



Emerging Network Technologies

NetSim Exercise 4

**Faculty of Architecture, Computing and Engineering
School of Applied Computing
Mount Pleasant Campus
Swansea
SA1 6ED**

4.Study the working and routing table formation of Interior routing protocols, i.e. Routing Information Protocol (RIP) and Open Shortest Path First (OSPF)

4.1 Theory:

RIP

RIP is intended to allow hosts and gateways to exchange information for computing routes through an IP-based network. RIP is a distance vector protocol which is based on Bellman-Ford algorithm. This algorithm has been used for routing computation in the network.

Distance vector algorithms are based on the exchange of only a small amount of information using RIP messages.

Each entity (router or host) that participates in the routing protocol is assumed to keep information about all of the destinations within the system. Generally, information about all entities connected to one network is summarized by a single entry, which describes the route to all destinations on that network. This summarization is possible because as far as IP is concerned, routing within a network is invisible. Each entry in this routing database includes the next router to which datagrams destined for the entity should be sent. In addition, it includes a "metric" measuring the total distance to the entity.

Distance is a somewhat generalized concept, which may cover the time delay in getting messages to the entity, the dollar cost of sending messages to it, etc. Distance vector algorithms get their name from the fact that it is possible to compute optimal routes when the only information exchanged is the list of these distances. Furthermore, information is only exchanged among entities that are adjacent, that is, entities that share a common network.

OSPF

In OSPF, the Packets are transmitted through the shortest path between the source and destination.

Shortest path:

OSPF allows administrator to assign a cost for passing through a link. The total cost of a particular route is equal to the sum of the costs of all links that comprise the route. A router chooses the route with the shortest (smallest) cost.

In OSPF, each router has a link state database which is tabular representation of the topology of the network (including cost). Using dijkstra algorithm each router finds the shortest path between source and destination.

Formation of OSPF Routing Table

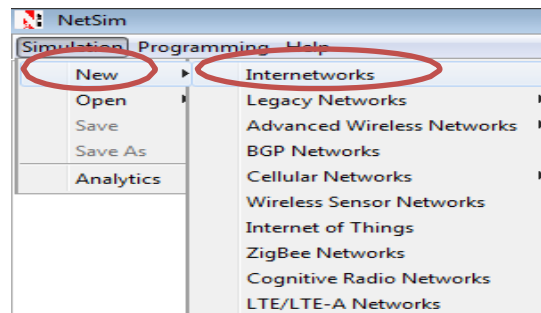
1. OSPF-speaking routers send Hello packets out all OSPF-enabled interfaces. If two routers sharing a common data link agree on certain parameters specified in their respective Hello packets, they will become neighbors.
2. Adjacencies, which can be thought of as virtual point-to-point links, are formed between some neighbors. OSPF defines several network types and several router types. The establishment of an adjacency is determined by the types of routers exchanging Hellos and the type of network over which the Hellos are exchanged.
3. Each router sends link-state advertisements (LSAs) over all adjacencies. The LSAs describe all of the router's links, or interfaces, the router's neighbors, and the state of the links. These links might be to stub networks (networks with no other router attached), to other OSPF routers, or to external networks (networks learned from another routing process). Because of the varying types of link-state information, OSPF defines multiple LSA types.
4. Each router receiving an LSA from a neighbor records the LSA in its link-state database and sends a copy of the LSA to all of its other neighbors.
5. By flooding LSAs throughout an area, all routers will build identical link-state databases.
6. When the databases are complete, each router uses the SPF algorithm to calculate a loop-free graph describing the shortest (lowest cost) path to every known destination, with itself as the root. This graph is the SPF tree.
7. Each router builds its route table from its SPF tree

4.2 Procedure

Sample 1:

