Project Documentation Guidelines

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1 Project Planning & Management

1.1 Project Proposal: Overview, Objectives, and Scope

Overview: This project aims to design and configure a network infrastructure using Cisco devices. The goal is to implement internal and external networks using Cisco routers and switches. The project involves configuring 10 routers, 2 switches, and integrating multiple routing protocols (OSPF, EIGRP, BGP) for inter-router communication. The primary objective is to set up a network that uses multiple routing protocols and secure configurations.

Objectives:

- Design a network using Cisco routers and switches (10 routers, 2 switches).
- Configure and implement OSPF, EIGRP, and BGP to establish communication between routers.
- Implement secure network practices such as password encryption and configuration security.
- Ensure communication between routers using different protocols via BGP.

Scope:

- Installation and configuration of network devices using GNS3.
- Configuration of routers with OSPF and EIGRP protocols.
- Integration of BGP for inter-protocol communication.
- Final report and presentation to demonstrate the project's outcome.

1.2 Project Plan: Timeline, Deliverables, and Resource Allocation

Timeline: The project involves tasks spread across several weeks, including network design and installation (Week 1), OSPF configuration (Week 2), EIGRP configuration (Week 3), BGP configuration and integration (Week 4), and ongoing testing and final documentation throughout, as shown by the Gantt Chart below **(Figure 1)**.

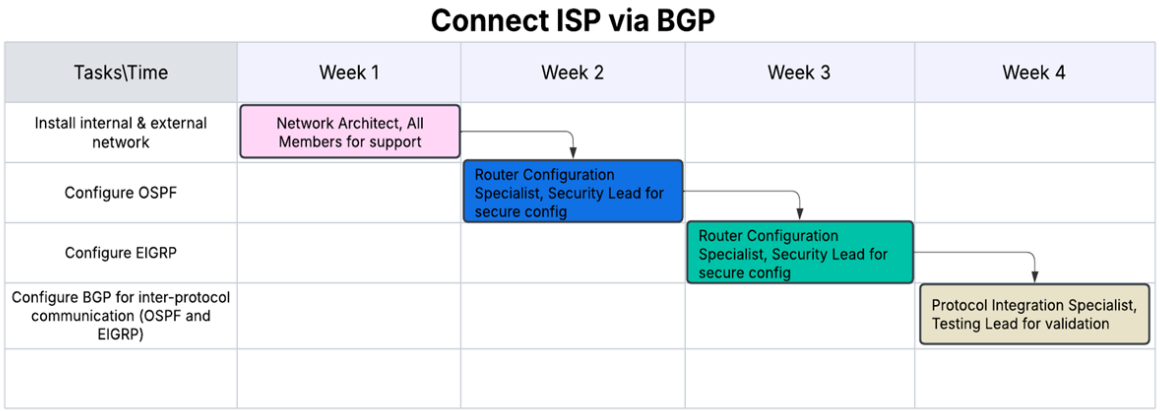

Figure 1: Gantt Chart of Timeline

Resource Allocation:

- **Tools:** GNS3
- **Hardware/Software Requirements:** 10 Cisco routers, 2 switches, simulation-capable computer

1.3 Task Assignment & Roles

Saif ElDeen Samir (Network Architect):
- Week 1: Design network topology (10 routers, 2 switches)
- Week 4: Oversee BGP configuration
- **Deliverables:** Network design document, BGP configuration overview

Ibrahim Zayed (Router Configuration Specialist):
- Week 2: Configure OSPF on routers R1–R5 (Areas 0, 1, 2)

- Week 3: Configure EIGRP on routers R6–R10
- **Deliverables:** OSPF/EIGRP configurations, CLI scripts

Abdelrahman Sobhy (Security & Configuration Lead):
- Weeks 2–3: Configure password encryption, VTY access passwords
- **Deliverables:** Secure access policies

Hanna Mostafa (Protocol Integration Specialist):
- Week 4: Configure BGP and integrate OSPF/EIGRP via ISP
- **Deliverables:** BGP configuration, troubleshooting report

Salma Amin (Testing & Documentation Lead):
- Throughout project: Testing and validation
- Final week: Final report and presentation slides
- **Deliverables:** Test reports, documentation

1.4 Risk Assessment & Mitigation Plan

Risk	Mitigation
Configuration errors leading to downtime	Frequent testing and validation after each configuration.
Incompatibility between protocols (OSPF, EIGRP)	Use detailed configuration guide to ensure compatibility.
Network misconfigurations in ISP section	Run simulations first and document every change.
Time overruns in configuration setup	Keep buffer times in the schedule for troubleshooting.
Incorrect BGP integration	Frequent testing of BGP configuration post-setup.

