

INTRODUCTION TO ROUTING BASICS AND PROTOCOLS

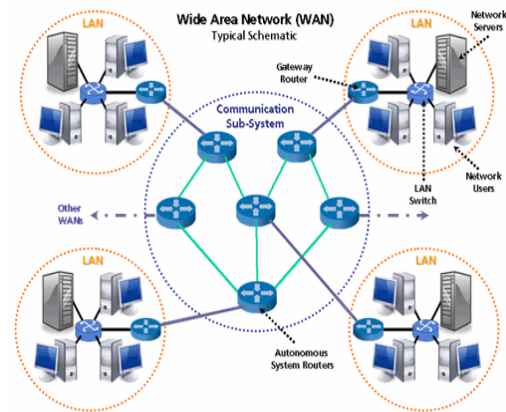
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Abstract- Networking is a field which involves a thorough study of both electronics and computer science. It is the connecting bridge between hardware and software. Today majority of the computer networks are packet switched networks and the transmission and reception of information is based on the method of Routing. Routing involves use of different protocols and algorithms for path selection. This study paper explores the basics of routing and is useful for viewing to all those students who are from a non-computer science background.

I OVERVIEW OF ROUTING

- **Routing** is the process of selecting paths in a network along which to send network traffic. Routing is performed for many kinds of networks, including the telephone network, electronic data networks (such as the Internet), and transportation (transport) networks.
- In packet switching networks, routing directs forwarding, the transit of logically addressed packets from their source toward their ultimate destination through intermediate nodes; typically hardware devices called routers, bridges, gateways or switches.
- The routing process usually directs forwarding on the basis of routing tables which maintain a record of the routes to various network destinations. Thus constructing routing tables, which are held in the routers' memory, becomes very important for efficient routing.

Following is an example of how LANs are connected in a Wide Area Network(WAN) and how many paths are available to reach each of them. The function of Routing is to select the best paths.



II TYPES OF ROUTING

Routing can be divided into two broad categories

- Static Routing
- Dynamic routing

III STATIC ROUTING

In static routing information about all networks must be entered manually by the administrator on all routers. Its Default Administrative Distance is 1(This shall be detailed later).As routing data is entered by the administrator there is no requirement to perform any metric calculations to determine paths.

A. Its advantages

- Doesn't exchange any routing tables hence it doesn't consume any bandwidth.
- Again the bandwidth which may be consumed in dynamic updates are saved.
- Low processing power may suffice, hence we can use cheaper routers.
- Higher Security as there is no information being regarding routing on the connecting links

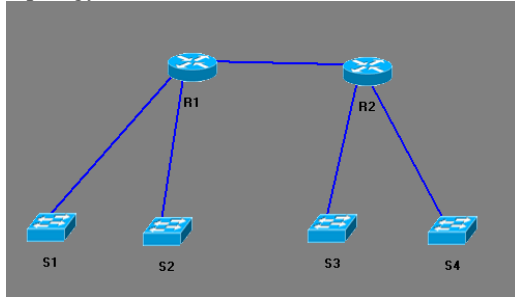
B. Its disadvantages

- Each remote network information is written manually.

- Reconfiguration is problematic and tedious if there is a change in the topology.

C. An Example

Consider a network of the following topology.



R1 IP Address 1: 192.168.10.1 (Connected to S1)

R1 IP Address 2: 192.168.20.1 (Connected to S2)

R1 IP Address 3: 192.168.30.1 (Connected to R2)

R2 IP Address 1: 192.168.40.1 (Connected to S3)

R2 IP Address 1: 192.168.50.1 (Connected to S4)

R2 IP Address 1: 192.168.30.2 (Connected to R1)

The router configuration can be accessed via a Windows console using the Hyperterminal software.

```

R1>en
R1#conf t
R1(config)#ip route 192.168.40.0 255.255.255.0
192.168.30.2
R1(config)#ip route 192.168.50.0 255.255.255.0
192.168.30.2
  
```

```

R2>en
R2#conf t
R2(config)#ip route 192.168.10.0 255.255.255.0
192.168.30.1
R2(config)#ip route 192.168.20.0 255.255.255.0
192.168.30.1
  
```

IV DYNAMIC ROUTING

- The router dynamically learns routes after an administrator configures a routing protocol that helps determine the routes.
- After dynamic routing is enabled the routing process automatically updates routes whenever new topology information is received

- The router learns and maintains routes to the remote destinations by exchanging routing updates with other routers

A. What is a routing protocol ?

- A routing protocol defines the rules that are used by a router when it communicates with the neighboring routers. Dynamic routing relies on a routing protocol to disseminate knowledge.
- Following are the information that routing protocols describe