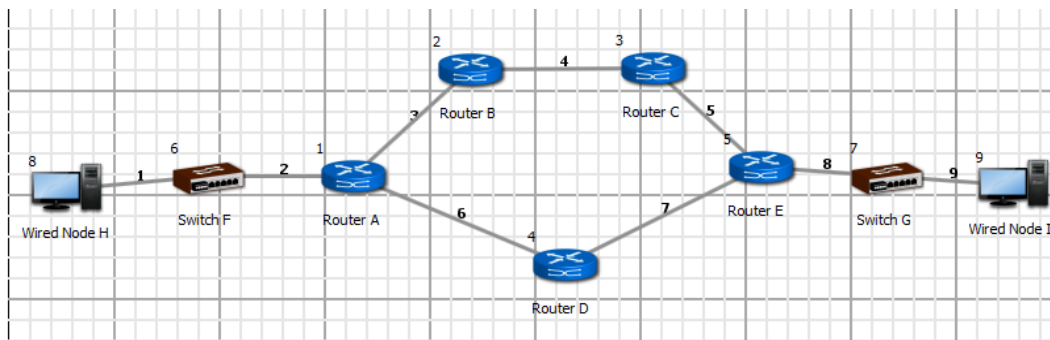
Step 1:

Go to Simulation → New → Internetworks



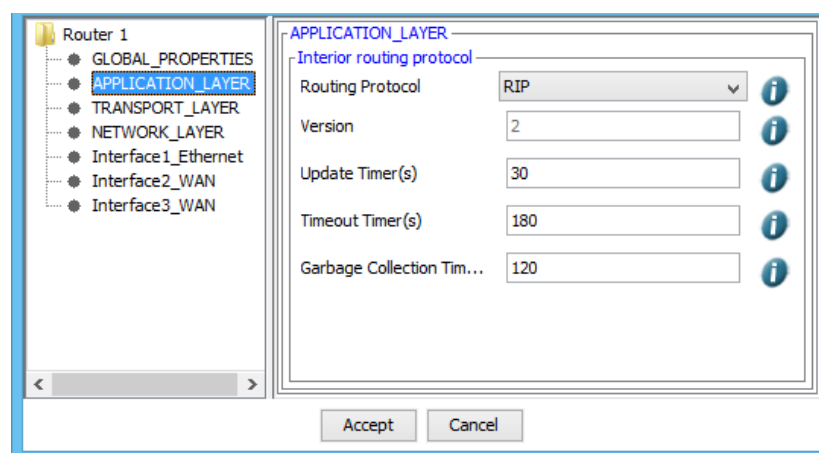
Step 2:

Click & drop Routers, Switches and Nodes onto the Simulation Environment and link them as shown:



Step 3:

These properties can be set only after devices are linked to each other as shown above.
Set the properties of the Router 1 as follows:



Node Properties: In Wired Node H, go to Transport Layer and set TCP as Disable

Switch Properties: Accept default properties for Switch.

Link Properties: Accept default properties for Link.

Application Properties: Click and drop the Application icon and set properties as follows:

The screenshot shows the 'Application Properties' dialog box. On the left, a tree view shows 'Application' and 'Application1'. The main area is divided into sections for 'Application1', 'PACKET_SIZE', and 'INTER_ARRIVAL_TIME'. Each section has a 'Distribution' dropdown and a 'Value' input field. The 'Src_to_Dest' dropdown is set to 'Disable line'. At the bottom are 'Add', 'Remove', 'Accept', and 'Cancel' buttons.

Property	Value
Application_Type	CUSTOM
Application ID	1
Source_Count	1
Source_ID	8
Destination_Count	1
Destination_ID	9
Start_Time(s)	0
End_Time(s)	10000
Src_to_Dest	Disable line
PACKET_SIZE Distribution	CONSTANT
PACKET_SIZE Value(Bytes)	1460
INTER_ARRIVAL_TIME Distribution	CONSTANT
INTER_ARRIVAL_TIME Value(micro sec)	20000

