



Design and Implementation of a Routing Protocol Based on CPT Simulator

Taking RIP Protocol as an Example

Shuying Liu, Tao Zeng*, Yan Chao

(School of Computer and Information Engineering, Fuyang Normal University , Fuyang Anhui 236037,China)

liushuying@fynu.edu.cn, 544307366@qq.com, 910984320@qq.com

Abstract. In order to effectively solve the problem of students being unable to attend laboratory classes in the classroom due to uncertain factors such as limited location of computer network experiments and the epidemic, this article uses Cisco Simulator to build a network simulation platform and introduces RIP routing protocol as an example. The construction of a network simulation experimental platform based on Cisco emulators has solved the shortcomings of traditional practical teaching. Practical teaching has shown that the construction of this platform can enhance students' interest in learning the network and their ability to innovate in the network.

Keywords: Network; Cisco Simulator; Simulation;

1 Introduction to CPT Simulator

Cisco Packet Tracer (CPT) ^[1-3] is a powerful network simulation software that can simulate network communication. Based on this platform, students can practice designing, configuring, discovering, and troubleshooting network faults anytime and anywhere. In response to the limitations of network experiment training conditions and uncertain factors such as the epidemic, which prevent the normal conduct of network experiments, a CPT network simulator is introduced. Building a network experiment simulation platform based on virtual technology eliminates the need to consider issues such as the location and time of classes for online experiments. Due to the fact that the devices in the platform are virtual, there are generally no common hardware device failures, connection issues, etc. in real network environments. This not only saves teaching costs, but also invisibly improves the efficiency of students conducting experiments, which has great theoretical and practical significance for improving students' practical and innovative abilities.

© The Author(s) 2024

G. Guan et al. (eds.), *Proceedings of the 2023 3rd International Conference on Education, Information Management and Service Science (EIMSS 2023)*, Atlantis Highlights in Computer Sciences 16, https://doi.org/10.2991/978-94-6463-264-4_55

2 Introduction to RIP Protocol

RIP protocol is one of the earliest network routing protocols used, which is based on distance vectors and suitable for routing with fewer network nodes^[4-5]. In the RIP protocol, "distance" is defined as "hop count", which means that for every router that a datagram passes through, the distance increases by 1. The network using RIP protocol requires all routers to maintain a distance record when working, which is used to record the distance from the router to other destination networks in the network, and it exchanges its own content-routing table with adjacent routers every 30 seconds. The RIP protocol uses user datagram packets to transmit information, which is a simple and low-cost datagram transmission method. But the disadvantage is that it is slow for bad message transmission, so it is not suitable for large-scale networks, etc. In response to this issue, the IETF Association later released a new version of the RIP protocol, RIP2. The new version of RIP2 supports subnet routing, CIDR, and multicast, as well as multicast support^[7].

3 Experimental Design and Implementation

3.1 Construction of network topology structure

This article takes the RIP protocol, which is often offered in computer network experimental courses, as an example to introduce the construction of a RIP routing selection protocol simulation experimental platform based on CPT simulator^[6]. Through the learning of simulation experiments, not only can students deepen their understanding of the working principle of RIP protocol and the format of RIP messages, but also break through the traditional network experimental teaching mode of fixed location and fixed time. The design of RIP routing protocol experimental network topology diagram based on CPT simulator is shown in Figure 1. This diagram is composed of four routers and three PCs. Each router is configured with RIP protocol^[8]. After receiving the message sent to it by its neighbor router, each router will update its own Routing table. Finally, routers in the entire network can get the routing message of the whole network by receiving the neighbor routing message update, thus forming a Routing table. Ultimately, communication between hosts is achieved. The allocation of IP addresses and subnet masks for three PCs is shown in Table 1.

Table 1. PC Host IP Address Allocation

host	interface	IP address	mask
PC1	Fa0	10.0.0.1	255.0.0.0
PC2	Fa0	13.0.0.1	255.0.0.0
PC3	Fa0	14.0.0.1	255.0.0.0

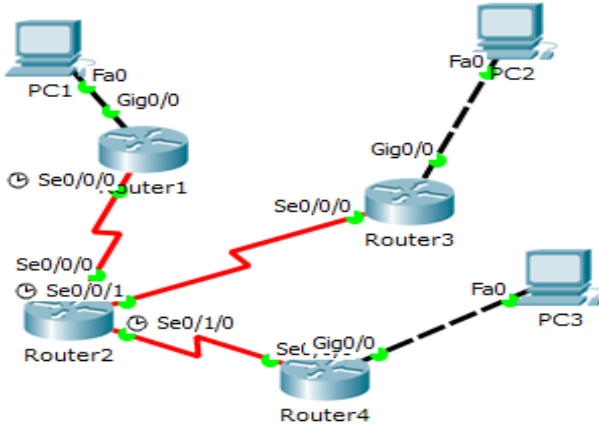


Fig. 1. Network Topology Diagram

3.2 Experimental Process

Related Parameter Configuration.

