CS 3205 – Introduction to Computer Networks: Jan-May 2020

Assignment 6 (Macro Assignment 4)

Understanding the behavior of OSPFv2 and RIPv2 using GNS3 and Cisco Router images

Individual assignment – Assignment posted 2nd May 2020.

Assignment Deadline: 15th July 2020 Total of 160 marks.

Assignment weightage – 10 marks out of 100 for final grading.

Aim of the Assignment: Understand the functioning of the Routing Information Protocol (RIP) and Open Shortest Path First – the two interior gateway protocols used for calculating routes in an Autonomous System (AS). The behavior of the protocols have been explained in the class lectures. The GNS3 tool is to be used for the assignment.

Scope:

Using GNS3, enable topologies as indicated in the figures placed below. First part is using RIP version 2 and second part is using OSPF, third part is using OSPF and RIP. NOTE: JUST DON'T PASTE SCREEN SHOTS where it is requested. For each screen shot, a short 2 to 3 sentence on your observation is required.

Section 1: RIP Protocol

Assignment Steps - 1:

Enable using GNS3 a topology comprising of two routers running RIP Version 2, and two terminals as shown in Figure 1. Configure the topology with the networks given. (Please note, the second byte value in the network should match your roll number. For example if your roll number is CS17B099 – then the networks should be 192.99.1.0/24, 192.99.2.0/24 etc.) Please use the convention of naming the last byte of the routers as 101 for R1, 102 for R2, 103 for R3 etc, This recommendation was given in the class discussions.

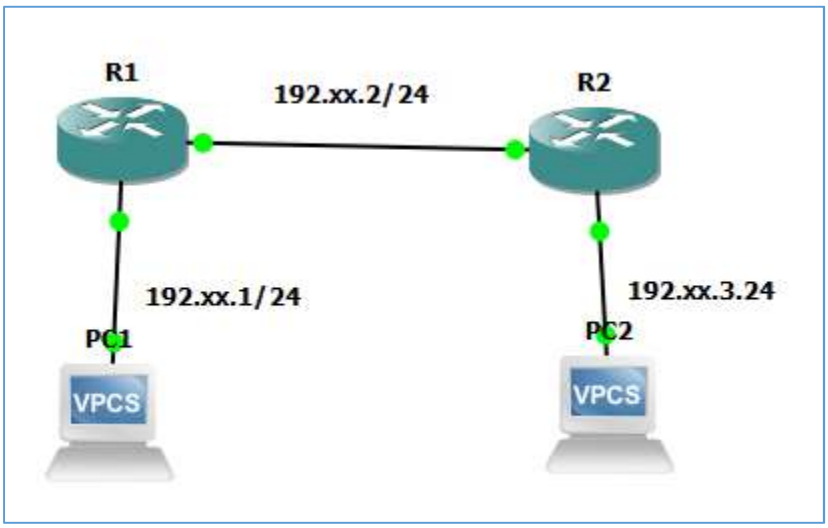

Figure 1. RIPv2 Enabled Topology - 2 Routers

Output expected: Enable necessary configurations in the routers, and PC. Save the running configuration to startup configuration in the routers.

1) Name the project as RIPv2_Routers, Zip the project folder
2) Screen shot of "show ip route" in routers R1 and R2
3) Screen shot of "Ping successful" from PC1 to both R1's interfaces, R2's interfaces and PC2 interface. (5 Ping executions – to different IPs)
4) Wireshark capture between R1 and R2, to understand RIP exchanges, containing atleast 3 RIP Reply / Response messages from R1 and R2.

Credits: 20 Marks (Working project – 6 marks, IP route screen shots at two routers – 2 marks each, 5 successful Ping response at PC1 – 1 mark each, Wireshark file – 5 marks). Please note, working project means, if the GNS3 project is loaded and enabled (started), the expected route table contents must be achieved.

Assignment Steps - 2:

Enable using GNS3 a topology comprising of four routers running RIP Version 2, and four terminals as shown in Figure 2.

