Static and Dynamic Routing with AD Values

Static Routing

Definition: Static routing is a form of routing that occurs when a network administrator manually adds routes to the routing table of a router. These routes remain in the routing table until they are manually removed or the router is restarted.

Characteristics of Static Routing:

- **Manual Configuration**: Routes must be manually configured by network administrators
- **No Automatic Updates**: Routes don't change automatically when network topology changes
- **Low Resource Usage**: Minimal CPU and memory consumption
- **Predictable Paths**: Traffic always follows the same predetermined path
- **Security**: More secure as routes are explicitly defined

Advantages:

- Simple to implement and understand
- No bandwidth overhead for routing updates
- Complete control over routing paths
- Suitable for small, stable networks
- Enhanced security through explicit route control

Disadvantages:

- Not scalable for large networks
- No automatic adaptation to network changes
- High administrative overhead
- Single point of failure if manually configured route fails
- Time-consuming to maintain

Use Cases:

- Small networks with few routers
- Stub networks (networks with only one exit point)
- Default routes to ISPs
- Backup routes for redundancy

Dynamic Routing

Definition: Dynamic routing uses routing protocols to automatically discover network destinations and maintain routing tables. Routers exchange routing information with neighboring routers to build and update their routing tables automatically.

Characteristics of Dynamic Routing:

- **Automatic Route Discovery**: Routes are learned automatically through routing protocols
- **Adaptive**: Automatically adjusts to network topology changes
- **Protocol-Based**: Uses specific routing protocols (RIP, OSPF, EIGRP, BGP)
- **Convergence**: Network reaches a stable state after topology changes

Types of Dynamic Routing Protocols:

Distance Vector Protocols:

- **Examples**: RIP (Routing Information Protocol), EIGRP (Enhanced Interior Gateway Routing Protocol)
- **Operation**: Share entire routing table with neighbors periodically
- **Metric**: Hop count (RIP) or composite metric (EIGRP)

Link State Protocols:

- **Examples**: OSPF (Open Shortest Path First), IS-IS
- **Operation**: Share link state information, each router builds complete network topology
- **Metric**: Cost based on bandwidth

Path Vector Protocols:

- **Examples**: BGP (Border Gateway Protocol)
- **Operation**: Maintains path information to prevent loops
- **Use**: Inter-domain routing (between different autonomous systems)

Advantages:

- Automatically adapts to network changes
- Scalable for large networks
- Provides redundancy and fault tolerance
- Optimal path selection based on metrics
- Reduced administrative overhead

Disadvantages:

- More complex to configure and troubleshoot
- Consumes bandwidth for routing updates

- Higher CPU and memory requirements
- Potential security vulnerabilities
- Convergence time during network changes

Administrative Distance (AD) Values

Definition: Administrative Distance (AD) is a rating of trustworthiness for a routing information source. It's a numeric value between 0-255 that routers use to select the best path when multiple routing sources provide information about the same destination network.

How AD Works:

- **Lower AD = Higher Trustworthiness**: Routes with lower AD values are preferred
- **Route Selection**: When multiple routes to the same destination exist, the route with the lowest AD is installed in the routing table
- **Cisco Proprietary**: AD is a Cisco concept, though other vendors have similar mechanisms

Default AD Values (Cisco):

Route Source	Administrative Distance
Connected Interface	0
Static Route	1
Enhanced Interior Gateway Routing Protocol (EIGRP)	90
Interior Gateway Routing Protocol (IGRP)	100
Open Shortest Path First (OSPF)	110
Routing Information Protocol (RIP)	120
External EIGRP	170
Internal Border Gateway Protocol (iBGP)	200
Unknown/External	255 (unreachable)

Key Points about AD:

- **Local Significance**: AD is only locally significant to the router
- **Not Advertised**: AD values are not shared between routers
- **Configurable**: Network administrators can modify AD values
- **Route Preference**: Only affects route installation, not route advertisement

Practical Example:

If a router learns about network 192.168.1.0/24 through:

- Static route (AD = 1)

- OSPF (AD = 110)
- RIP (AD = 120)

The router will install the static route in its routing table because it has the lowest AD value.

Modifying AD Values:

Network administrators can change AD values to influence route selection:

```
# Cisco IOS example
router ospf 1
distance 95  # Changes OSPF AD from 110 to 95
```

Static vs Dynamic Routing Comparison

When to Use Static Routing:

- Small networks (fewer than 10 routers)
- Stub networks
- Default routes
- When you need complete control over routing paths
- Networks with minimal topology changes
- Security-sensitive environments

When to Use Dynamic Routing:

- Large, complex networks
- Networks with frequent topology changes
- When redundancy and automatic failover are required
- Multi-vendor network environments
- When administrative overhead needs to be minimized

Hybrid Approach:

Many networks use both static and dynamic routing:

- Dynamic routing for the core network
- Static routes for stub networks
- Static default routes pointing to ISPs
- Static routes for specific traffic engineering requirements

Best Practices

For Static Routing:

- Document all static routes thoroughly
- Use next-hop IP addresses rather than exit interfaces when possible
- Implement backup static routes with higher AD values
- Regular review and cleanup of unused routes

For Dynamic Routing:

- Choose appropriate routing protocols for network size and requirements
- Implement proper authentication for routing protocols
- Use route filtering and summarization to optimize routing tables
- Monitor convergence times and network stability
- Implement redundant paths for critical connections

For AD Management:

- Understand default AD values for all routing sources
- Document any AD modifications
- Use AD modifications sparingly and with clear justification
- Test AD changes in a lab environment before implementation

Conclusion

Static and dynamic routing each serve important roles in network design. Static routing provides simplicity and control for small networks, while dynamic routing offers scalability and automatic adaptation for larger networks. Administrative Distance values ensure proper route selection when multiple routing sources are present, providing a mechanism for controlling route preferences and implementing routing policies. Understanding these concepts is crucial for effective network design and management.