The Internet

Part 1: Local Area Network Communication

Notes for CSC 100 - The Beauty and Joy of Computing
The University of North Carolina at Greensboro

Reminders

Project:

- Start work on implementation - work time on Friday

Blown to Bits, Chapter 5

- On-line discussion by next Wednesday

Warning....

Networking is complex, with many subtle issues and details

We only barely scratch the surface of the concepts

Want to know more?

Relevant UNCG classes:

- CSC 567: Principles of Computer Networks
- CSC 568: Principles of Wireless Networks
- CSC 580: Cryptography and Security in Computing

Networking: Scenario

We will look at a wired Ethernet connection

- Wireless is similar - we'll say a little more later

Connections for a host:

- Ethernet network port ("RJ-45")
- Has a hardware (MAC) address
- Is connected to a particular port on the switch

The switch:

- Has a "MAC table" that says which addresses are connected to which physical port

About Ethernet MAC Addresses

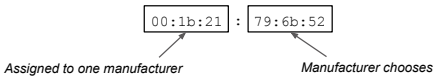
MAC = "Media Access Control"

Example MAC address: `00:1b:21:79:6b:52`

Question 1: What do the numbers look like?
Question 2: How many bits in a MAC address?

Every network interface must have a unique address

How do manufacturers ensure addresses are unique?

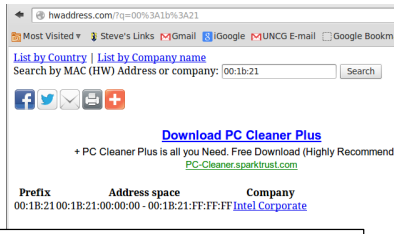


Manufacturer for given MAC prefix

First 24 bits of MAC address are assigned to a manufacturer

Several web sites will look up a MAC prefix and tell you the manufacturer

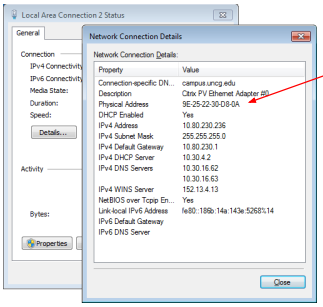
Example lookup using http://hwaddress.com/



So MAC address in our previous example is from a network card manufactured by Intel.

MAC Addresses

Finding MAC address in Windows 7



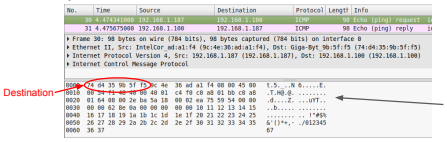
"Physical Address" is MAC address

Sending a message on a LAN

Our example: Ethernet

For hosts connected locally, through a switch, send packet to MAC address

Sample from a network "sniffer":



Destination

Bytes sent out on wire

- The "switch" has a "MAC table" that says who has what MAC address

Notes:

- Easy to get packet from one host to another, since switch knows MAC addresses of all connected hosts
- No structure to MAC addresses (randomly assigned)
- How does this scale? What if all of the (billions) host in the Internet had to send through a central switch to an unstructured address?

Internet Addresses

IP = "Internet Protocol"

IP addresses look like aaa.bbb.ccc.ddd

Question: Who has a phone or device hooked up to wireless? What are the IP addresses?

Each of the 4 numbers is in the range 0..255 (1 byte)

Question 1: How many bits are in an IP address?

Question 2: From a collection of IP addresses on a LAN: What's the pattern?

Internet Protocol

Answer/Information to Question 1

Size of IP addresses:

- 4 numbers, each one byte (8 bits)
- Therefore, ***addresses are 32 bits***

Why important? Means at most 2^{32} different IP addresses.

2^{32} is about 4 billion - what happens when we run out of IP addresses???

InformationWeek

Internet Runs Out Of IP Addresses

The supply of IPv4 addresses is technically exhausted. It's time to accelerate the transition to IPv6.

By Thomas Claburn, InformationWeek
February 04, 2011
URL: http://www.informationweek.com/internet/policy/internet-runs-out-of-ip-addresses/229201157

The pool of Internet addresses has officially been drained. Four non-profit Internet administrative groups -- the Internet Corporation for Assigned Names and Numbers (ICANN), the Number Resources Organization (NRO), the Internet Architecture Board (IAB) and the Internet Society -- said at a press conference in Miami, Florida, on Wednesday that the supply of IPv4 addresses has been depleted.

"This is a major turning point in the ongoing development of the Internet," said Rod Beckstrom, ICANN's president and CEO, in a statement.

The situation however isn't imminently dire: It's not as if companies or individuals who want to launch a Web site will be unable to do so. There are likely to be addresses to be had for months if not years, and the dwindling supply may be extended through network addressing tricks. But the limits of IPv4 are no longer theoretical.

Oops - we are out of IP addresses!

Important points:

- These addresses are "IPv4" (or IP version 4) addresses
- There is a new version "IPv6" (version 6) - addresses are 128 bits

128 bits gives over 10^{38} addresses - we won't run out of these!

Internet Protocol

Answer/Information to Question 2

IP address examples (simplified…):

- All in UNCG SPAN Lab look like 152.13.218.???
- General hosts in Petty Building look like 152.13.136.???
- All on UNCG campus look like 152.13.???.???
- All on North Carolina Research and Education Network look like 152.?.?.?

So: All in the same LAN agree on the first three numbers
All on the same campus agree on the first two numbers
All in the same multi-campus network (NCREN here) agree on first number

Hierarchical addressing allows us to ***route messages*** between LANs

Note: This example is somewhat simplified (buildings, campuses, etc.). In reality things don't always match up to specific numbers in the IP address, but the ideas are similar!

More on how routing works next time… but first, what about local delivery?

Local Delivery

IP to Ethernet mapping using ARP

ARP = "Address Resolution Protocol"

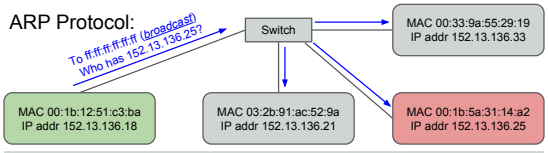
Example:

152.13.136.18 wants to send "hello" to 152.13.136.25

Important points

- Recognizes a "local connection" since only last number differs
- Problem: Local communication uses Ethernet MAC addresses

ARP Protocol:



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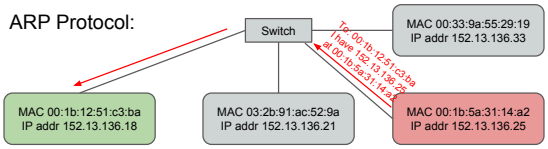

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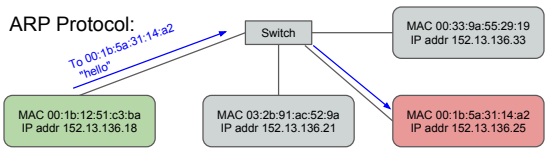

Summary

Concepts introduced in this class:

- Two kinds of addressing: Ethernet and IP
- Ethernet (MAC) addresses are 48 bits with a manufacturer prefix
- Local area network communication and switches
- Translating IP addresses to MAC addresses (ARP)

Next class:

- Scaling up to a global network - routing
- Host and domain names for ease of use
- Transport layer: TCP vs UDP
- Application layer protocols - http, smtp, imap, ...
- Some security issues (more later!)