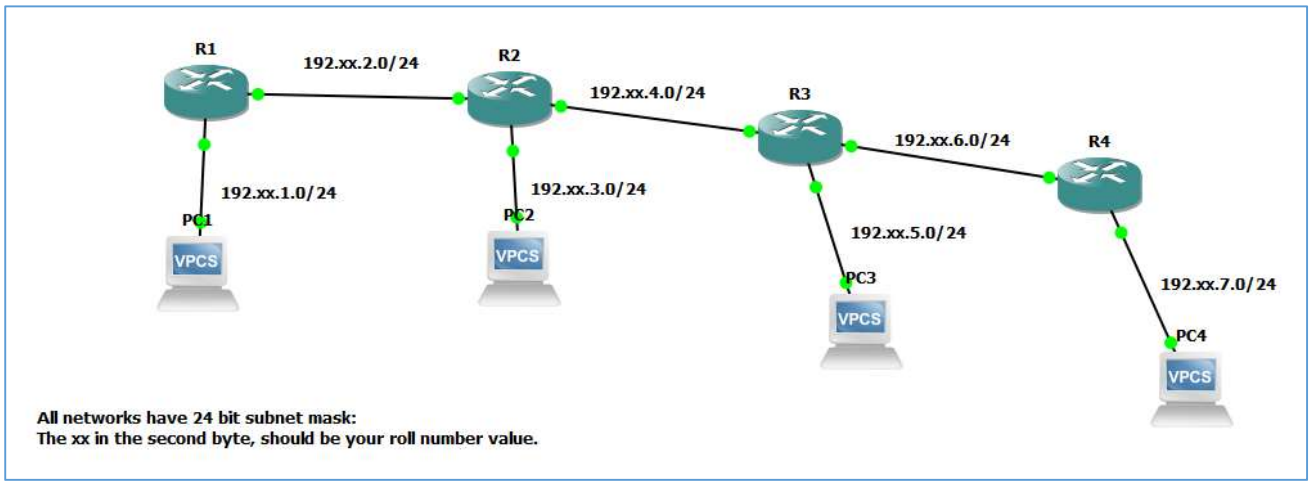

Figure 2. RIPv2 enabled Topology - 4 Routers

Output expected: Enable necessary configurations in the routers, and PC. Save the running configuration to startup configuration in the routers.

1) Name the project as RIPv4_Routers, Zip the project folder
2) Screen shot of "show ip route" in routers R1, R2, R3 and R4
3) Wireshark capture between R1 and R2, and R2 and R3, to understand RIP exchanges, containing atleast 3 RIP Reply / Response messages from corresponding routers.
4) Screen shot of RIP message contents (using Wireshark) from R2 expanded, when exchanged between R1-R2, and between R2-R3.
5) Screen shot of Trace route message at Router R1 to R4's 192.xx.6.107 and R3's 192.xx.6.106 interfaces

Credits: 20 Marks (Working project – 4 marks, IP route screen shots at four routers – 1.5 marks each, Wireshark file – 2 marks each, Screen shot of R2 RIP message expanded at Wireshark – 1 marks each. Trace route screen shot for R3 and R4 – 1 marks each)

Assignment Steps - 3:

Enable using GNS3 a topology comprising of five routers running RIP Version 2, and five terminals as shown in Figure 3.

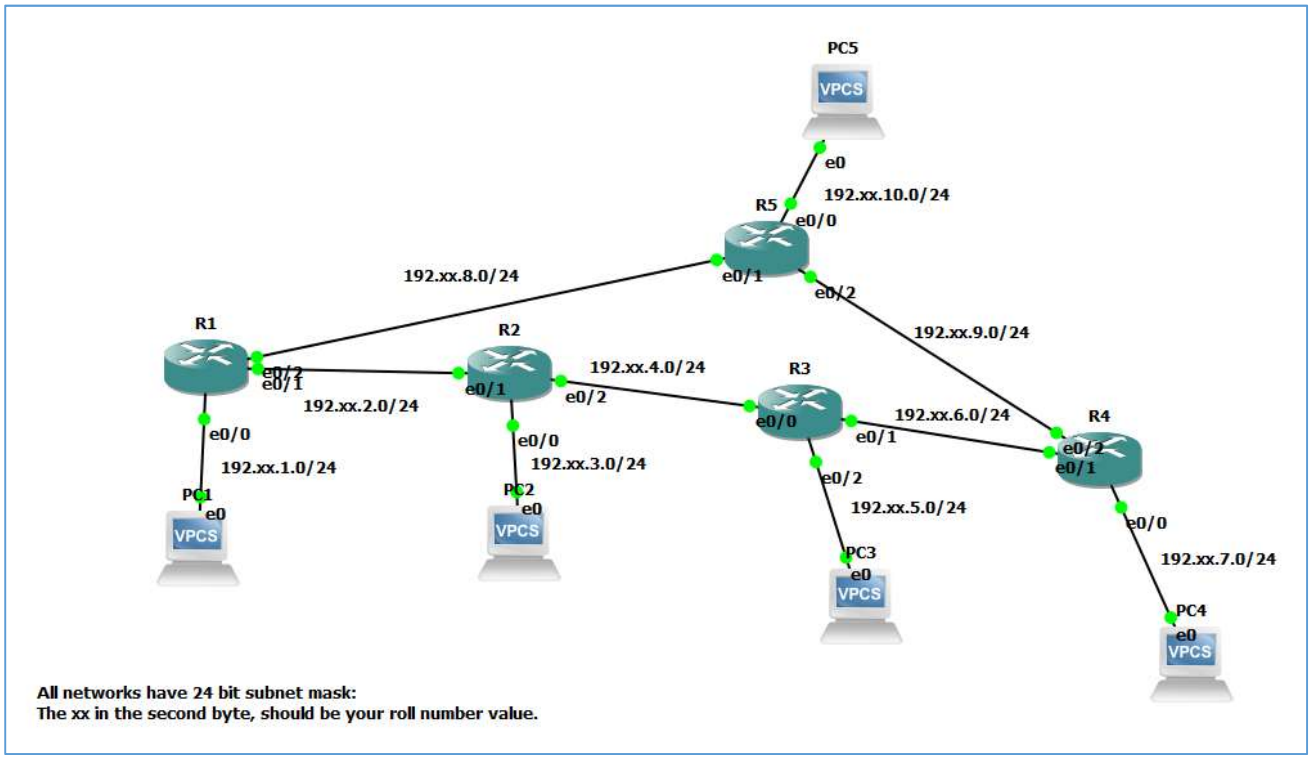

Figure 3. RIPv2 enabled Topology - 5 Routers

Output expected: Enable necessary configurations in the routers, and PC. Save the running configuration to startup configuration in the routers.

