Nick Parlante

Networking 4

Summary So Far

IP addr -- subnet and host
IP addr. vs. LAN addr (such as ethernet)
IP datagram -- uses IP addr
Router -- forward datagram hop by hop
Router has "next hop" table
IP datagrams sent **inside** LAN packets

IP Datagram Service

"Best effort"

The IP system will try, hop by hop, to get the packet through, but it may fail

Independent packets

The IP datagrams are routed independently. At the IP level, the routers are not aware that the IP datagrams are a continuous part of larger "connection". The routers just deal with the IP datagrams one by one. In some ways, this keeps the routers simple, but it will have other disadvantages.

UDP and TCP

These are more sophisticated services that are built on top of the basic IP datagram service.

Traceroute -- Time To Live

Time-to-live field

Neat bit of design -- every packet has a max number of hops counter, so it cannot get stuck in a loop -- a robust design, even in the face of router errors. When the packet expires, a polite router will send back a "failure" notification, which will identify the IP addr of the router.

Send out packets with TTL values 1, 2, 3, 4,to probe the path to somewhere.

Example

```
elaine40:/usr/class/cs193i/WWW> traceroute www.sjsu.edu
traceroute to rhea.sjsu.edu (130.65.3.13), 30 hops max, 40 byte packets
 1  leland-gateway (171.64.15.97)  1.277 ms  1.371 ms  0.973 ms
 2  Core2-gateway (171.64.1.233)  0.530 ms  0.624 ms  0.513 ms
 3  Core4-gateway-2 (171.64.3.18)  0.897 ms  0.785 ms  0.926 ms
 4  i2-gateway (171.64.1.225)  1.180 ms  0.770 ms  0.777 ms
 5  STAN.POS.calren2.NET (171.64.1.213)  1.125 ms  0.784 ms  1.084 ms
 6  SUNV--STAN.POS.calren2.net (198.32.249.73)  1.562 ms  1.119 ms
 1.438 ms
```

7 QSV-QSV-C2-GSR-ATM.CSU.net (137.145.203.209) 1.791 ms 2.051 ms 2.078 ms
8 SJSU-QSV-ATM.CSU.net (137.145.203.106) 286.774 ms 149.992 ms 150.181 ms
9 firewall.sjsu.edu (130.65.11.6) 138.667 ms 137.488 ms 147.755 ms
10 cc1omnicore.sjsu.edu (130.65.11.2) 134.991 ms 134.259 ms 111.274 ms
11 cc1omni-a.sjsu.edu (130.65.5.252) 313.109 ms 142.407 ms 146.947 ms
12 rhea.sjsu.edu (130.65.3.13) 137.231 ms * 134.619 ms

ping

Send little packets to see if a host responds at all -- see if its up and reachable.

• •Traceroute Contest• •

Who can find the host on the internet which is the largest number of hops from an elaine? Email me your entry by Wed the 18th -- there will be doofy little prizes.

Broadcast

It's possible to send a packet on the LAN specifically marked as "broadcast", so everyone reads it. You may be able to see a broadcast packet on your hub if all your "receive" lights blink at once.

IP to LAN Translation

How does the router know the right LAN addr to use?

i.e. given an IP addr, what is the LAN addr of that machine?

ARP -- address resolution protocol

Broadcast "who has IP addr 171.64.64.250" on local LAN

The owner answers back with it's LAN addr (e.g. its ethernet addr if ethernet is the LAN)

Reverse ARP

At boot time, a machine broadcasts its ethernet addr. A RARP server notices the broadcast, and replies with an IP addr to use. DHCP has pretty much replaced RARP.

IP Port Numbers

Each IP addr is logically divided into logical port numbers in the range 1-65535.

Traffic is addressed to a specific port number at the IP -- this allows a computer with one IP to be in multiple conversations at once. As we'll see, specific port numbers are reserved for specific purposes -- e.g. port 80 is used for HTTP traffic.

