Enterprise Network Design Report: OSPF, BGP, and SDN

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Introduction

This project demonstrates the design of a medium-scale enterprise network using hierarchical routing and centralized control. The goal is to **improve scalability, routing efficiency, and management** through the strategic implementation of modern networking protocols. The design integrates **Open Shortest Path First (OSPF)** for internal routing, **Border Gateway Protocol (BGP)** for external connectivity, and **Software-Defined Networking (SDN)** principles for centralized policy enforcement.

This report explains the design, protocols, and implementation strategies used in the enterprise network project described in your document.

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1. Project Overview

This project demonstrates the design of a medium-scale enterprise network that utilizes hierarchical routing and centralized management. The primary objective is to enhance scalability and routing efficiency by integrating three core networking technologies: OSPF for internal traffic, BGP for internet connectivity, and SDN concepts for centralized policy control.

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2. Network Architecture & Components

The design is structured to simulate a real-world enterprise environment connected to an Internet Service Provider (ISP).

Core Router (R-Core):

- **Explanation:** This is the "brain" of your network. It performs two jobs: it connects the internal OSPF areas together and talks to the outside world using BGP.
- **In the Project:** (for BGP and Default Routes).

Branch Routers (R1 & R2):

- **Explanation:** These act as the gateways for specific departments or buildings. They handle local traffic and send anything destined for other departments or the internet up to the R-Core.

- **In the Project:** "Area 1" and R2 handles "Area 2".

ISP Router (ISP-R):

- **Explanation:** This represents your Internet Service Provider. It is not part of your internal company network but is necessary to test if your company can reach the "Internet" (simulated here by a Loopback interface).
- **In the Project:** The BGP connection and the simulated internet address ($100.100.100.1$) are configured.

SDN Segment:

- **Explanation:** This is a "Software-Defined" testing area. Instead of using a complex SDN controller, the project simulates SDN by using the R-Core to centrally manage security policies (ACLs) for the devices in this segment.
- **In the Project:** The conceptual explanaed , and the results of the policy testing (allowing PC-SDN1 but blocking PC-SDN2) are explained

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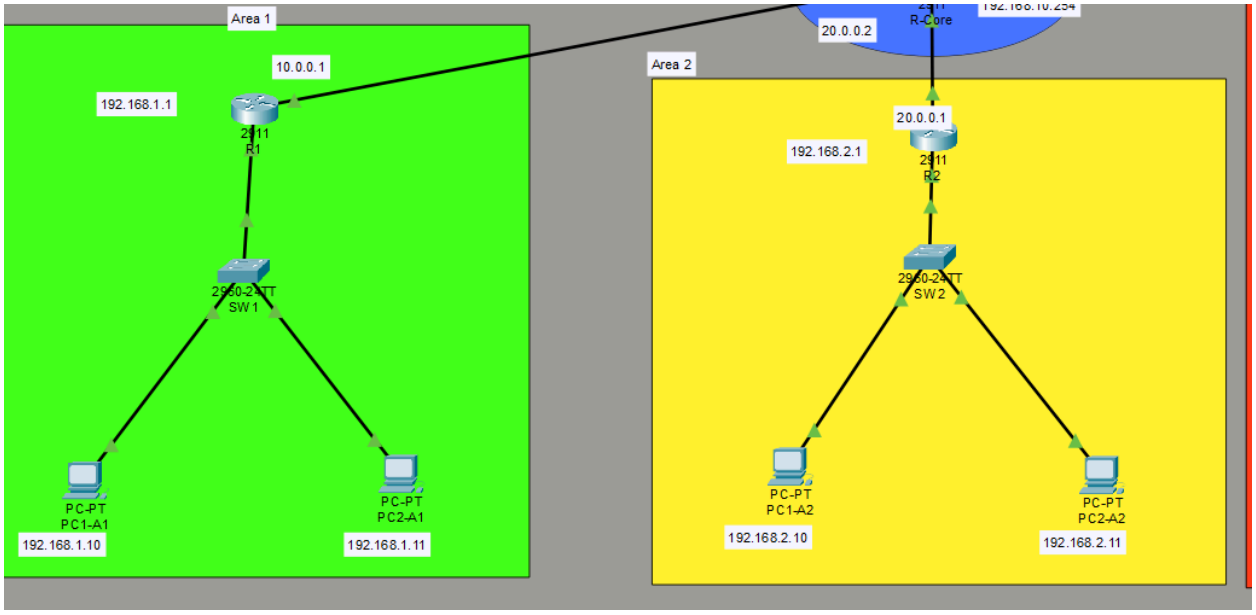
3. Internal Routing (OSPF)

OSPF multi-area was implemented to ensure efficient and scalable internal routing.

- **Area 0 (Backbone):** Connects the R-Core to other areas.
- **Branch Networks:** Placed in different areas (Area 1, Area 2) to localize link-state updates and improve scalability.
- **Connectivity:** OSPF enables all internal hosts to reach one another



4. External Connectivity (BGP)

- **BGP Purpose:** BGP was configured to manage the exchange of routing information between the enterprise network and the external ISP.
- **BGP Peering:** An External BGP (eBGP) session was established between the enterprise Core Router (R-Core) and the ISP Router (ISP-R).
- **Internet Simulation:** To simulate the internet, the ISP advertised a specific network, represented by a loopback interface.
- **Default Route:** A critical default route ($0.0.0.0/0$) was created on the R-Core pointing to the ISP.
- **OSPF Redistribution:** This default route was redistributed from the BGP process into the internal OSPF process to ensure all internal devices could reach the internet.

5- SDN Concept Implementation

- **Demonstration of Principles**: While the simulation environment may not support real OpenFlow, the principles of Software-Defined Networking (SDN) were demonstrated through centralized control mechanisms.

- **Dedicated Segment**: A dedicated segment was created featuring a switch and specific hosts named PC-SDN1 and PC-SDN2.
- **Centralized Control Simulation**: Centralized control was simulated by applying Access Control Lists (ACLs) on the core router (R-Core).
- **Policy Enforcement Point**: The R-Core acted as the central policy enforcement point for the entire segment.
- **Policy Enforcement Examples**: To demonstrate centralized management, one SDN host (PC-SDN1) was explicitly allowed internet access, while the other (PC-SDN2) was blocked.
- **Core Objective**: This setup effectively achieved the core SDN principle of separating the control plane (the ACL policy) from the data plane (the actual forwarding of packets by the router)

Conclusion

The project successfully demonstrates the integration of three critical networking concepts—OSPF multi-area routing, BGP external connectivity, and SDN-style centralized control—within a single enterprise network design. The hierarchical OSPF design ensures scalability, BGP provides robust external peering, and the ACL-based policy enforcement simulates the centralized control inherent in SDN architectures. Although a full OpenFlow implementation was not possible, the core principles of separating the control plane (ACL policy) from the data plane (router forwarding) were effectively achieved.