1) Name the project as RIPv5_Routers, Zip the project folder
2) Screen shot of "show ip route" in routers R1, R2, R3, R4 and R5. How have the routes changed in this new topology.
3) Screen shot of Trace route message at Router R1 to R4's 192.xx.6.107 interface. Write down the observation compared to the trace route done in the earlier Step 2.5
4) Screen shot of Trace route message at Router R1 to R3's 192.xx.6.106 interface. Is there any change compared to earlier step 2.5?

Credits: 20 Marks (Working project – 3.5 marks, IP route screen shots at five routers – 2.5 marks each, - Please highlight the difference observed in this topology compared to the last Step 2 If there is a change why, if no change why?. Trace route screen shots – 2 marks each).

Assignment Steps - 4:

Enable using GNS3 a topology comprising of five routers running RIP Version 2, and five terminals as shown in Figure 4. (Save the project used in earlier step as a new project. At the interface e0/0 at R3 execute the command "shutdown" at the interface. i.e. the interface is administratively down, i.e. no data show flow across the link. It is sufficient to do this at any one of the routers. You may do it at both interfaces, it does not matter.

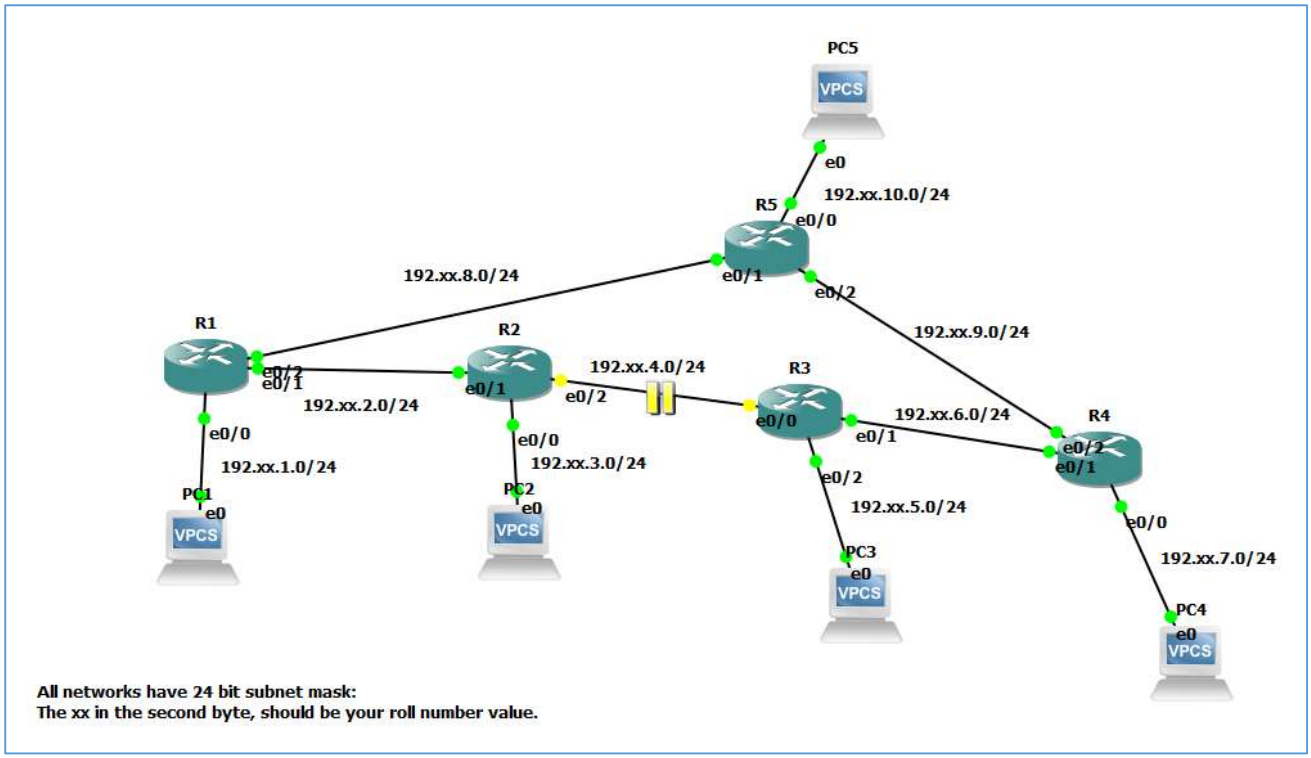

Figure 4. RIPv2 enabled Topology - 5 Routers. The interface connection between R2 and R3 disabled.

Output expected: Enable necessary configurations in the routers, and PC. Save the running configuration to startup configuration in the routers.

1) Name the project as RIPv5_Routers_LinkSuspend, Zip the project folder
2) Screen shot of "show ip route" in routers R1, R2, R3, R4 and R5. How have the routes changed in this new topology.
3) Screen shot of Trace route message at Router R1 to R4's 192.xx.6.107 interface. Write down the observation compared to the trace route done in the earlier Step 3.3
4) Screen shot of Trace route message at Router R1 to R3's 192.xx.6.106 interface. Is there any change compared to earlier step 3.4?