Each end of a connection has a source and destination port number as well as IP addr.

Host Configuration

Things that need to be set for a computer to use TCP/IP...
1. IP addr -- need to know what IP addr to use
2. Subnet mask -- this number encodes what the local set up is for which part of the IP is subnet vs. which part is host addr.
3. Router -- the IP addr of the local router to forward traffic to
4. DNS server addr -- the IP addr of the DNS server(s) to use.

DHCP

Dynamic Host Configuration Protocol

Allows a host, at boot time or whatever, to broadcast a query to a local DHCP server. The DHCP server can reply with all of the above configuration values. The DHCP may give out an arbitrary IP addr from its supply, or it may use a specific setup based on the LAN addr of the sender.

This is much more convenient way to do configuration for the end user -- just set the use-DHCP checkbox and you're done.

On the Internet...

1. Ethernet on campus

a. The IP addr is assigned ahead of time.

b. The IP addr is acquired through DHCP

Incoming traffic -- server

If IP addr is the same every time and the computer and network are on all the time, then others on the Internet can connect to the computer using its IP addr.

2. PPP

Dial in to a PPP server

The PPP server has an IP addr on the Internet

There's a special (PPP) connection between you and the PPP server. It is your proxy on the Internet -- you appear to use its IP addr.

You relay traffic to the PPP server, it re-sends it on the Internet and pipes the results back to you.

Server

It's not possible to be a server -- the connection is not up all the time, and the IP addr is not fixed.

Special IP Addrs

The IP subnet 192.168.0.0 is set aside as a special "non-routable" network. An organization can use 192.168.0.0 addresses internally, and the routers are not supposed to let those addrs leak outside the local network. That way, another organization can also use

192.168.0.0 addresses, and the two organizations will not conflict. 10.0.0.0 is another non-routable network, but 192.168.0.0 is more commonly used and so is probably more reliable.

3 Cable / DSL Modem with NAT

- Cable / DSL modem has one IP addr and an upstream router as usual
- Network Address Translation NAT
  - RFC 2663
  - Allow computers on a network to share a single IP addr on the Internet.
- Translating router
  - Single transfer point between the internal network and the Internet at large -- it has a "LAN" side and an "Internet" side
  - The router has one IP addr on the Internet side
  - On the LAN side, the router is 192.168.1.1
  - The hosts on the LAN have addrs in the range 192.168.1.100, 192.168.1.101, 192.168.1.102, ...
  - The router will probably use a DHCP server to distribute configuration to the LAN computers
- Translate
  - Suppose we have a computer on the LAN with IP addr 192.168.1.100
  - A computer on the LAN operates like any other TCP / IP computer. It forwards its packets to its router in the usual way.
  - Suppose the router's IP addr on the Internet side is 1.2.3.4
  - The router takes in traffic from it's LAN side, and then translates the packet on its way out -- the packet used to say "From: 192.168.1.100", gets translated to appear to be from the router itself "From:1.2.3.4". The other end of the connection thinks it is interacting with 1.2.3.4 in the usual way. However, the router knows to re-send incoming packets in that conversation on its internal network to 192.168.1.100. The router keeps track of which port numbers are currently part of which conversation.
- Results
  - Multiple computers on the LAN side can have conversations at the same time. The router needs to keep these straight.
  - To the outside world, it appears that all of the traffic is coming from 1.2.3.4 -- just a lot of traffic, since it's actually the sum of all the traffic from the LAN computers.
  - Internally, the computers think they have IP addrs in the 192.168.1.100 -- which is not the same addr that the computers in the outside world think they are using.
  - Problem: if a computer on the inside sends what it thinks is its IP addr to a computer outside the LAN, it's not going to work. Mostly, that's not a problem -- regular "call / response" connections work fine.
  - Incoming calls don't work well -- what LAN computer should it go to? Can set up certain ports to go to certain LAN side computers.