Host naming

Dave Eckhardt
de0u@andrew.cmu.edu

Synchronization

- P3 survey: shell?

- No class Monday

  - Faculty candidate talk

  - Click, From Extensible Router to Versatile Packet Processsor

  - 10:00 a.m., 4623 Wean Hall

- No class Friday

  - Spring Carnival ("Mobot" races @ noon)

Synchronization

- Today: Naming (in the Internet)

  - DNS vs. ARP

- Upcoming topics survey

  - Distributed deadlock management?

  - Who is reading about Plan 9? EROS?

  - Kerberos? PGP?

  - Proof-carrying code?

Overview

- Three names for your PC

  – Why?

- Two resolution protocols

  – DNS, ARP

- Security considerations

Three names for ~~your~~ my PC

- PIPER.NECTAR.CS.CMU.EDU
  - What's a "nectar"?
  - What's a "piper"?
- 128.2.194.80
- 00-20-AF-D9-FD-CA
- *All* are globally unique
  - Won't one do?

Questions about names

- Who uses the name?

  - For what?

- Who owns/defines the namespace?

- How long is the name valid?

PIPER.NECTAR.CS.CMU.EDU

- Who?
  - Human beings
- What?
  - Remembering a name for each box
  - Crude service-location mechanism
    - *www*.<organization>
  - Crude *device*-location registry
    - pa-mtlebanon3a-39.pit.adelphia.net
    - p4-2-1-0.r02.mclnva02.us.bb.verio.net

Fun break – hostname schemes

- Animals, birds, dinosaurs
- Cars, wines
- CMU SCS Facilities
  - Desktop machines: astronomical entities
  - Servers: fruits, nuts, vegetables
- Wean cluster: Medication
- MIT AI Lab: Breakfast cereals

PIPER.NECTAR.CS.CMU.EDU

- How long is it valid?
  - Lifetime of "the machine"
- How long is the *binding* valid?
  - See below

128.2.194.80

- Who/what *pairs*
  - IP router
  - End-system hosts

IP routers

- Which link does the packet leave on?
  - (definition of router)
  - Used as table lookup key
    - Short fixed length
    - String would *not* do
  - IP address structure
    - "Network ID": top bits
    - "Host ID": bottom bits
    - Network/host division depends on frame of reference

IP routers

- Link parameters (optional)
  - Again, table lookup key
  - Link address (station)
  - Link-level encryption state
  - Link-level scheduling policy

End-system hosts

- Connection management
  - TCP connection *defined by* (IP1, port1, IP2, port2)
    - "only" 65536 TCP connections per host pair
  - Client: my ____ server is x.y.z.w
  - Server: (IP, port) -> security state

128.2.194.80

- How long is it valid?
- Historically: "a long time"
  - 128.2 = CMU.EDU
  - 194 = some chunk of CS
  - 80 = random selection
  - No need to change for "lifetime of machine"

128.2.194.80

- Nothing fails like success
  - IP router table size explosion
- CIDR compresses via hierarchy
  - 12.0.0.0/8 (12.*) belongs to ATT.net
  - 216.218.128.0/17 belongs to he.net (Hurricane Electric)
  - 216.218.132.24/29 belongs to Panasas.com
- Change ISPs, your netblock changes
  - ... "ISP" can be Starbucks 802.11

00-20-AF-D9-FD-CA

- Who assigns?
  - IEEE http://standards.ieee.org/regauth/oui/
  - 00-20-AF assigned to 3Com
  - D9-FD-CA assigned by factory

IEEE MAC address

- Globally unique address
- For every "Ethernet" "card"
- "Ethernet"
  - Or 802.11, or ATM, or Frame Relay, or ...
- "card"
  - Semi-permanent expansion card
  - PCMCIA/CompactFlash card
  - Chip on motherboard

IEEE MAC address - Usage

- "Station" identification on "a network"
- Cooperating set of bridges agree on location
  - Which bridge owns which stations
  - Dynamic "spanning tree" algorithm
- Not "routable" outside that network
  - Then why is it *globally* unique?

Link addresses – why?

- Why do we need a MAC address?

    – Can't we just use the IP address?