Credits: 20 Marks (Working project – 3.5 marks, IP route screen shots at five routers – 2.5 marks each, - Please highlight the difference observed in this topology compared to the last Step 3 If there is a change why, if no change why?. Trace route screen shots – 2 marks each).

Section 2: OSPF Protocol

Assignment Steps - 1:

Enable using GNS3 a topology comprising of two routers running OSPF Version 2, and two terminals as shown in Figure 1. Configure the topology with the networks given. (Please note, the second byte value in the network should match your roll number. For example if your roll number is CS17B099 – then the networks should be 10.99.1.0/24, 10.99.2.0/24 etc.) (Generic NOTE: Enable Wireshark between the interfaces at R1 e0/1 and switch e0. Stop the wireshark capture only when all aspects are done, and save the wireshark capture.) The goal is to understand the Type 1 and Type 2 – Router LSA, and Network LSA. Network LSA is typically generated by the Designated Router. Also please not Network LSA is generated for multi-access network. i.e. a network accessed by many routers. Multiple routers are connected to the common 10.xx.2.0/24 network by a switch

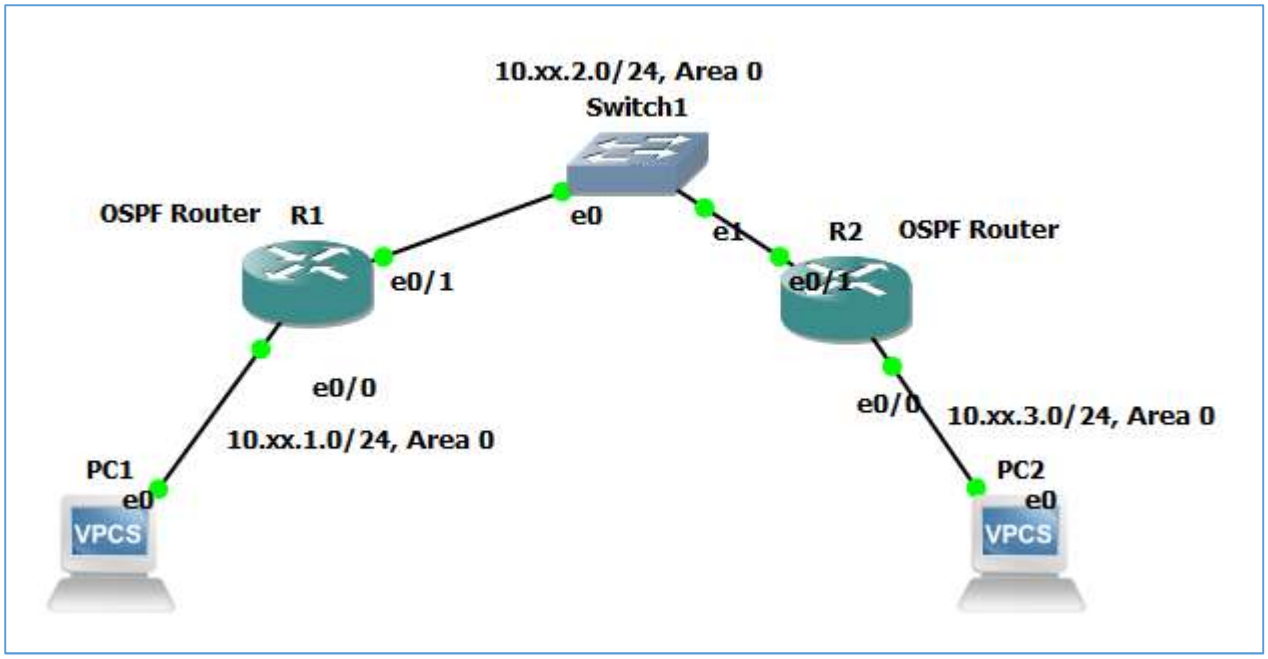

Figure 5. OSPFv2 Enabled Topology - 2 Routers

Output expected: Enable necessary configurations in the routers, and PC. Save the running configuration to startup configuration in the routers.

1) Name the project as OSPFv2_Routers, Zip the project folder
2) Screen shot of "show ip route" in routers R1 and R2
3) Screen shot of Link State Database in the routers R1 and R2. How many LSA are there in each router and what are their types.
4) Screen shot of "Ping successful" from PC1 to both R1's interfaces, R2's interfaces and PC2 interface. (5 Ping executions – to different IPs)
5) Wireshark capture between R1 and R2 (captured), to understand OSPFv2 exchanges, enabling the full complete transition and database exchanges. List which messages constitute the LS Data Base Exchange sequence.

Credits: 20 Marks (Working project – 4 marks, IP route screen shots at two routers – 2 marks each, Link State Database screen shots at the two routes – 2 marks each, 5 successful Ping response at PC1 – 4 marks, Wireshark file – 4 marks). Please note, working project means, if the GNS3 project is loaded and enabled (started), the expected route table contents must be achieved.

Assignment Steps - 2:

Enable using GNS3 a topology comprising of three routers running OSPF Version 2, and three terminals as shown in Figure 2. In this setup, the goal is to enable each router one by one with a sufficient time gap between each router configuration. The goal is to understand the neighbor states DR/BDR and DR-Other, when more than 3 routers are connected in a multi-access network.