Configure the three hosts according to the content in Table 1.

Taking host PC1 as an example, click PC1 to enter the Config interface^[9], click FastEthernet0, and write the IP address 10.0.0.1 and subnet mask 255.0.0.0 in the IP Address column, as shown in Fig.2 below.

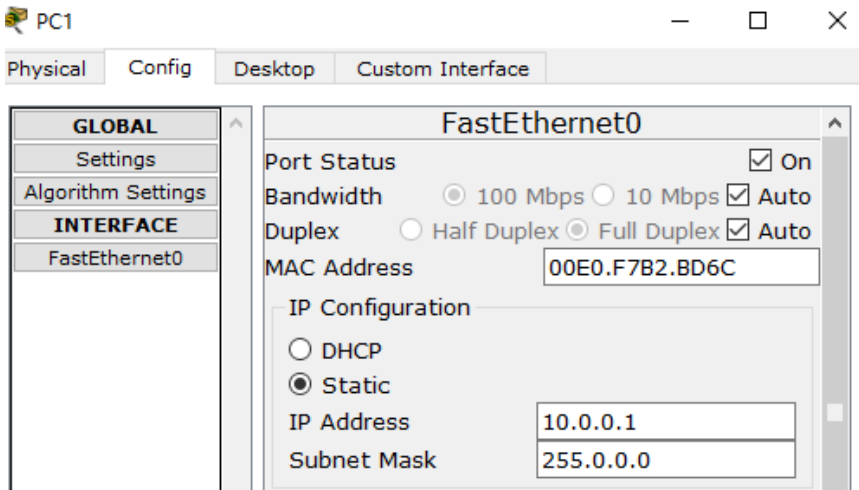


Fig. 2. Configuration of PC1



```

Router1
  Physical  Config  CLI
  IOS Command Line Interface

Router>en
Router#config
Configuring from terminal, memory, or network [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#interface GigabitEthernet0/0
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up

Router(config-if)#ip address 10.0.0.2 255.0.0.0
Router(config-if)#exit
Router(config)#
Router(config)#interface GigabitEthernet0/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Serial0/0/0
Router(config-if)#no shutdown
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#
  
```

Fig. 3. Configuration of Router1

Router configuration.

Due to the fact that each port of the router is initially in a closed state, before configuring addresses for each port, the ports should be turned on first. The opening and configuration methods for each port of the router are the same. Taking Router 1 and Router 2 as examples, the specific commands are shown in Fig. 3 and Fig. 4.

Observing the forwarding of RIP datagrams.

After completing the relevant configuration through the above steps, switch to Simulation mode and click the Auto Capture/Play button. RIP datagrams will automatically exchange with adjacent routers. Through observation, it is found that RIP packets are continuously forwarded between Router2 and the three surrounding routers, namely Router1, Router3, and Router4. In this way, each router knows how to forward the datagram to its destination through the latest route after receiving it.

