

## - Static vs. Dynamic Routing -

### Static vs. Dynamic Routing

There are two basic methods of building a routing table:

- **Static Routing**
- **Dynamic Routing**

A **static** routing table is created, maintained, and updated by a network administrator, *manually*. A static route to *every* network must be configured on *every* router for full connectivity. This provides a granular level of control over routing, but quickly becomes impractical on large networks.

Routers will *not* share static routes with each other, thus reducing CPU/RAM overhead and saving bandwidth. However, static routing is *not fault-tolerant*, as any change to the routing infrastructure (such as a link going down, or a new network added) requires manual intervention. Routers operating in a purely static environment cannot seamlessly choose a better route if a link becomes unavailable.

Static routes have an Administrative Distance (AD) of **1**, and thus are always preferred over dynamic routes, unless the default AD is changed. A static route with an adjusted AD is called a **floating static route**, and is covered in greater detail in another guide.

A **dynamic** routing table is created, maintained, and updated by a *routing protocol* running on the router. Examples of routing protocols include **RIP** (Routing Information Protocol), **EIGRP** (Enhanced Interior Gateway Routing Protocol), and **OSPF** (Open Shortest Path First). Specific dynamic routing protocols are covered in great detail in other guides.

Routers *do* share dynamic routing information with each other, which increases CPU, RAM, and bandwidth usage. However, routing protocols are capable of dynamically choosing a different (or better) path when there is a change to the routing infrastructure.

Do not confuse *routing* protocols with *routed* protocols:

- A **routed** protocol is a Layer 3 protocol that applies logical addresses to devices and routes data between networks (such as IP)
- A **routing** protocol dynamically builds the network, topology, and next hop information in routing tables (such as RIP, EIGRP, etc.)

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### **Static vs. Dynamic Routing (continued)**

The following briefly outlines the advantages and disadvantages of *static* routing:

#### **Advantages of Static Routing**

- Minimal CPU/Memory overhead
- No bandwidth overhead (updates are not shared between routers)
- Granular control on how traffic is routed

#### **Disadvantages of Static Routing**

- Infrastructure changes must be manually adjusted
- No “dynamic” fault tolerance if a link goes down
- Impractical on large network

The following briefly outlines the advantages and disadvantages of *dynamic* routing:

#### **Advantages of Dynamic Routing**

- Simpler to configure on larger networks
- Will dynamically choose a different (or better) route if a link goes down
- Ability to load balance between multiple links

#### **Disadvantages of Dynamic Routing**

- Updates are shared between routers, thus consuming bandwidth
- Routing protocols put additional load on router CPU/RAM
- The choice of the “best route” is in the hands of the routing protocol, and not the network administrator

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## Dynamic Routing Categories

There are two distinct categories of dynamic routing protocols:

- **Distance-vector protocols**
- **Link-state protocols**

Examples of distance-vector protocols include **RIP** and **IGRP**. Examples of link-state protocols include **OSPF** and **IS-IS**.

**EIGRP** exhibits both distance-vector and link-state characteristics, and is considered a *hybrid* protocol.

## Distance-vector Routing Protocols

All **distance-vector** routing protocols share several key characteristics:

- **Periodic** updates of the **full** routing table are sent to routing neighbors.
- Distance-vector protocols suffer from slow convergence, and are highly susceptible to loops.
- Some form of *distance* is used to calculate a route's metric.
- The **Bellman-Ford algorithm** is used to determine the shortest path.

A distance-vector routing protocol begins by advertising directly-connected networks to its neighbors. These updates are sent *regularly* (RIP – every 30 seconds; IGRP – every 90 seconds).

Neighbors will add the routes from these updates to their own routing tables. Each neighbor trusts this information *completely*, and will forward their full routing table (connected *and* learned routes) to every other neighbor. Thus, routers fully (and blindly) rely on neighbors for route information, a concept known as **routing by rumor**.

There are several disadvantages to this behavior. Because routing information is propagated from neighbor to neighbor via periodic updates, distance-vector protocols suffer from slow convergence. This, in addition to blind faith of neighbor updates, results in distance-vector protocols being highly susceptible to routing loops.

Distance-vector protocols utilize some form of **distance** to calculate a route's metric. RIP uses **hopcount** as its distance metric, and IGRP uses a composite of **bandwidth** and **delay**.

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## Link-State Routing Protocols

**Link-state routing protocols** were developed to alleviate the convergence and loop issues of distance-vector protocols. Link-state protocols maintain three separate tables:

- **Neighbor table** – contains a list of all neighbors, and the interface each neighbor is connected off of. Neighbors are formed by sending **Hello** packets.
- **Topology table** – otherwise known as the “link-state” table, contains a map of all links within an **area**, including each link’s status.
- **Shortest-Path table** – contains the *best* routes to each particular destination (otherwise known as the “routing” table”)

Link-state protocols do *not* “route by rumor.” Instead, routers send updates advertising the *state* of their *links* (a **link** is a directly-connected network). All routers know the state of all existing links within their **area**, and store this information in a **topology** table. All routers within an area have *identical* topology tables.

The best route to each link (network) is stored in the **routing** (or **shortest-path**) table. If the state of a link changes, such as a router interface failing, an advertisement containing *only this link-state change* will be sent to all routers within that area. Each router will adjust its topology table accordingly, and will calculate a new *best* route if required.

By maintaining a consistent topology table among all routers within an area, link-state protocols can **converge very quickly** and are **immune to routing loops**.

Additionally, because updates are sent only during a link-state change, and contain *only* the change (and not the full table), link-state protocols are **less bandwidth intensive** than distance-vector protocols. However, the three link-state tables **utilize more RAM and CPU** on the router itself.

Link-state protocols utilize some form of **cost**, usually based on bandwidth, to calculate a route’s metric. The **Dijkstra formula** is used to determine the shortest path.

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