Step 2.a: Enable Router R1 first. Allow it to settle down. Say 2 minutes. Capture screen shots at R1 for "Show ip route" and "OSPF LSA Database". What is the status w.r.to on OSPF neighbors? Enable Wireshark between the interfaces at R1 e0/1 and switch e0.

Step 2b: Enable Router R2. Capture screen shot for “show ip route” and “OSPF LSA Database”. What is the status w.r.to OSPF neighbours? Which router is the “Designated Router” and “Backup Designated router”? How did you find this information?

Step 2c: Enable Router R3. Capture screen shot for “show ip route” and “OSPF LSA Database”. What is the status w.r.to OSPF neighbours? Which router is the “Designated Router” and “Backup Designated router”? How did you find this information? What is the state at R3?

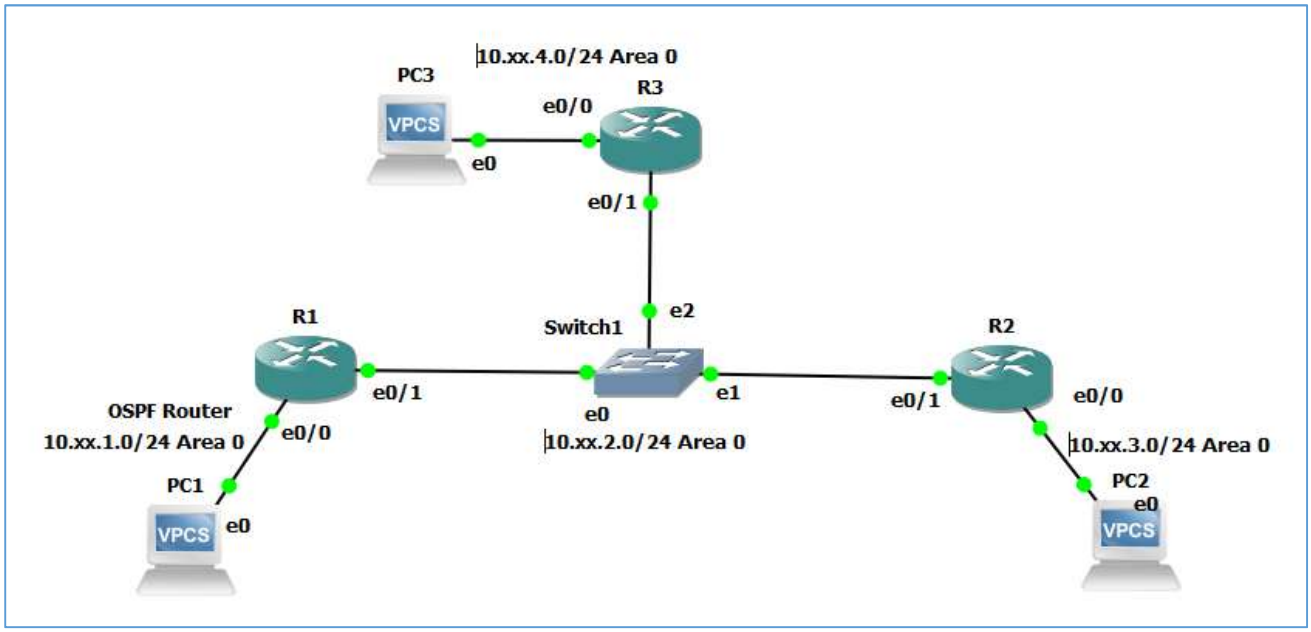

Figure 6. OSPFv2 Enabled Topology - 3 Routers

Output expected: Enable necessary configurations in the routers, and PC. Save the running configuration to startup configuration in the routers.

1) Name the project as OSPFv3_Routers, Zip the project folder
2) Screen shot at R1 as indicated in the progressive steps, highlight changes, what are your observations.
3) After Step 2.c completion, screen shot at R2 and R3 w.r.to “OSPF LSA Database”. Share your observations.
4) Wireshark capture to understand OSPFv2 exchanges, enabling the full complete transition and database exchanges. List which messages constitute the LS Data Base Exchange sequence. The wire shark file needs analysis i.e. list all the key messages that enables the correct route table formation. i.e. ensure the packets are related to only OSPF packets. You can filter OSPF, and also exclude all hello packets. This will enable you to capture the other packets and ease the analysis. Please add your comment in the packet when you analyse. You can place your comments against the packets in the Wireshark. Wireshark has the ability to enable user to place a comment by right click on a chosen packet (Ref Figure 7, Figure 8), and comment saved (Ref Figure 9). The comment can be later viewed.

Credits: 20 Marks (Working project – 5 marks, the screen shots at R1 for each stage – ip route, LSA database – 6 marks total. OSPF LSA database at R2 and R3 – 2 marks each. Wireshark file with analysis – 5 marks).