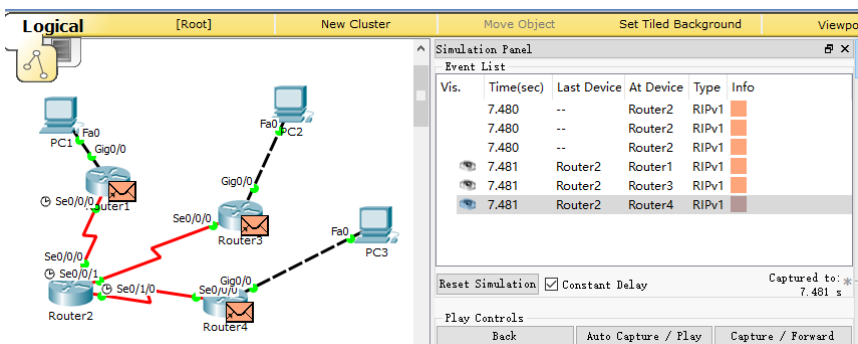


Fig. 4. RIP datagram forwarding

Check for route updates and RIP messages

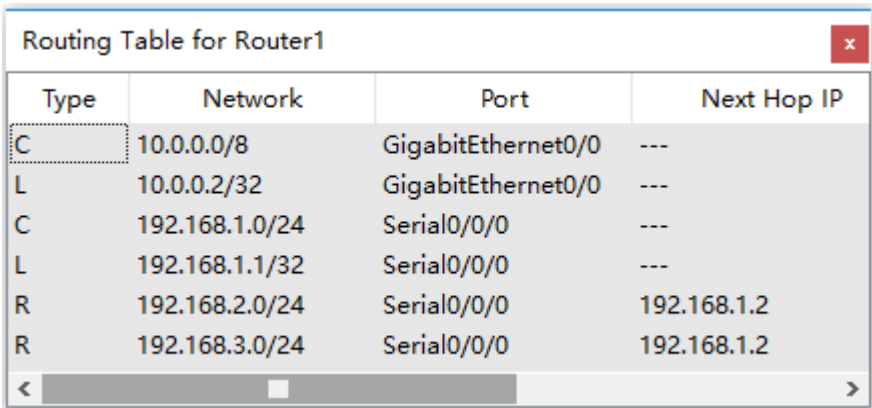
Clear the Routing table

In the simulation mode interface, click Reset Simulation to restart the simulation experiment. Before the experiment, use the clear ip route command to clear the router's Routing table

After clearing the Routing table of Router1 through the above command, click the inspect button, and then click to select the Routing Table on Router1. It can be seen that the Routing table in Router2, Router3, and Router4 has been deleted in the same way except for the local route and direct link route information.

Observe the change of Routing table

Click the Capture/Forward button to gradually track the routing information of RIP messages and observe the update process of routing information. When the first RIP message arrives at Router2 from Router1, click the Inspect button, and then click Routing Table on Router1. It is found that the Routing table of Router1 has not changed. Click the Capture/Forward button again. When the RIP message is sent from Router 2 to Router 1, observe the Routing table of Router 1, and it can be found that two pieces of routing information have been added, indicating that Router 1 can reach the network 192.168.2.0 and 192.168.3.0 through the next hop 192.168.1.2, as shown in Fig. 5. The learning process of other routers is similar to Router1, and we will not introduce them one by one here.



The screenshot shows a window titled "Routing Table for Router1" with a close button in the top right corner. The table contains the following data:

Type	Network	Port	Next Hop IP
C	10.0.0.0/8	GigabitEthernet0/0	---
L	10.0.0.2/32	GigabitEthernet0/0	---
C	192.168.1.0/24	Serial0/0/0	---
L	192.168.1.1/32	Serial0/0/0	---
R	192.168.2.0/24	Serial0/0/0	192.168.1.2
R	192.168.3.0/24	Serial0/0/0	192.168.1.2

Fig. 5. Routing table of Router1 after Learning

Analyze RIP datagrams

During the above single step execution process, when the first RIP datagram is generated, we view the format of the RIP message as shown in Fig. 6.

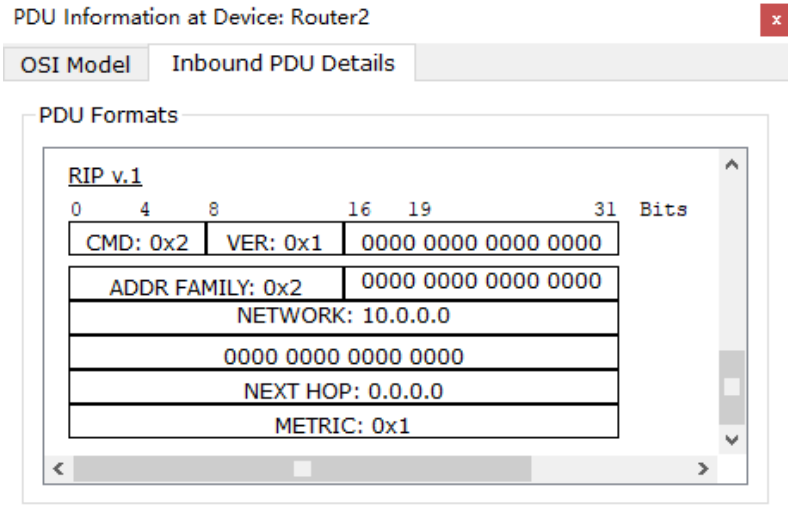


Fig. 6. RIP Datagram

4 Testing Network Connectivity in Simulation Platforms

After configuring, observing, and analyzing the devices in the experiment through the above steps, use the ping command to test the connectivity between PC1 and PC2, PC2 and PC3. After experimental testing, it is found that PC1 can communicate with PC2 and PC3, and PC1, PC2, and PC3 can also ping each other

After the connectivity test, click on PC1 and use the TRACERT command to track the datagram with IP address 14.0.0.1. The tracking result is shown in Fig.7. The datagram sent by PC1 enters Router1 through port 10.0.0.2, then enters Router2 through port 192.168.1.2, then enters Router4 through port 192.168.3.2, and finally reaches the destination^[10]. The RIP routing protocol is a protocol based on distance vectors. From the network topology diagram, it can be seen that the shortest path from PC1 to PC3 does indeed pass through Router1, Router2, and Router4, ultimately reaching PC3.