KPIs:

- Response Time: Ping response for each router
- System Uptime: Network availability percentage
- User Adoption Rate: Count of successful configurations per member

2 Literature Review

Feedback & Evaluation: Seek feedback after each protocol configuration to guide adjustments.

Suggested Improvements:

- Explore ACLs and VPNs for advanced security.
- Implement QoS policies for traffic management.
- Utilize OSPF route summarization and EIGRP redistribution.

Grading Criteria:

- Documentation (40%)
- Implementation (30%)
- Testing (20%)
- Presentation (10%)

3 Requirements Gathering

3.1 Stakeholder Analysis

- Internal Team: Collaborates on configurations and testing
- Lecturer: Requires progress reports and presentation
- End Users: Require secure, reliable network communication between protocols

3.2 User Stories & Use Cases

1. As a network administrator, I need to configure OSPF on routers for efficient routing.
2. As a network engineer, I need to integrate BGP between protocols for inter-network communication.

3.3 Functional Requirements

- OSPF configuration for three areas: 0 (Backbone), 1 (Stubby), and 2 (Totally Stubby).
- EIGRP configuration with Autonomous System 1 (Branch 1).
- BGP configuration to allow communnication between OSPF and EIGRP
- Secure configurations practices (`enable secret`, VTY password encryption).

3.4 Non-functional Requirements

- Performance: Ensure that routing protocols are capable of high-volume traffic handling.
- Security: Encrypt passwords and secure VTY access.
- Reliability: Ensure routers and switches remain operational 99.9% of the time.

4 System Analysis & Design

4.1 Problem Statement & Objectives

Problem Statement & Objectives The core problem addressed is configuring multiple routing protocols (OSPF, EIGRP, BGP) across a network with diverse requirements, aiming for secure, reliable, and efficient device communication.

4.2 Software Architecture

The architecture is hybrid, combining OSPF, EIGRP, and BGP. Routers connect using different protocols, with BGP acting as the intermediary for inter-protocol communication.

4.3 Deployment System & Integration

Technology Stack:

- **Router Configuration:** Cisco C2961; used for all routing functions (OSPF, EIGRP, BGP)
- **Multilayer Switches:** Cisco C3725; handles VLAN routing, DHCP relays, and trunking
- **Access Switches:** IOU L2 access switches; configured with trunk/access modes per departmet
- **DHCP Servers:** MikroTik RouterOS; deployed separately in Branch 1 and Branch 2 for VLAN-based IP allocation.
- **Tools:** GNS3 for configuration and simulation. RouterOS CLI was used to manage DHCP services.
- **Security:**Password encryption, access control lists (ACLs), and secure management.

Deployment Diagram: Referring to **Figure 2**, the topology includes multilayer switches utilizing BGP. It features Branch 1 associated with EIGRP (AS 65000) and Branch 2 associated with OSPF (AS 65001). The OSPF domain is structured into Backbone Area 0, Stubby Area 1, and Totally Stubby Area 2. The diagram also lists departments (IT, HR, Accounting, Sales, CS) for both Branch 1 and Branch 2, and demonstrates the presence of MikroTik DHCP servers 1 and 2. The deployment shows how routers are distributed across different subnets, with BGP acting as an intermediary for protocol communication.