* How updates are conveyed

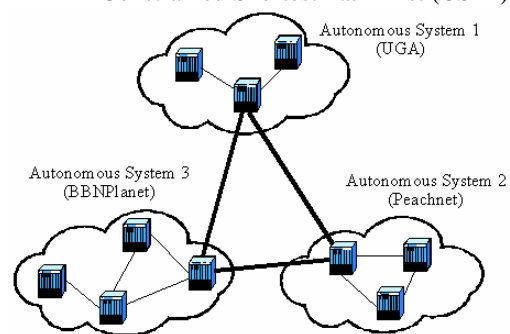
* What knowledge is conveyed

* When to convey knowledge

* How to locate recipients of the updates

B. Autonomous Systems: Interior and Exterior Routing Protocols

- **AUTONOMOUS SYSTEM:** It is a collection of networks under a common administrative domain.
- **Interior Gateway Protocol (IGP):** These routing protocols are used to exchange information within an autonomous system. E.g. RIP V1, RIP V2, OSPF, EIGRP
- **Exterior Gateway Protocol (EGP):** These routing protocols are used to connect autonomous systems. An autonomous system is a collection of networks under a common system and sharing a common routing strategy. E.g. Border Gateway Protocol (BGP), Constrained Shortest Path First (CSPF).



V IGP ROUTING ALGORITHMS

A. DISTANCE VECTOR ALGORITHM

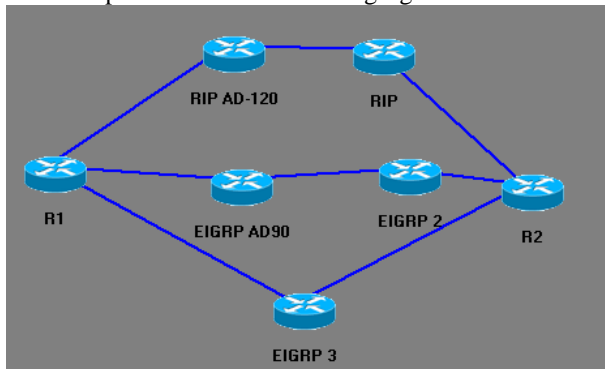
- The distance vector routing approach determines the direction and distance (hops) to any link in the internetwork.

- A metric calculation is done for each path and path with lowest metric is used.
- It is used by the routing protocol to select the best path.
- Works by broadcasting.
- Its disadvantage is that it does not consider the speed or type (called cost) of the link connecting the routers

B. DVA METRIC CALCULATION

Router will first see the administrative distance (AD) of routing protocol and route the packet towards the destination with lower AD

For example consider the following figure-



- ADMINISTRATIVE DISTANCE- It is an integer from 0 to 255. A routing protocol with a lower AD is more trustworthy than one with higher AD.
- Then the hop count shall be checked and the packet shall be routed to destination with lower hop count
- If the hop count is same then load balancing will occur.
- In the above case R1 shall transfer data to R2 using EIGRP 3 router

VI LINK STATE ALGORITHM

- The link-state approach, also known as Shortest Path First (SPF) algorithm, creates an abstraction of the exact topology of the entire inter network, or at the least of the partition in which the router is situated
- It works by multicasting and unicasting
- It exchanges its complete table with neighbor route once a time, after that it will send only hello packets
- Partial or Triggered update- Whenever change occurs in a topology then routing will send partial or triggered update.

A. Functioning of Link State

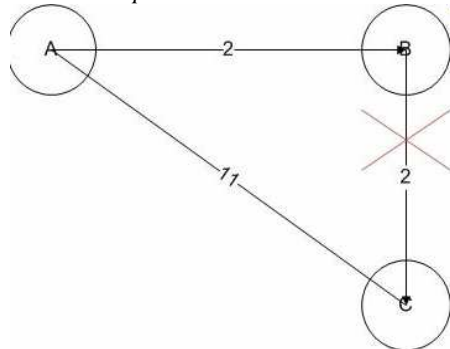
- It creates 3 tables
- First Neighborhood Table is formed

- All paths for communication with each network is kept in a Topology Table
- The best paths to reach the destination network is stored in the Routing Table

VII ROUTING LOOPS

A **routing loop** is a common problem with various types of networks, particularly computer networks. They are formed when an error occurs in the operation of the routing algorithm, and as a result, in a group of nodes, the path to a particular destination forms a loop.