Simulation Time - 100 Sec

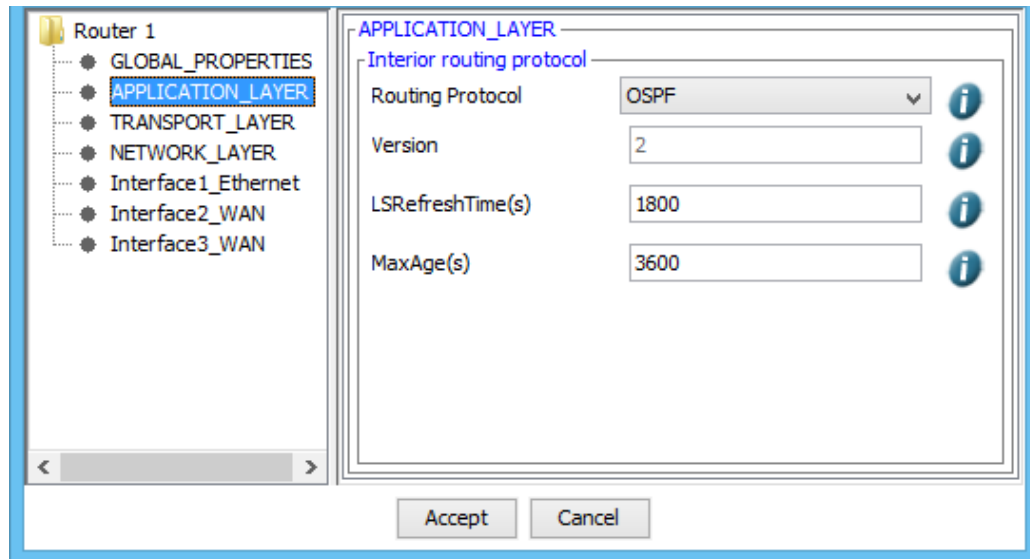
After Simulation is performed, save the experiment.

(Note: The Simulation Time can be selected only after doing the following two tasks,

- Set the properties of Node, Switch, Router& Application
- Then click on Run Simulation button).

Sample 2:

To model a scenario, follow the same steps as given in Sample1 and set the Router A properties as given below:



Link Properties:

Link Properties	Link 3	Link 4	Link 5	Link 6	Link 7
Uplink Speed	100	100	100	10	10
Downlink Speed	100	100	100	10	10

Node Properties: In Wired Node H, go to Transport Layer and set TCP as Disable

Switch Properties: Accept default properties for Switch.

Application Properties: Click and drop the Application icon and set properties as in Sample 1.

Simulation Time- 100 Sec

(Note: The Simulation Time can be selected only after doing the following two tasks,

- Set the properties of Node, Switch, Router& Application
- Then click on Run Simulation button).

4.3 Output and Inference:

RIP

In Distance vector routing, each router periodically shares its knowledge about the entire network with its neighbors. The three keys for understanding the algorithm,

1. Knowledge about the whole network

Router sends all of its collected knowledge about the network to its neighbors

2. Routing only to neighbors

Each router periodically sends its knowledge about the network only to those routers to which it has direct links. It sends whatever knowledge it has about the whole network through all of its ports. This information is received and kept by each neighboring router and used to update that router's own information about the network.

3. Information sharing at regular intervals

For example, every 30 seconds, each router sends its information about the whole network to its neighbors. This sharing occurs whether or not the network has changed since the last time information was exchanged

In NetSim the Routing table Formation has 3 stages

Initial Table: This table will show the direct connections made by each Router.

Intermediate Table: The Intermediate table will have the updates of the Network in every 30 seconds

Final Table: This table is formed when there is no update in the Network.

