

## Chapter 5. Using PIN/XINU to Design Networking

### Assignments

We use the courseware, PIN/XINU, to design several assignments for the networking course. Students can have a hands-on experience for learning TCP/IP networking and can fully understand the TCP/IP protocols from these assignments. The followings illustrate three sample assignment which we designed, ARP protocol assignment, a network application program- chat, and RIP protocols assignment.

#### 5.1. ARP Protocol Assignment

ARP, the address resolution protocol, is the method for finding a host's hardware address when only its IP address is known. ARP is used to translate MAC addresses form IP addresses in TCP/IP.

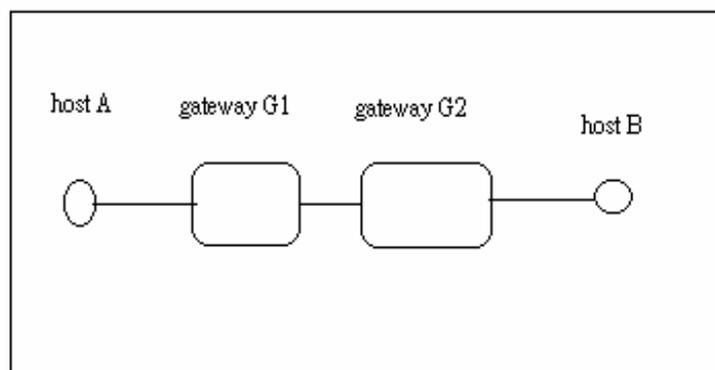
In PIN/Xinu, the ARP software is divided into three parts: an output module, an input module, and a cache manager. When sending a packet, the TCP/IP software calls output module to bind an IP address to its corresponding MAC address. The input module deals with ARP packets that arrive from the network; it updates the ARP cache by adding new bindings. The cache manager examines *arp* entries in the cache and removes them by the cache replacement policy.

We designed an ARP protocol assignment which helps that students can understand ARP protocols more clearly. The assignment has two sub-task, the first task, we eliminated the *arp<sub>send</sub>* function which is in output module. The intension of *arp<sub>send</sub>* is to broadcast an ARP request. Students need write the *arp<sub>send</sub>* function according

the purpose of the function and the format of the arp entry which is defined in PIN/XINU. The second task we ask students rewrite ARP cache management. We provide a simple ARP cache replacement policy: *when allocating space for a new addition to the ARP cache, choose an unused entry in the table if one exists. Otherwise, delete entries in a round-robin fashion.* We asked students to design a ARP cache replacement policy to replace original replacement policy, and then compare new replacement policy with original, find which one is more efficiency.

## 5.2. An Network Application Program – Chat

This assignment asks students write a network application program which can send a message to another host. The assignment gives a network topology which is shown in Figure 5.1. There are two hosts and two gateways in the network. Students have to design a chat program which can communicate with destination hosts across gateways.



**Figure 5.1 Given network topology in this assignment**

This assignment contains several protocols concepts, such as UDP protocol, IP protocol, ARP protocol. UDP provides connectionless communication among application programs. It allows a program on one host to send datagrams to a program

on another host, student have to use UDP to build a communication, and IP selects a route to send packet to destination host correctly. Though IP, packet can be send to destination across different nets.

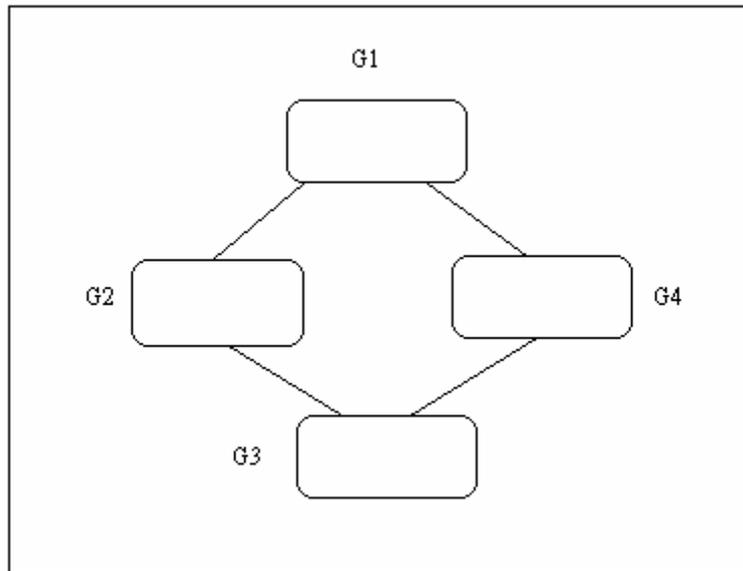
Besides achieve the chat program, we also ask students to observe the message flow in TCP/IP. Each layers of TCP/IP has its data format to process the message, students need inspect all data format in TCP/IP and observe how message send to destination across gateways.

This assignment comprises many protocols that all interact. Through doing this assignment, students can understand more clearly how multiple protocols operate together.

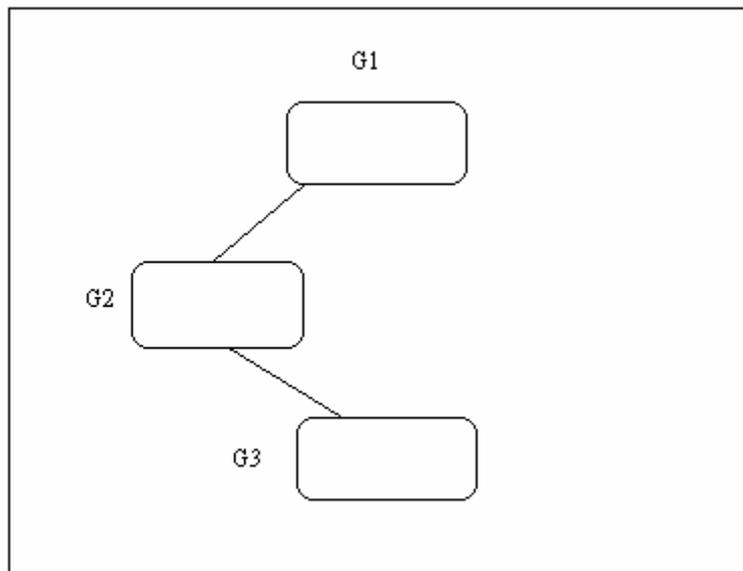
### **5.3. RIP Protocol Assignment**

RIP is one of the most commonly used interior gateway protocol (IGP) routing protocols on internal networks, which help routers change network connections by communicating routing information with near router. This assignment is designed for learning how RIP updates network connections by communicating routing information.

In this assignment, we eliminated the *riprecv* function and the *riprepl* function in RIP. The *riprecv* function handles incoming response a message which contains routing information, and the *reprepl* function process a received RIP request. Students need to finish the two functions according the purpose of the function. And then, students run RIP in PIN/XINU follow the network topology shown in Figure 5.2, and next, remove one gateway the same as Figure 5.3, and then observe the variation of routing table in each gateway to see whether gateways have a correct activity.



**Figure 5.2 The network topology in this assignment**



**Figure 5.3 The network topology after removes a gateway in this assignment**

Through doing this assignment, students can learn how RIP used to propagate routing information among gateways hosts and see that there are many subtle rules that govern which routes to advertise and when to advertise them.

Above assignments are sample projects which can help students understand more

clear for studying TCP/IP networking course, the networking instructor also can design other assignments for teaching TCP/IP protocol.