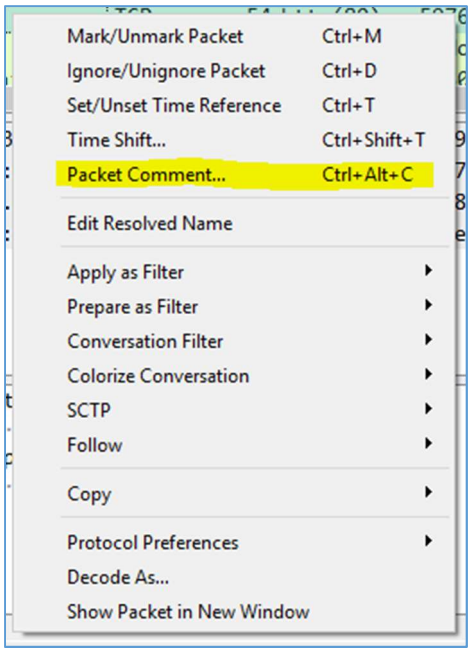

Figure 7. Wireshark - Packet comment enabling option.

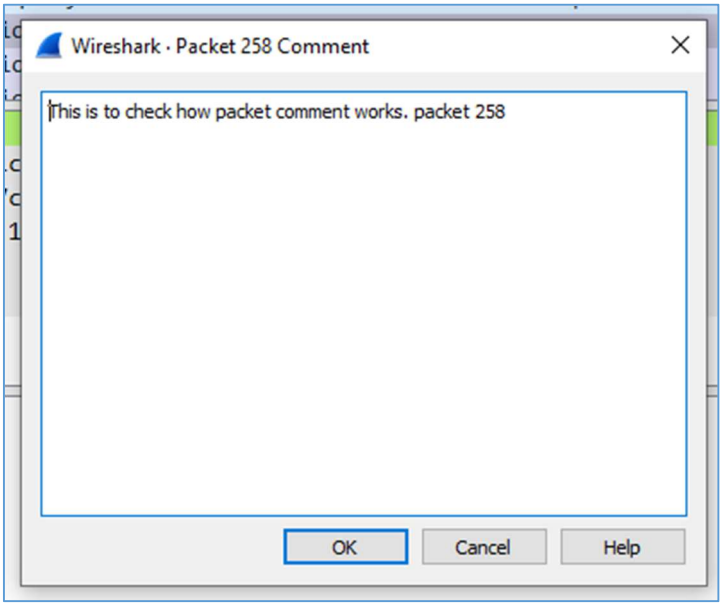

Figure 8. Comment window pop up to enable capturing the comments.

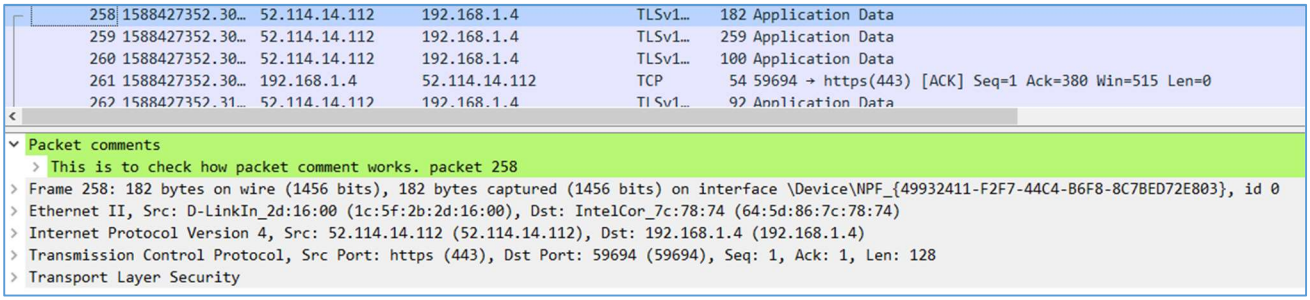

Figure 9. Wireshark a packet with comments, viewable in section.

Assignment Steps - 3:

Enable using GNS3 a topology comprising of four routers running OSPF Version 2, and Four terminals as shown in Figure 10. In this setup, the goal is to understand the role of Area Border Router. Router 3 is part of both back bone area and Area 100. In an OSPF Topology the back bone area is a must need and it enables the routes to be efficiently learnt in a hierarchical way with splitting the topology in to suitable areas. Area border routers generate "Type 3" – Network Summary LSAs. (For example, in IIT Campus, all networks within a department can be an area, and there can be one area – backbone which interconnects).