The data should be forwarded using Routing Table with the shortest distance

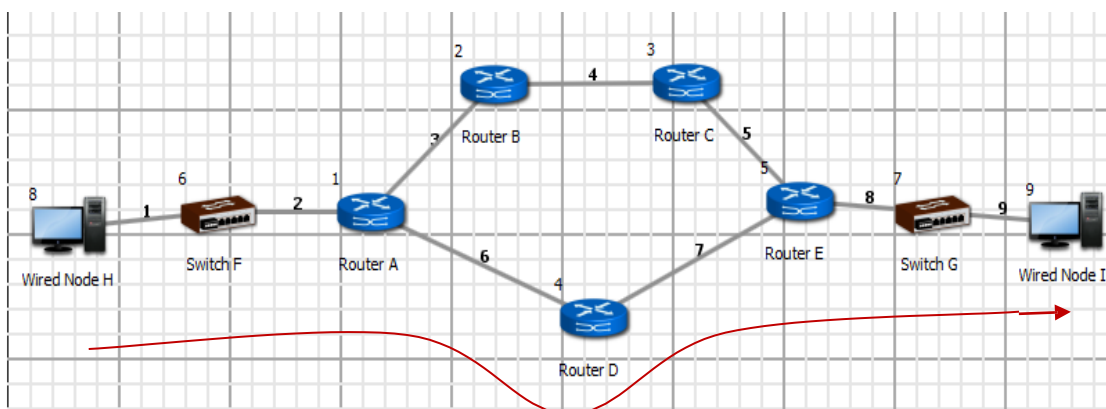
The RIP table in NetSim

- After running Sample1, click RIP table in Performance Metrics screen. Then click the respective router to view the Routing table.
- We have shown the routing table for Router 1,

Performance Metrics					
Router1					
Initial					
DestinationIP	Subnet mask	NextHopIP	Interface	Metric	Timer(Micro sec)
11.1.0.0	255.255.0.0	11.1.1.1	1	0	3000000.000000
11.2.0.0	255.255.0.0	11.2.1.1	2	0	3000000.000000
11.3.0.0	255.255.0.0	11.3.1.1	3	0	3000000.000000
Intermediate					
DestinationIP	Subnet mask	NextHopIP	Interface	Metric	Timer(Micro sec)
11.1.0.0	255.255.0.0	11.1.1.1	1	0	3000000.000000
11.2.0.0	255.255.0.0	11.2.1.1	2	0	3000000.000000
11.3.0.0	255.255.0.0	11.3.1.1	3	0	3000000.000000
12.2.0.0	255.255.0.0	11.2.1.2	2	1	48.200000
Final					
DestinationIP	Subnet mask	NextHopIP	Interface	Metric	Timer(Micro sec)
11.1.0.0	255.255.0.0	11.1.1.1	1	0	3000000.000000
11.2.0.0	255.255.0.0	11.2.1.1	2	0	3000000.000000
11.3.0.0	255.255.0.0	11.3.1.1	3	0	3000000.000000
12.2.0.0	255.255.0.0	11.2.1.2	2	1	48.200000

Shortest Path from Wired Node H to WiredNode I in RIP (Use Packet Animation to view):

WiredNode H→Switch F→Router1→Router4→Router5→Switch G→Wired Node I



OSPF

The main operation of the OSPF protocol occurs in the following consecutive stages and leads to the convergence of the internetworks:

1. Compiling the LSDB.
2. Calculating the Shortest Path First (SPF) Tree.
3. Creating the routing table entries.

Compiling the LSDB

The LSDB is a database of all OSPF router LSAs. The LSDB is compiled by an ongoing exchange of LSAs between neighboring routers so that each router is synchronized with its neighbor. When the Network converged, all routers have the appropriate entries in their LSDB.

Calculating the SPF Tree Using Dijkstra's Algorithm

Once the LSDB is compiled, each OSPF router performs a least cost path calculation called the Dijkstra algorithm on the information in the LSDB and creates a tree of shortest paths to each other router and network with themselves as the root. This tree is known as the SPF Tree and contains a single, least cost path to each router and in the Network. The least cost path calculation is performed by each router with itself as the root of the tree

Calculating the Routing Table Entries from the SPF Tree

The OSPF routing table entries are created from the SPF tree and a single entry for each network in the AS is produced. The metric for the routing table entry is the OSPF-calculated cost, not a hop count.

