CSCE 331301 Course Project
Media Streaming over IP and Standby Router Protocols

Due Date: Sunday May 11th, 2025 (11:59 pm) – (Hard Deadline)

Project Goal and Description

The project is two main parts. The goal of the first part is to understand and analyze the following two media transport protocols: 1) The Real-time Transport Protocol (RTP) and 2) the RTP Control Protocol (RTCP). The RTP is a network layer protocol that provides Voice over Internet Protocol (VoIP) support through which audio and video traffic can be transferred over IP networks. While RTP delivers media streams, RTCP monitors the quality of service (QoS).

Second, **the Hot Standby Router Protocol (HSRP)** is a Cisco proprietary redundancy protocol designed to ensure high availability for IP networks. **HSRP** enables a group of routers to present themselves as a single virtual router by sharing a virtual IP and MAC address. This setup allows one router to take over the forwarding role if the active router fails, thus providing seamless network access. HSRP operates by selecting an active router, which handles the traffic for the virtual IP address, and a standby router that monitors the active router's status and takes over if it becomes unavailable. HSRP relies on priority configurations to determine active and standby roles and uses a series of states (such as Initial, Learn, Listen, Standby, and Active) to manage transitions between routers. The protocol is ideal for maintaining uninterrupted network services in IP environments, particularly for mission-critical applications. This project is divided into two parts to ensure a full understanding of the different protocols. In addition, you will be able to learn and demonstrate different networking and programming skills.

First Part: RTP and RTCP Protocols

In this part, you will establish a real-time conference session over a wired or wireless network using open-source video conferencing software based on the RTP/RTCP protocol suite **without encrypting the payload**. You will capture and analyze the data and control packets using the Wireshark monitoring and analysis tool.

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Project Requirements:

1. Explain the RTP and RTCP protocols in details.
2. Filter the RTP and RTCP packets in Wireshark
3. Identify the payload type, whether audio or video.
4. Inspect the following different reports used by RTCP:
   - Sender Report (SR)
   - Receiver Report (RR)
   - Source Description (SDES)
   - End of Participation (BYE)
   - Application Specific (APP)
5. Examine and compute the end-to-end (E2E) delays.
6. VoIP test from VM1 to VM2 using Cisco IP communicator

- **RTP and RTCP (Socket Programming using C++)**

  This part will introduce you to the **socket programming APIs** and **operating system concepts** essential for deploying **real-time networked applications**. You are required to build an **RTP-like server socket**. This can be realized by implementing two modules:

  1. **A server socket** that listens for any incoming **RTP-like connection**.
     - The server provides **read and write operations** to handle real-time media transmission.
     - In addition, the server must generate **RTCP feedback** to report network performance metrics such as **packet loss, jitter, and delay**.

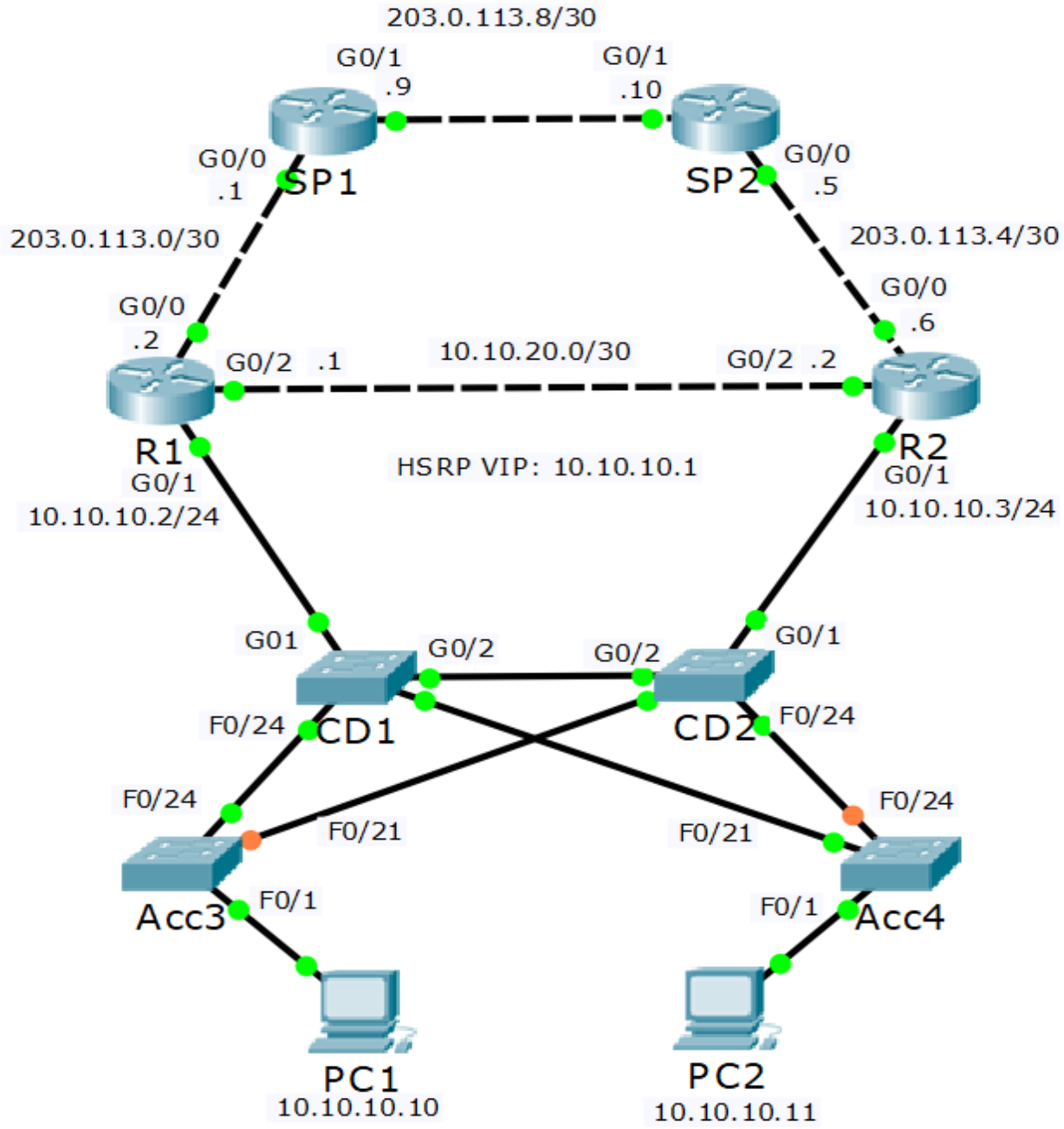
  2. **A client socket** that connects to the server and transmits **RTP-like packets**.
     - The client should simulate real-time data transmission (e.g., sending dummy media packets).
     - The client should also receive **RTCP reports** and adjust transmission accordingly.

