture.

Functional Requirements:

- Dynamic IP address allocation for voice and data networks.
- Inter-VLAN routing between departments.
- VoIP services with internal dialing per department.
- Secure router access via SSH.
- Centralized DHCP, DNS, Email, and Web services.
- OSPF dynamic routing across routers.

Non-Functional Requirements:

- High network availability.

- Scalable design for future growth.
- User-friendly dialing scheme.
- Secure configuration with encrypted passwords.
- Minimal latency in VoIP communication.

LAN Requirements:

- Each department (Finance, HR, ICT) has a Cisco 2960 access switch.
- Each PC connects to an IP phone, which then connects to the switch.
- VLANs:
  - VLAN 100: Voice (All IP Phones)
  - VLAN 10X: Data (X based on department: 101 for HR, 102 for Finance, etc.)

WAN Requirements:

- Routers are interconnected via serial connections using the 10.10.10.0/24 network.
- Use of Cisco 2811 routers with VoIP and DHCP enabled.
- OSPF is used for WAN routing.
- VPN setup is optional for external branch connections.

Technical Requirements

IP Addressing:

- Data: 192.168.100.0/24

- Voice: 172.16.100.0/24
- Router-Router: 10.10.10.0/24

Devices:

- Routers: Cisco 2811
- Switches: Cisco 2960
- IP Phones: Cisco 7960 or equivalent

Protocols:

- OSPF for dynamic routing
- SSH for secure access
- DHCP for dynamic IP
- DNS, Email, HTTP for server functionality

Services:

- VoIP and Dial-Peering
- VLAN tagging and sub-interfaces
- Remote management
- Banner messages and password encryption

In Scope:

- Design and implementation of a LAN/WAN infrastructure.
- VoIP integration with internal dial plans.
- Subnetting and IP planning.
- VLAN creation and inter-VLAN routing.

- SSH and password security.
- DHCP configuration (central and distributed).
- Server integration (DNS, Email, Web).
- Full simulation and verification in Packet Tracer.

Design and Implementation

Network Design:

- Hierarchical model: Core (routers), Distribution (inter-VLAN), Access (switches).
- Each department connects to a departmental router with subinterfaces.
- VLANs are configured on switches and associated with specific ports.
- IP Phones are part of VLAN 100 and tagged accordingly.
- PCs receive untagged data VLAN connections.
- OSPF routing on routers using all active interfaces.
- SSH configured with usernames, encryption, and RSA keys.
- DHCP pool configuration:
    - Central DHCP server handles data VLAN scopes.
    - Routers handle voice VLAN scopes locally.

Dial Plan:

- Finance: 1XX (e.g., 101–199)
- HR: 2XX (e.g., 201–299)
- Sales: 3XX

- ICT: 4XX

Testing:

- All devices successfully obtain IP addresses dynamically.
- SSH login to routers tested.
- IP phones can call across departments.
- Access to central services (HTTP, DNS, Email) verified.
- VLAN separation tested with ping and trace.
- All OSPF routes verified with show ip route.

Conclusion

- The network infrastructure designed for Etisalat Misr's new branch successfully meets all the functional and technical requirements set by the IT management. This VoIP-enabled IP telephony system enhances interdepartmental communication, improves resource sharing, and supports scalability for future expansion.
- The implementation leverages Cisco best practices in VLAN management, dynamic routing (OSPF), and VoIP configuration, ensuring both high performance and security.
- This setup provides a robust platform for unified communication, aligns with the company's digital transformation goals, and significantly reduces operational costs by leveraging VoIP technology. The use of Packet Tracer in simulation and testing ensures reliability before real-world deployment.