The OSPF table in NetSim

- After running Sample 2, click OSPF Metrics in Performance Metrics screen. Then click the router to view the Routing table
- We have shown the routing table for Router 1:

Performance Metrics

Router1

Link State Database

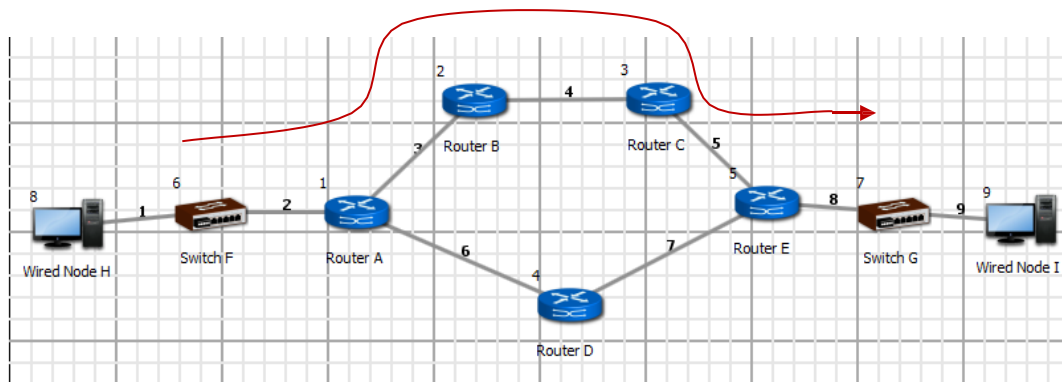
Advertising Router	LinkStateId	LS Sequence Number
11.2.1.1	11.2.1.1	0x80000031

Routing Table

Destination IP	Next Hop IP	Subnet mask	Cost	AreaID	Pathtype
11.1.0.0	11.1.1.1	255.255.0.0	1	0	intra_area
11.2.0.0	11.2.1.1	255.255.0.0	1	0	intra_area
11.3.0.0	11.3.1.1	255.255.0.0	10	0	intra_area
12.2.0.0	11.2.1.2	255.255.0.0	2	0	intra_area
13.2.0.0	11.2.1.2	255.255.0.0	3	0	intra_area
15.2.0.0	11.2.1.2	255.255.0.0	13	0	intra_area
14.3.0.0	11.2.1.2	255.255.0.0	4	0	intra_area

Shortest Path from Wired Node H to WiredNode I in OSPF (Use Packet Animation to view):

WiredNode H→Switch F→Router1→Router2→Router3→Router5→Switch G
→WiredNode I



Note: The Cost is calculated by using the following formula

$$Cost = \frac{ReferenceBandwidth}{LinkSpeedUp}$$

Reference Bandwidth = 100 Mbps

For Example,

Let us take, Link Speed UP = 100 Mbps

$$Cost = \frac{100 (ReferenceBandwidth)}{100 (LinkSpeedUP)} = 1$$

4.4. Study the working of BGP and formation of BGP Routing table

4.4.1 Theory:

In BGP, the Packets are transmitted between the Autonomous system using Path vector Routing.

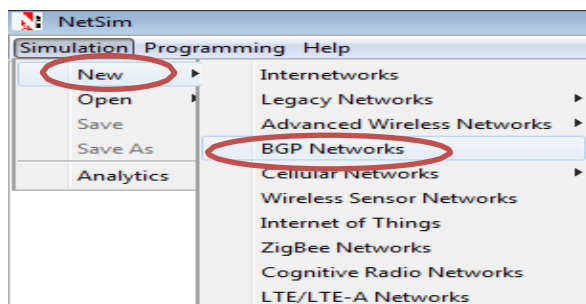
Path Vector Routing:

Path vector routing is used for inter-domain routing. It is similar to distance vector routing. In path vector routing we assume that there is one Router (there can be many) in each autonomous system which acts on behalf of the entire autonomous system. This Router is called the Border Router. The Border Router in one Autonomous System creates a routing table and advertises it to neighboring Border Router which belongs to neighboring autonomous systems. The idea is same as distance vector routing except that only Border Routers in each autonomous system can communicate with each other. The Border Routers advertises the path, not the metric, in its autonomous system or other autonomous systems.