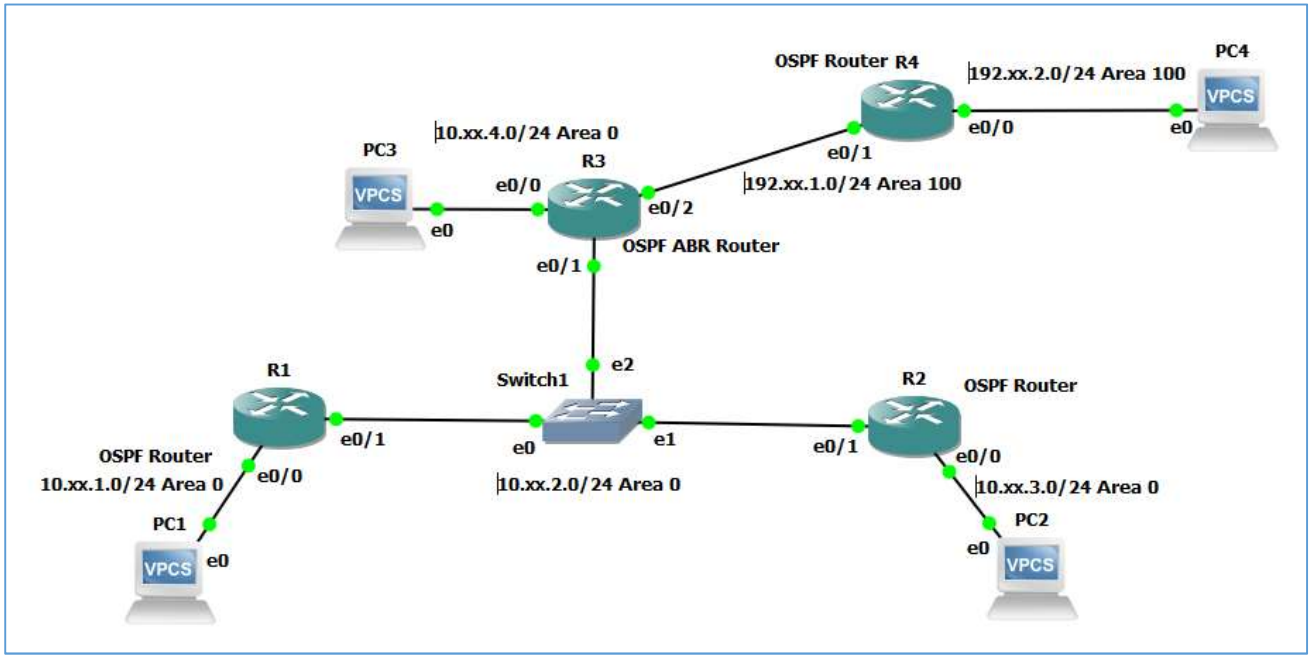

Figure 10. OSPF Four routers - Two areas.

Save the previous step as a project, and build this exercise on top of it. Enable wireshark between the interfaces at R3 e0/1 and Switch e0. This to check all the OSPF PDUs exchanged between R3 and R1, R2.

Step 3.a: Enable Routers R1, R2, R3 and with only the interfaces associated with Backbone enabled. Let the topology and routes converge. Check the IP route table, and Link state database at R1, R2, and R3. Make screen shots at R1, R2 and R3 of the Link state database.

Step 3.b Enable Router R4 with necessary configurations. Enable interface e0/2 at Router R3, and associate that interface with the Area 100. What is the LSA database and route information available at R4. Make screen shot.

Step 3.c Observe the routes at R1, R2, R3, and R4 and the link states. What new Link State Advertisements (LSAs and types) are added at R1, R2, R3 compared to the earlier Step 2 (where there was only back bone area). Which router generates these new LSAs? Make screen shots of the Link State Data base.

Output expected: Enable necessary configurations in the routers, and PC. Save the running configuration to startup configuration in the routers.

1) Name the project as OSPFv2_ABR_Routers, Zip the project folder.
2) Screen shot at R1, R2 andR3 as indicated in the progressive steps, highlight changes, what are your observations.
3) At R4 what do you observe?
4) Wireshark capture to understand OSPFv2 exchanges, when new area is added. Can you observe how the new area addition and the networks reachable are communicated by R3 to R1 and R2? Highlight/identify those packets, place comments. List the packet identifiers in the analysis.

Credits: 20 Marks (Working project – 4 marks, The screen shots (3 * 4) at R1, R2, R3 for two stage – ip route (3 marks), lsa database (6 marks) – 9 marks total. Screen shot at R4 – 2 marks. Wireshark file with analysis – 5 marks).

Section 1: OSPFv2 and RIPv2 Combined deployment

Enable using GNS3 a topology comprising of four routers running OSPF Version 2, two routers running RIP and Six terminals as shown in Figure 11Figure 10. In this setup, the goal is to understand the role of Autonomous System Boundary Router, the generation of ASBR summary LSA by a ABR, and generation of (Type 5) External Network (route) summary LSAs by a ASBR router.

Router 1 is supporting both OSPFv2 and RIPv2. Typically within an AS one of the interior gateway protocols would be enabled. Hence here, OSPFv2 is assumed to be enabled within one AS say AS1, and RIPv2 enabled in another AS say AS2. Router 1, will generate the Type 5 "External LSAs".