A. An Example



- **Node A** is transmitting data to node **C** via node **B**. If the link between nodes **B** and **C** goes down and **B** has not yet informed node **A** about the breakage, node **A** transmits the data to node **B** assuming that the link **A-B-C** is operational and of lowest cost.
- Node **B** knows of the broken link and tries to reach node **C** via node **A**, thus sending the original data back to node **A**.
- Furthermore, node **A** receives the data that originated back from node **B** and consults its routing table. Node **A**'s routing table will say that it can reach node **C** via node **B** (because it still has not been informed of the break) thus sending its data back to node **B** creating an infinite loop.

VIII LOOP AVERTING TECHNIQUES

A. Maximum Hop Count

A packet can travel maximum up to 15 hops. This is a bad technique as loops are first formed then averted

B. Split Horizon

Updates can be sent in the forward direction only, routing updates cannot be returned back to source.

C. Poison Reverse

Route poisoning is a method of quickly removing outdated routing information from

other router's routing tables by changing its hop count to be unreachable (higher than the maximum number of hops allowed) and sending a routing update.

D. Hold Down Timer

It is mainly used for fluctuating links. It is a function that prevents a router from being updated for a specified period in order to give other nodes some time to reconfigure and prevent a routing loop.

- When a router is notified of a route failure, it starts the hold down timer. In the meantime, if a notification of a route is received from its neighbor with equal or better metrics than the route that failed, the router stops the timer and updates its routing table.
- If the new route metrics are inferior, it keeps the timer running and does not update.

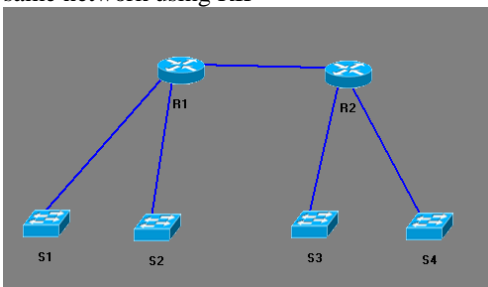
IX ROUTING INFORMATION PROTOCOL (RIP) Version 1

And now we finally explore the various IGP Protocols

- It's an open standard protocol. It can be used by routers of all vendors
- The AD is 120
- It's a classful routing protocol which means it follows an older system of addressing.
- It works by DVA.
- It can route a packet upto maximum 15 hops.
- Makes use of Split Horizon and Poison Reverse.

A. An Example

Again let's see how we shall configure the same network using RIP



R1 IP Address 1: 192.168.10.1 (Connected to S1)

R1 IP Address 2: 192.168.20.1 (Connected to S2)

R1 IP Address 3: 192.168.30.1 (Connected to R2)

R2 IP Address 1: 192.168.40.1 (Connected to S3)

R2 IP Address 1: 192.168.50.1 (Connected to S4)

R2 IP Address 1: 192.168.30.2 (Connected to R1)

```

R1>en
R1#conf t
R1(config)#router rip
R1(config-router)#network 192.168.10.0
R1(config-router)#network 192.168.20.0
R1(config-router)#network 192.168.30.0
  
```

```

R2>en
R2#conf t
R2(config)#router rip
R2(config-router)#network 192.168.30.0
R2(config-router)#network 192.168.40.0
R2(config-router)#network 192.168.50.0
  
```

X RIP V2(DISSIMILARITIES WITH RIP V1)

RIP V2 is an update of RIP V1. Let us see what improvements yhave been done in the updated version-

- It can route up to 255 hops, by default 100
- It supports authentication and auto-summarization. Authentication is used for secure routing and auto-summarization reduces traffic.
- It's a classless routing protocol.
- It works on an advanced version of DVA.
- It exchanges its routing table using multicasting.

XI INTERIOR GATEWAY PROTOCOL (IGRP)

- It's a propriety of Cisco. It can be used only by Cisco routers.
- It's a classful routing protocol.
- Works on DVA.
- It can route upto 255 hops (by default 100).
- It's AD is 100.
- IGRP uses autonomous systems.