4.4.2 Procedure:

Step 1:

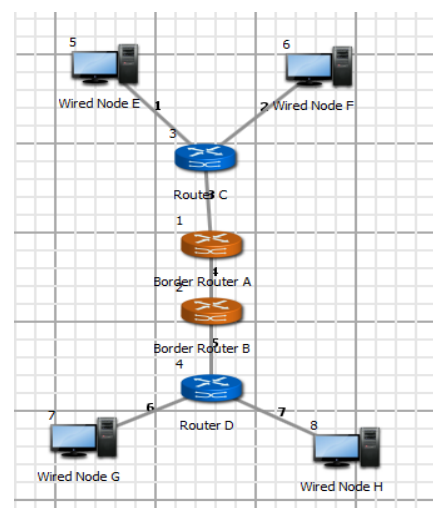
Go to Simulation → New → BGP Networks



Sample Inputs:

Follow the steps given in the different samples to arrive at the objective.

- Total no of nodes used: 4
- Total number of Internal Routers used: 2
- Total number of Border Routers used: 2



The devices are interconnected as given below,

- Wired Node E and Wired Node F are connected by Link 1 and Link 2 to Router C.
- Internal Router C and Border Router A are connected by Link 3.
- Border Router A and Border Router B are connected by Link4.
- Border Router B and Router D are connected by Link 5.
- Router D is connected by Link 6 and Link 7to Wired Node G and Wired Node H respectively.

Set the properties for each device by following the tables,

Application Properties	Application 1	Application 2
Application_Type	CUSTOM	CUSTOM
Source_Id	5	6
Destination_Id	7	8
Application Data size		
Distribution	Constant	Constant
Application Data size (bytes)	1472	1472
Inter Arrival Time		
Distribution	Constant	Constant
Mean Inter Arrival Time (μs)	20000	20000

Link Properties	Link 1	Link 2	Link 3	Link 4	Link 5	Link 6	Link 7
Bit Error Rate (BER)	0	0	0	0	0	0	0
Downlink Speed (Mbps)	8.448	8.448	10	1000	10	8.448	8.448
Uplink Speed (Mbps)	8.448	8.448	10	1000	10	8.448	8.448

Sample 1:

If selected internal gateway protocol is RIP then Router properties are as follows:

Router Properties	Border_ Router A		Border_ Router B	
	Interior Routing table	Exterior Routing table	Interior Routing table	Exterior Routing table
Protocol Type	RIP	BGP	RIP	BGP
Update Timer	30	-	30	-
Timeout Timer	180	-	180	-
Garbage Collection Timer	120	-	120	-

Router Properties	Router C	Router D
Routing Protocol	RIP	RIP
Update Timer	30	30
Timeout Timer	180	180
Garbage Collection Timer	120	120

Simulation Time - 10 Sec

(**Note:** The Simulation Time can be selected only after doing the following two tasks,

- Set the properties of Routers
- Then click on Run Simulation button).

After simulation save the experiment.

Sample 2:

If you want to select your internal gateway protocol as OSPF then here is the information you need to fill in for Router properties:

Router Properties	Border_ Router A		Border_ Router B	
	Interior Routing table	Exterior Routing table	Interior Routing table	Exterior Routing table
Protocol Type	OSPF	BGP	OSPF	BGP
LSRefreshTime	1800	-	1800	-
MaxAge	3600	-	3600	-

Router Properties	Router C	Router D
Routing Protocol	OSPF	OSPF
LSRefreshTime	1800	1800
MaxAge	3600	3600

Simulation Time - 10 Sec

(**Note:** The Simulation Time can be selected only after doing the following two tasks,

- Set the properties of Routers
- Then click on Run Simulation button).

4.4.3 Output:

After running this scenario, in Performance Metrics screen, routing tables are obtained in BGP table and RIP metrics.

If you click over the RIP metrics, you will get the RIP routing table for internal routers. If you click over the BGP table, you will get the routing table for Border routers. We have shown the routing tables for Border Router 1 and 2.