Second Part: HSRP Protocol Configuration

The Hot Standby Router Protocol (HSRP) is a Cisco proprietary redundancy protocol for establishing a fault-tolerant default gateway in a network. This protocol provides high network availability by creating a virtual router as a standby when there is a failure in the primary router.

In this part, you will gain a thorough understanding of the functionality and operation of the Hot Standby Router Protocol (HSRP), including its classification within networking protocols. You should also explore and answer the following points in detail in your report. In this part, you will configure and test HSRP for a small campus network (shown below).

Campus Network Topology



Using Cisco's Packet Tracer network simulation tool, build the given network topology and apply the following configurations: (*Include all necessary screenshots in your report*)

Basic HSRP

1. Configure basic HSRP for the 10.10.10.0/24 network using the IP addresses shown in the topology diagram.
2. Wait for HSRP to come up on both routers and then check which is the active router.
3. Verify that the PCs can ping their default gateway using the HSRP address 10.10.10.1.
4. Verify that the PCs have upstream connectivity via their HSRP default gateway. Ping SP1 at 203.0.113.1
5. What is the MAC address on the physical interface of the active router?
6. What is the MAC address of the HSRP virtual interface?
7. Verify the PCs are using the virtual MAC address for their default gateway.

Priority and Pre-emption

8. Configure HSRP so that R1 will be the preferred router. Use a single command.
9. Which router do you expect will be active now? Verify this.
10. Ensure that R1 is the active router. Do not reboot.

Test HSRP

11. Run a continuous ping to the HSRP IP address from PC1 with the ping 10.10.10.1 -n 1000 command.
12. Save the configuration on R1, then reboot.
13. View the ping output on PC1. You should see a few dropped pings as R2 transitions to active following the outage of R1.
14. Verify R2 has transitioned to HSRP active.
15. Wait for R1 to complete booting and HSRP to come up. Verify R1 transitions to HSRP active because pre-emption is enabled.
16. Hit 'Ctrl-C' to cancel the ping on PC1. If you scroll back, you should see a dropped ping or two as R1 transitioned back to HSRP active.

Project Learning Outcomes:

1. Deep understanding of media transport protocols used over the Internet.
2. Extensive use of Wireshark filters, beyond their classic use with the TCP/IP protocol stack.
3. Understanding of the Network Time Protocol (NTP) and wall-clock protocol.
4. Understanding the VoIP network communication between two VMs using GNS3.
5. Socket programming in C/C++.
6. Create comprehensive network applications using sockets.
7. Learn about and use the Packet Tracer network simulation tool.
8. Learn and configure the HSRP.

Project Logistics:

- Each team consists of two students only. For the demo and discussion, **each student will be questioned independently and may receive a different grade**. Be prepared!
- Avoid short answers, you have to answer each question in every detail related to it.
- You need to provide the references from which you got your information.
- It is recommended to use Cisco's documentation.

Project Deliverables:

- Network setup configuration, Pcap files and Cfg files. **(7 points)**
- VoIP with Cisco IP communicator over GNS3. **(4 points)**
- Project C/C++ files (Server.c and Client.c). **(5 points)**
- Technical report summarizing the results and major findings. **(4 points)**
- Demo & Discussion: 10 minutes Q&A session per group. **(5 points)**
  - **Demo Date and Time:** Tuesday May 13th, 2025, 2:30 – 3:30 pm
    (*More info. will be provided later*)

Part of the grade will be dedicated to the organization of your submission and the technical report.