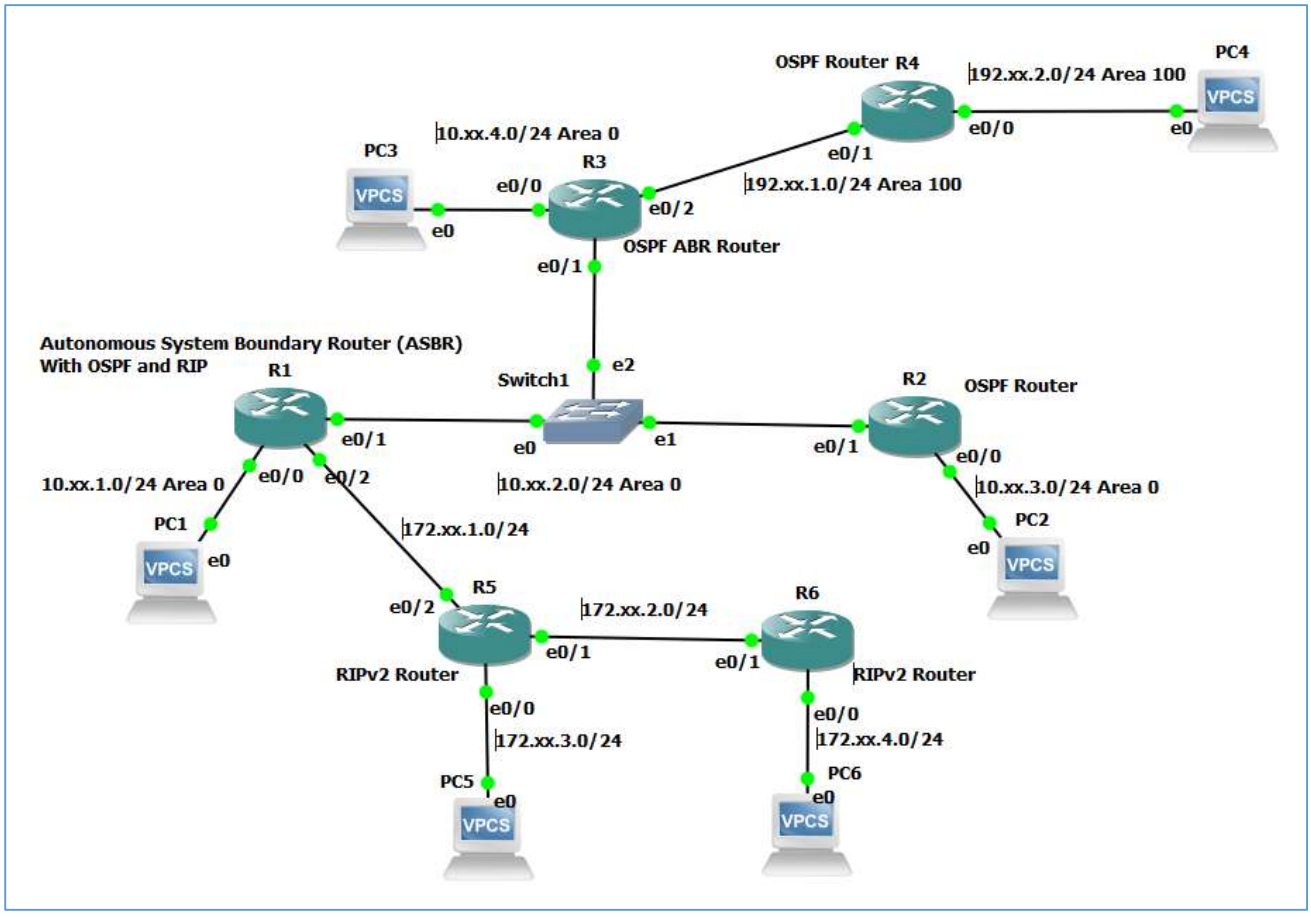

Figure 11. OSPFv2 and RIPv2 Combined deployment

Router 3 being an ABR, generates Type 4 – "ASBR summary LSA" in the given topology.

Please note, you would need to enable the necessary configurations for the routes to be re-distributed across the two routing protocols. OSPF configuration must include to redistribute RIP routes, and vice versa.

Save the previous step as a project, and build this exercise on top of it. Enable wireshark between the interfaces at R3 e0/1 and Switch e0. This to check all the OSPF PDUs exchanged between R3 and R1, R2.

Step 1.a: Bring up the 4 OSPF Router setup as in previous Section 2 – Assignment Step 3. Check the IP Routes, and LSA database states.

Step 1.b Enable Routers R5 and R6 with necessary RIPv2 configurations. Check the Routing table at R5 and R6.

Step 1.c Enable Router R1 interface e0/2. Enable RIP routing protocol. Check the Routing table at R1.

Step 1.d. Enable wireshark between a) interfaces R3 e0/1 and Switch e2 b) interfaces R3e0/2 and R4 e0/1, and c) between interfaces R5 e0/1 and R6 e0/1 (A total of 3 wireshark captures).

Step 1.e) Enable the route redistribution for RIP routes to OSPF and vice versa at Router R1.

Step 1.f.) Allow route info to converge. Check the ip routes at all 6 routers. Check the LSA Data base in the four OSPF Routers.

Step 1.g) Perform Ping, Trace route between Terminal PC4 to PC5 and PC6 to PC3. (if trace route can be done only at rotuers, perform at the nearest gateway router)

Output expected: Enable necessary configurations in the routers, and PC. Save the running configuration to startup configuration in the routers.

1) Name the project as OSPFv2_RIPV2_Routers, Zip the project folder. (4 marks)
2) Screen shot at R5, R6 for routes at end of Step 1.b (2 marks)
3) Screen shot at all routers for the routes at the end of step 1.f, LSA database at the four OSPF Routers. Is the count of LSAs in all four routers same or different? Share observation as what you observed in Section 2 end of Step 3. (8 marks)
4) Wireshark captures with Analysis. A) When does Router R1 generate the External summary LSA i.e. in which OSPF PDU is it observed from the capture? B) When does Type 4 LSA get generated from R3? C) When does RIP Routers (R6) come to know of the additional routes (from R5 response)? (6 marks)

Credits: 20 Marks (splits given above)