Router1

Router1								
PeerState	PeerLocalPort	PeerRemoteAddr	PeerRemotePort	PeerInUpdates	PeerOutUpdates	PeerInTotalMessages	PeerOutTotalMessages	NextHop
Internal	41	11.3.0.0	179	6	6	8	8	11.3.1.2
Internal	18467	12.2.0.0	179	6	6	8	8	12.2.1.1
Established	14604	13.2.0.0	179	6	6	8	8	12.2.1.2
Established	292	11.1.0.0	179	6	6	8	8	11.3.1.1
Established	17421	11.2.0.0	179	6	6	8	8	11.3.1.1
Established	17035	14.2.0.0	179	6	6	8	8	12.2.1.2
Established	23811	14.3.0.0	179	6	6	8	8	12.2.1.2

Router2

Router2								
PeerState	PeerLocalPort	PeerRemoteAddr	PeerRemotePort	PeerInUpdates	PeerOutUpdates	PeerInTotalMessages	PeerOutTotalMessages	NextHop
Internal	6334	12.2.0.0	179	6	6	8	8	12.2.1.2
Internal	26500	13.2.0.0	179	6	6	8	8	13.2.1.1
Established	4827	11.3.0.0	179	6	6	8	8	12.2.1.1
Established	19718	14.2.0.0	179	6	6	8	8	13.2.1.2
Established	5447	14.3.0.0	179	6	6	8	8	13.2.1.2
Established	14771	11.1.0.0	179	6	6	8	8	12.2.1.1
Established	19912	11.2.0.0	179	6	6	8	8	12.2.1.1

The Border Routers stores the node's remote address in its Routing Table as shown in the above Tables under -PeerRemoteAddr column.

Output: (Sample 2)

After running this scenario, in Performance Metrics screen, routing tables are obtained in BGP table and OSPF metrics.

If you click over the OSPF metrics, you will get the OSPF routing table for internal routers. If you click over the BGP table, you will get the routing table for Border routers. We have shown the routing tables for Border Router 1 and 2.

Router1

Router1								
PeerState	PeerLocalPort	PeerRemoteAddr	PeerRemotePort	PeerInUpdates	PeerOutUpdates	PeerInTotalMessages	PeerOutTotalMessages	NextHop
Internal	41	11.3.0.0	179	6	6	8	8	11.3.1.2
Internal	18467	12.2.0.0	179	6	6	8	8	12.2.1.1
Established	14604	13.2.0.0	179	6	6	8	8	12.2.1.2
Established	19718	11.1.0.0	179	6	6	8	8	11.3.1.1
Established	5447	11.2.0.0	179	6	6	8	8	11.3.1.1
Established	14771	14.2.0.0	179	6	6	8	8	12.2.1.2
Established	19912	14.3.0.0	179	6	6	8	8	12.2.1.2

Router2

Router2								
PeerState	PeerLocalPort	PeerRemoteAddr	PeerRemotePort	PeerInUpdates	PeerOutUpdates	PeerInTotalMessages	PeerOutTotalMessages	NextHop
Internal	6334	12.2.0.0	179	6	6	8	8	12.2.1.2
Internal	26500	13.2.0.0	179	6	6	8	8	13.2.1.1
Established	4827	11.3.0.0	179	6	6	8	8	12.2.1.1
Established	292	14.2.0.0	179	6	6	8	8	13.2.1.2
Established	17421	14.3.0.0	179	6	6	8	8	13.2.1.2
Established	17035	11.1.0.0	179	6	6	8	8	12.2.1.1
Established	23811	11.2.0.0	179	6	6	8	8	12.2.1.1

4.4.4 Inference:

First the internal Routing tables (RIP/OSPF table) are formed among all the Routers. The Border Routers contains the network address of the next hop and the destination nodes as represented in the routing table. Border Routers communicate with each other by passing their Routing tables resulting in the formation of external Routing tables (BGP table). Then actual packet transmission takes place from Source to Destination.