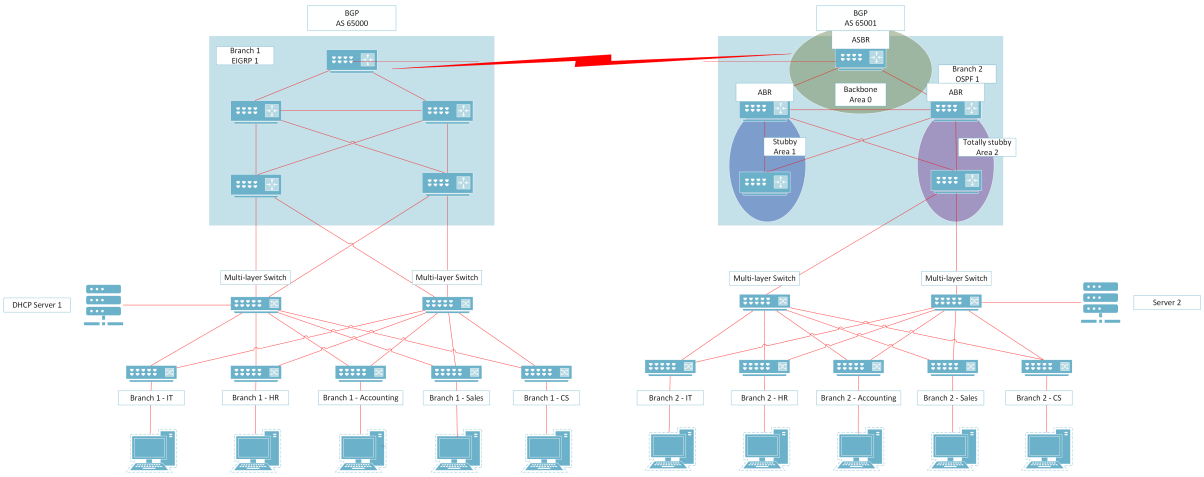

Figure 2: Deployment Diagram

Additional Deliverables:

- **Testing & Validation**
  - **Unit Tests:** Check individual configurations for OSPF, EIGRP, BGP.
  - **Integration Tests:** Ensure all routers communicate effectively between the two protocols.
  - **User Acceptance Testing:** : Test end-to-end communication after protocol configuration.
- **Deployment Strategy:** The network will be deployed using GNS3 for simulation, with potential future deployment on actual hardware.

5 Implementation (Source Code & Execution)

- **Source Code**: The implementation phase involves generating configuration scripts (source codes) for the Cisco routers and switches, and MikroTik DHCP server.
- **Version Control & Collaboration:** The entirety of the project is managed in a GitHub repository
  `https://github.com/Saif-samir/Depi-Project`
- **Deployment & Execution:** A `README.md` file is included in the repository, detailing installation steps, system requirements, configuration instructions, and an execution guide

6 Testing & Quality Assurance

6.1 Test Plan & Test Cases

6.2 Bug Reports

During the testing phase, two major bugs were encountered and resolved as follows:

Bug 1: No Connectivity Between Branch 1 and Branch 2

- **Symptoms:** Ping failed between hosts across branches; routes to remote networks were missing.
- **Root Cause:** BGP routes were not being redistributed into EIGRP (Branch 1) or OSPF (Branch 2).
- **Resolution:**
  - On R7:

    ```
    redistribute ospf 1
    ```
  - On R7 under OSPF:

    ```
    redistribute bgp 65001 subnets
    ```
  - On R5:

    ```
    redistribute ospf 1
    ```
  - On R5 under EIGRP:

    ```
    redistribute bgp 65000 subnets
    ```
  - This ensured that internal protocols learned external routes from BGP and vice versa.
- **Status:** Resolved.

Bug 2: No Multilayer Switch in GNS3

- **Symptoms:** Could not implement inter-VLAN routing in GNS3 due to missing L3 switch models.
- **Root Cause:** GNS3 does not natively support Catalyst multi-layer switches.
- **Resolution:**
  - Used Cisco C3725 routers.
  - Configured subinterfaces and trunk ports to simulate layer 2 switching and layer 3 routing.

    ```
    -- VLANs defined via:
    interface vlan X

    -- Trunks configured with:
    switchport trunk encapsulation dot1q
    ```
- **Status:** Resolved.

7 Technical Documentation

7.1 System Architecture

The network is built around a hybrid routing architecture, divided into two main branches (Branch 1 and Branch 2), interconnected by BGP, with each branch using an interior routing protocol (EIGRP in Branch 1, OSPF in Branch 2). VLAN segmentation and DHCP services are provided locally at each branch.