- IP was designed to be *subnet-independent*

    – ARPAnet, SATnet, ARPA mobile radio network

    – DIX Ethernet, IBM Token Ring, Corvus Omninet, PPP

    – Each link has its own kind of address

        - Differ in size, meaning

Three names for my PC

- piper.nectar.cs.cmu.edu
  - For human use
  - Good for "a long time"
  - Maps to IP address
- 128.2.194.80
  - For use by IP routers and IP protocols
  - Good while attached via a given ISP
  - Typically mapped to link-level address

Three names for my PC

- 00-20-AF-D9-FD-CA

    - Address used by Ethernet link hardware

    - Good for lifetime of interface card

    - Binding to machine is variable

        - Motherboard: pretty permanent
        - PCI card: almost as long
        - PCMCIA/CF card: at least 1 minute

Three names for my PC

- User specifies host name

- Data packet sent to IP address

- Last-hop router must know MAC address

- Two lookup problems

  – Name -> IP address: global, pretty stable

  – IP address -> MAC address: local, variable

22

Host name lookup

- In the beginning...
    - RFC 606: HOSTS.TXT!
    - One line per host
    - HOST : 128.2.194.80 : PIPER.NECTAR.CS.CMU.EDU : INTEL-GATEWAY : NetBSD ::
    - Available by FTP from SRI-NIC.ARPA
        - 10.0.0.51, the first time
    - Good for ~10 years, 1973 – 1983

Problems with HOSTS.TXT

- http://public.planetmirror.com/pub/textfiles/internet/hosts.txt

- Size

  – July 23, 1992

  – 22,000 hosts, 1 megabyte

  – Scale *that* up!

- Update frequency

Domain Name System

- RFC 882 (1983)
- Goals
  - Distributed database
  - Frequent updates
  - Cacheing
  - High availability
    - Map name to address even while host is down

DNS concepts

- Resource Record (RR)
  - Name, class (IN = Internet), type, value
  - PIPER.NECTAR.CS.CMU.EDU IN A 128.2.194.80
  - cs.cmu.edu   IN NS BLUEBERRY.SRV.cs.cmu.edu
  - cs.cmu.edu   IN NS MANGO.SRV.cs.cmu.edu
  - cs.cmu.edu   IN NS PEACH.SRV.cs.cmu.edu
  - cs.cmu.edu   IN NS BANANA.SRV.cs.cmu.edu

DNS concepts

- TTL = Time-To-Live
  - How many seconds a record will remain valid
  - Promise about stability of mapping
  - CS.CMU.EDU default: 2 days
- Query
  - Question, flags, query id #

DNS Concepts

- Response
  - Question, flags, query id # - from query
  - Result (Ok, "No such domain", ...)
  - Answer records
    - Answer to your question
    - Answers to questions you *meant* to ask

DNS Concepts

- DNS server

  - Knows "all the answers" for a sub-tree

    - Except for sub-sub-trees it *delegates*

    - Like Unix file system mounts

    - EDU servers delegate CMU.EDU

    - CMU.EDU servers delegate CS.CMU.EDU

- Resolver (library)

  - Consults one or more DNS servers

  - Contains retry logic, "marshalling"

DNS Flow

- gethostbyname("PIPER.NECTAR.CS.CMU.EDU")

- Resolver contacts D.ROOT-SERVERS.NET
  - EDU IN NS L3.NSTLD.COM (and others)
  - *L3.NSTLD.COM IN A 192.41.162.32*

- Resolver contacts L3.NSTLD.COM
  - CMU.EDU IN NS T-NS1.NET.cmu.edu (...)
  - *T-NS1.NET.CMU.EDU IN A 128.2.4.14*

DNS Flow

- Resolver contacts T-NS1.NET.cmu.edu
  - CS.CMU.EDU IN NS PEACH.SRV.cs.cmu.edu
  - *PEACH.SRV.CS.CMU.EDU IN A 128.2.242.81*
- Resolver contacts PEACH.SRV.CS.CMU.EDU
  - PIPER.NECTAR.CS.CMU.EDU IN A 128.2.194.80

Advanced topics

- Flow for LAPIS.PRT.CS.CMU.EDU?

- How do we handle gethostbyaddr()?

  - Map *IP address onto name*

Advanced topics

- Flow for LAPIS.PRT.CS.CMU.EDU?

- How do we handle gethostbyaddr()?

  - Map *IP address onto name*

  - 80.194.2.128.IN-ADDR.ARPA IN PTR PIPER.NECTAR.CS.CMU.EDU

- IP over DNS

ARP design

- Map IP address onto MAC address

- Within a single "network"

- MAC addresses have internal structure

  – But it's wrong: manufacturer, serial-number

- Two solutions

  – Ask a server

    • Why not?

  – ...?

ARP protocol

- Ask *everybody!*

    – That should include asking the right person

- Ethernet supports broadcast

    – Send packet to all stations on "network"

- WHO-HAS 128.2.194.80 TELL 128.2.254.36

    – Broadcast

- REPLY 128.2.194.80 IS-AT 00-20-AF-D9-FD-CA

Summary

- Three names for three purposes
- Two mapping protocols
  - Totally different according to function