XII ENHANCED IGRP (EIGRP)

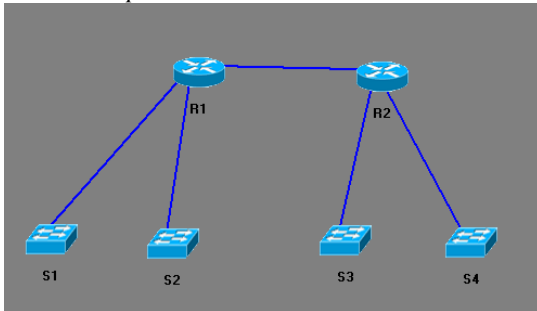
- It's a classless routing protocol
- The AD is 90
- It's a hybrid routing protocol. It uses characteristics of both DVA and Link State Algorithm
- Metric calculation for EIGRP includes Bandwidth, Delay, Load, Reliability and Max. Transferable Unit (MTU) and is done by using the EIGRP

DUAL(Diffusing update dual algorithm)

A. Other characteristics of EIGRP

- Very fast convergence time (Availability of feasible Successor)
- Has knowledge of Neighborhood
- Supports Multiple internet protocols simultaneously using PDM (Protocol Dependent Module)
- Makes use of Reliable Transport Protocol to stop loops. It multicasts (at to all neighbors every 5 s.
- It supports auto-summarization

B. An Example



R1 IP Address 1: 192.168.10.1 (Connected to S1)
 R1 IP Address 2: 192.168.20.1 (Connected to S2)
 R1 IP Address 3: 192.168.30.1 (Connected to R2)
 R2 IP Address 1: 192.168.40.1 (Connected to S3)
 R2 IP Address 1: 192.168.50.1 (Connected to S4)
 R2 IP Address 1: 192.168.30.2 (Connected to R1)
 Autonomous System No. – 12

```
R1>en
R1#conf t
R1(config)#router eigrp 12
R1(config-router)#network 192.168.10.0
R1(config-router)#network 192.168.20.0
R1(config-router)#network 192.168.30.0
```

```
R2>en
R2#conf t
R2(config)#router eigrp 12
R2(config-router)#network 192.168.30.0
R2(config-router)#network 192.168.40.0
R2(config-router)#network 192.168.50.0
```

XIII OPEN SHORTEST PATH FIRST (OSPF)

- It's an open standard routing protocol

- It's an internet standard routing protocol
- It's a classless routing protocol
- The AD is 110
- It works on Link State Algorithm
- Multicasts using 224.0.0.5 for all OSPF routers and 224.0.0.6 for OSPF Designated Router
- It makes a Routing Table, Database Table and Neighborhood table
- It makes use of process no.s in its configuration.
- The process ID is a unique arbitrary no. that is selected to identify the routing process
- It has local significance. It is not important for 2 neighbors to have same process no.
- However Area No. must match.
- Area no. range is from 0 to 4.2 billion
- Area 0 is known as backbone area and it is used for communication between multiple areas
- There are around 40 to 80 routers in an area

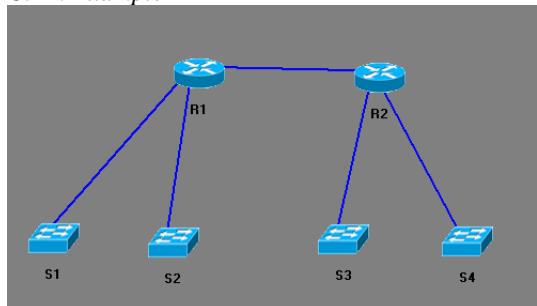
A. Benefits of Area Numbers

- * Smaller routing Table
- * Lesser Processing Power is required
- * Lesser DRAM is required
- * Less problems in troubleshooting

B. Designated Router and Backup Designated Router

- DR and BDR are awarded in multipoint and Broadcast Multiaccess network (BMA)(For example a network in which various routers are connected to a single switch).
- It is used to reduce adjacencies or neighborhood
- There is only one DR and BDR in an area
- Only DR is assigned a neighborhood table

C. An Example



R1 IP Address 1: 192.168.10.1 (Connected to S1)

```
R1 IP Address 2: 192.168.20.1 (Connected to S2)
R1 IP Address 3: 192.168.30.1 (Connected to R2)
R2 IP Address 1: 192.168.40.1 (Connected to S3)
R2 IP Address 1: 192.168.50.1 (Connected to S4)
R2 IP Address 1: 192.168.30.2 (Connected to R1)
R1 Process ID.- 11,R2 Process ID.- 12, Area no.- 0
R1>en
R1#conf t
R1(config)#router ospf 11
R1(config-router)#network 192.168.10.0 0.0.0.255 area 0
R1(config-router)#network 192.168.20.0 0.0.0.255 area 0
R1(config-router)#network 192.168.30.0 0.0.0.3 area 0

R2>en
R2#conf t
R2(config)#router ospf 12
R2(config-router)#network 192.168.30.0 0.0.0.3 area 0
R2(config-router)#network 192.168.40.0 0.0.0.255 area 0
R2(config-router)#network 192.168.50.0 0.0.0.255 area 0
```

XVI REFERENCES

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