Branch 1 (EIGRP + BGP AS 65000)

- **Core Router (R2):**
  - `Serial0/0: 192.168.1.1/24` — BGP peer to Branch 2 R7 (192.168.1.2, AS 65001)

```
router bgp 65000
  no synchronization
  bgp log-neighbor-changes
  neighbor 192.168.1.2 remote-as 65001
```

- **Routers R1, R3, R4, R5:**

```
-- Uplink to the multi-layer switches:
f0/0: 10.0.0.28/30
f0/1: 10.0.0.32/30

router eigrp 1
  network 10.0.0.28 0.0.0.3
  network 10.0.0.32 0.0.0.3
```

- **Multilayer Switch DS1:**
  - Connected to MikroTik-1 DHCP server
  - VLANs: 10 (IT), 20 (HR), 30 (Accounting), 40 (Sales), 50 (Customer Service), 100 (DHCP Server)
  - SVIs with `ip helper-address 192.168.100.100`
  - Trunk to R5 on `f1/5`; trunks to access switches on `f1/0-4`
- **Multilayer Switch DS2:**
  - `f0/0 → 10.0.0.42/30; f0/1 → 10.0.0.38/30`
  - EIGRP networks: `10.0.0.40/30` and `10.0.0.36/30`

Branch 2 (OSPF + BGP)

- **Router R7:**

```
s0/0 → 192.168.1.2/24, BGP peer to Branch 1 R2 (192.168.1.1, AS 65000)

router bgp 65001
  no synchronization
  bgp log-neighbor-changes
  redistribute ospf 1
  neighbor 192.168.1.1 remote-as 65000
```

- **OSPF Domains:**
  - Area 0 (Backbone): R7 <–> R8/R9
  - Area 1 (Stubby): on R8 toward its stub-area router, R6

    `area 1 stub`
  - Area 2 (Totally Stubby): on R9 toward the totally-stub router, R10

    `area 2 stub no-summary`
  - Redistribution on R7:

    `redistribute bgp 65001 subnets`
- **ABRs R8 & R9:**
  - `router-id 11.11.11.11 (R8)`, `12.12.12.12 (R9)`
  - `network 10.1.0.X 0.0.0.3 area 2` and all VLAN subnets in Area 2
  - Passive-interface on VLAN SVIs
- **Multilayer Switches in Branch 2:**
  - Mirror Branch 1's VLAN/trunk design
  - `Fa0/0 uplinks: 10.1.0.30/30, 10.1.0.34/30`

Access Switches (All Departments)

```
int range e0/0-1
  duplex full
  switchport trunk encapsulation dot1q
  switchport mode trunk
  switchport trunk allowed vlan 50
  no shutdown

int range e0/2-3, e1/0-3, e2/0-3, e3/0-3
  switchport mode access
  switchport access vlan 50
  spanning-tree portfast
  no shutdown
```

7.2 DHCP Server Configuration

Branch 1 MikroTik DHCP Server

```
/interface vlan
  add name=IT vlan-id=10 interface=ether1
  add name=HR vlan-id=20 interface=ether1
  add name=Accounting vlan-id=30 interface=ether1
  add name=Sales vlan-id=40 interface=ether1
  add name=CS vlan-id=50 interface=ether1
  add name=DHCP vlan-id=100 interface=ether1

/ip address
  add address=192.168.10.100/24 interface=IT
  add address=192.168.20.100/24 interface=HR
```

```
  add address=192.168.30.100/24 interface=Accounting
  add address=192.168.40.100/24 interface=Sales
  add address=192.168.50.100/24 interface=CS
  add address=192.168.100.100/24 interface=DHCP

/ip pool
  add name=IT_POOL ranges=192.168.10.2-192.168.10.254
  add name=HR_POOL ranges=192.168.20.2-192.168.20.254
  add name=Accounting_POOL ranges=192.168.30.2-192.168.30.254
  add name=Sales_POOL ranges=192.168.40.2-192.168.40.254
  add name=CS_POOL ranges=192.168.50.2-192.168.50.254

/ip dhcp-server network
  add address=192.168.10.0/24 gateway=192.168.10.1 dns-server=8.8.8.8
  add address=192.168.20.0/24 gateway=192.168.20.1 dns-server=8.8.8.8
  add address=192.168.30.0/24 gateway=192.168.30.1 dns-server=8.8.8.8
  add address=192.168.40.0/24 gateway=192.168.40.1 dns-server=8.8.8.8
  add address=192.168.50.0/24 gateway=192.168.50.1 dns-server=8.8.8.8

/ip dhcp-server
  add interface=IT name=IT_DHCP disabled=no
  add interface=HR name=HR_DHCP disabled=no
  add interface=Accounting name=Accounting_DHCP disabled=no
  add interface=Sales name=Sales_DHCP disabled=no
  add interface=CS name=CS_DHCP disabled=no
```