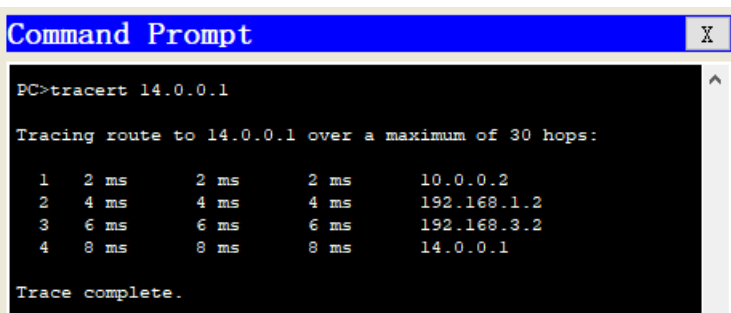


Fig. 7. Route Tracking

5 Conclusion

This article establishes a network simulation experimental environment on a CPT simulator, and takes the RIP routing protocol experiment as an example to introduce the construction of network topology, the configuration of host IP addresses and routers, the learning process of RIP datagrams, and the composition of RIP message formats. Finally, use the ping command to verify the connectivity between hosts in the network, and use the tracer command to check if the route selected by the RIP routing protocol is the shortest distance. The experiment proves that each host in the simulation experiment can communicate with each other, and the route selection is also the shortest path. By utilizing this platform, students can use their knowledge to simulate online experiments anytime and anywhere through their own computers. Students who have spare time can also carry out innovative experiments, which not only eliminates restrictions on their learning time and location, but also stimulates their interest in learning [7-10].

Acknowledgment

Fuyang Normal University Youth Talent Key Project (rcxm202211 and rcxm202106); General Natural Science Program of Fuyang Normal University (2021FSKJ12 and 2020FSKJ12); General Teaching Research Project of Fuyang Normal University (2022JYXM0024); 2021 Provincial Quality Engineering Project for Higher Education Institutions (2021xqhzsjjd055); General Teaching Research Project in Anhui Province (2021jyxm1100 and 2021xsxxkc213).

Reference

1. Feng h.h., Ren x., Research on the scheme of realizing cross device communication between VLANs based on Cisco simulator [J]. Journal of Yunnan University (Natural Science Edition), 2017, 39 (S1): 36-40.
2. Zhang q.h., Huang y.y., Building a Computer Network Teaching Experimental Platform Based on Packet Tracer [J]. Computer Knowledge and Technology, 2013, 9 (17): 3960-3962.
3. Luo y.j., Shi q.p., Implementation of multi-layer switch DHCP function in Packet Tracer [J]. Journal of Pu'er University, 2019, 35 (06): 30-33.
4. Lin n., Practical Research on Network Security Technology Based on Cisco Packet Tracer - Taking ICMP Protocol Analysis as an Example [J]. Technology Innovation and Productivity, 2021, No.332 (09): 104-108.
5. Wu s., Li r.x., Research and simulation implementation of fast Spanning Tree Protocol based on Packet Tracer [J]. Journal of Heilongjiang University of Technology (Integrated Edition), 2020,20 (03): 94-100.
6. Wang h.f., Liu z.q., Research and implementation of experimental evaluation system for computer network courses based on Packet Tracer [J]. Journal of Inner Mongolia University of Technology (Natural Science Edition), 2015, 34 (02): 125-130.

7. Deng J.s., Li r., Exploration of Teaching Reform in the Course of "Network Switching and Routing" [J]. Journal of Pingxiang University, 2022, 39 (06): 91-95
8. Xie y., Zhang y.f., Exploration of Online Teaching in Computer Network Experimental Courses [J]. Computer Education,2023(05):35-39.
9. Wu y.l., Li t. Development of Network Experimental Assessment Platform for Packet Tracer [J]. Gansu Science and Technology,2022,38(18):11-17.
10. Guo x.j., Research on the Integration of Virtual and Real Experiments in Computer Network Teaching [J].Information Systems Engineering,2020(10):161-162.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