Branch 2 MikroTik DHCP Server

```
/ip address
  add address=192.168.15.100/24 interface=IT
  add address=192.168.25.100/24 interface=HR
  add address=192.168.35.100/24 interface=Accounting
  add address=192.168.45.100/24 interface=Sales
  add address=192.168.55.100/24 interface=CS
  add address=192.168.105.100/24 interface=DHCP

/ip pool
  add name=IT_POOL ranges=192.168.15.2-192.168.15.254
  add name=HR_POOL ranges=192.168.25.2-192.168.25.254
  add name=Accounting_POOL ranges=192.168.35.2-192.168.35.254
  add name=Sales_POOL ranges=192.168.45.2-192.168.45.254
  add name=CS_POOL ranges=192.168.55.2-192.168.55.254

/ip dhcp-server network
  add address=192.168.15.0/24 gateway=192.168.15.1
  add address=192.168.25.0/24 gateway=192.168.25.1
  add address=192.168.35.0/24 gateway=192.168.35.1
  add address=192.168.45.0/24 gateway=192.168.45.1
  add address=192.168.55.0/24 gateway=192.168.55.1

/ip dhcp-server
  add interface=IT name=IT_DHCP disabled=no
```

```
add interface=HR name=HR_DHCP disabled=no
add interface=Accounting name=Accounting_DHCP disabled=no
add interface=Sales name=Sales_DHCP disabled=no
add interface=CS name=CS_DHCP disabled=no
```

Test Case ID	Scenario	Test Steps	Expected Result	Actual Result	Status
TC-01	EIGRP adjacency in Branch 1	Configure EIGRP on all R1–R5 routers with proper network masks.	All routers in Branch 1 form EIGRP neighbor relationships.	EIGRP adjacency formed	Passed
TC-02	OSPF area design in Branch 2	Configure OSPF Areas 0, 1, 2 with ABRs and stub/totally-stubby configurations.	OSPF forms adjacencies within and across areas. Route types appear correctly in routing tables.	Adjacencies verified	Passed
TC-03	BGP peering between branches	Configure BGP AS 65000 and 65001 with mutual peering over serial link.	BGP session established between R5 and R7.	Session established	Passed
TC-04	Route redistribution between IGP and BGP	Redistribute BGP into EIGRP and OSPF, and vice versa.	End-to-end connectivity across branches with appropriate routes visible in routing tables.	Initially failed, resolved (see below)	Resolved
TC-05	VLAN DHCP assignment (Branch 1)	Connect host in VLAN 10 to trunk port. Relay DHCP to MikroTik via `helper-address`.	Host receives IP from `192.168.10.0/24` pool with gateway `192.168.10.1`.	IP assigned correctly	Passed
TC-06	VLAN DHCP assignment (Branch 2)	Connect host in VLAN 20. Ensure DHCP server in Branch 2 responds.	Host receives IP from `192.168.25.0/24` pool with gateway `192.168.25.1`.	IP assignment correct	Passed
TC-07	Inter-VLAN routing within each branch	Ping between hosts in different VLANs (e.g., VLAN 10 to VLAN 40) via multilayer switch.	ICMP echo replies received.	Successful routing	Passed
TC-08	End-to-end connectivity, Ping PC1 to PC2	Test ping and traceroute from one end host to another.	End-to-end connectivity confirmed through BGP and redistributed routes.	Successful after BGP redistribution fix	Passed

Table 1: Key Test Cases