Naming in Networking

COS 316: Principles of Computer System Design

Lecture 6

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Network Naming

Type of Name	Example
Uniform Resource Locator	http://www.cs.princeton.edu/~jrex/index.html
Hostname	www.cs.princeton.edu
Internet Protocol (IP) Address	128.112.136.61
Media Access Control (MAC) Address	00:15:C5:49:04:A9

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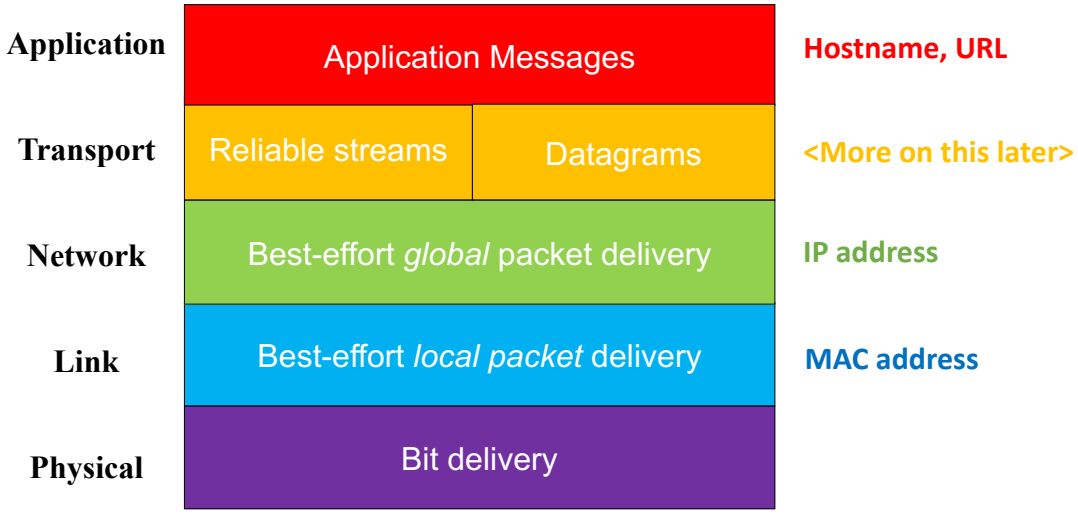
Internet Protocol Stack



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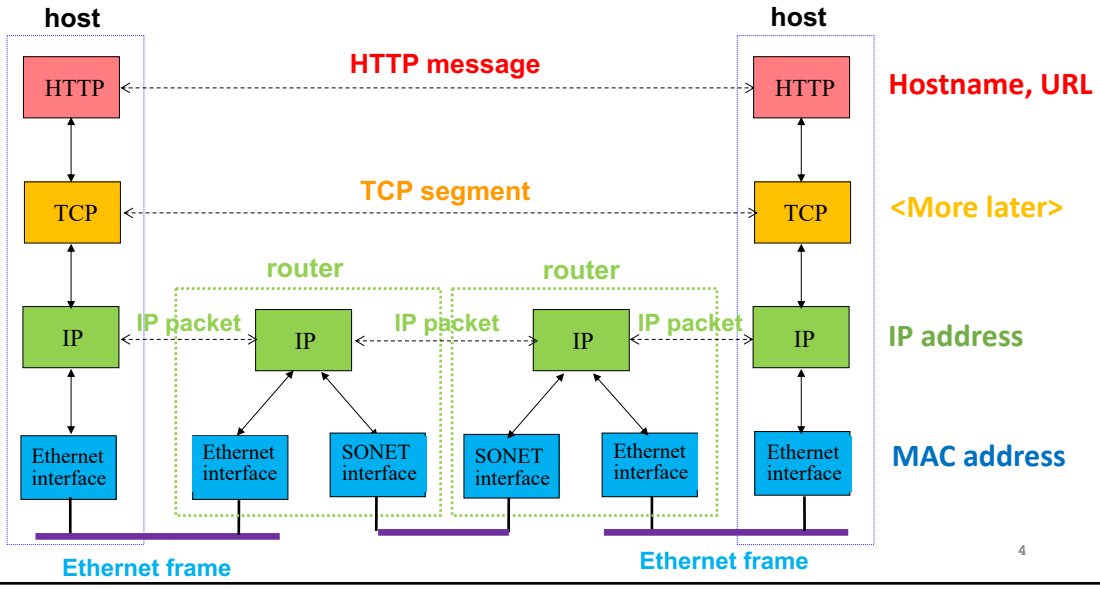
Internet Protocol Stack



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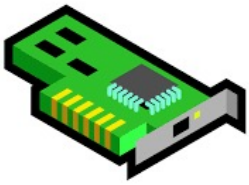
MAC Layer Names for Local Packet Delivery

- *What are we naming?*
- Network interfaces
  - Ethernet interface
  - Optical interface
  - …



Values:

Names:

Allocation:

Lookup:

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MAC Layer Names for Local Packet Delivery

- *Who will use the names?*
- Network adaptors
  - This packet is for you.
  - Is this packet for me?

Ethernet interface

- *Goals for name?*
  - Fast and easy for adaptors to check
  - Globally unique
- MAC addresses are 48-bit addresses
  - 00:15:C5:49:04:A9

Values: Network Interfaces

Names:

Allocation:

Lookup:

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MAC Layer Names for Local Packet Delivery

- *Globally unique names?*
- Ask central authority for every name? X
- Random allocation? X
- Two-level allocation? √
  - Central authority allocates blocks to venders
  - Vendors assigns address for its blocks
  - **00:15:C5:**49:04:A9
    Dell

Values: Network Interfaces

Names: 48-bit address

Allocation:

Lookup:

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MAC Layer Names for Local Packet Delivery

- Lookup
  - Flood packet to all hosts in the network
  - (Optionally) learn what direction to go

Values: Network Interfaces

Names: 48-bit address

Allocation: Vendor from their assigned blocks

Lookup: Local flooding

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Network Layer Names for Global Packet Delivery

- *What are we naming?*

- Hosts
  - My laptop
  - Zoom server
  - Your laptop
  - …

Values:

Names:

Allocation:

Lookup:

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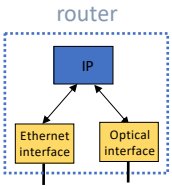
Network Layer Names for Global Packet Delivery

- *Who will use the names?*

- Routers
  - Where is this packet headed?



- *Goals for name?*
  - Fast and easy for routers to process
  - Globally unique
  - Location-based: enable routing packets to destination

- IP addresses are 32 or 128 bit addresses
  - 128.112.7.156

Values: Hosts

Names:

Allocation:

Lookup:

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Network Layer Names for Global Packet Delivery

- *Globally unique and location-based names?*
- Multi-level allocation? √
  - ICANN assigns large blocks to
  - Regional Internet registries assign sub-blocks to
  - Internet Service Providers assign addresses to
  - Hosts
  - ISPs serve a group of nearby hosts
  - ISPs can route to hosts in their sub-blocks

Values: Hosts

Names: 32 bit address

Allocation:

Lookup:

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Network Layer Names for Global Packet Delivery

- *How to map 128.112.7.156 to host?*
- Network Routing!
  - Can't get all the way there right away, so figure out next hop: use routing table
  - Routing protocols map destination to next-hop IP address (fill in routing table)
    - BGP, OSPF, RIP, …
  - ARP maps next-hop IP address to MAC address

Values: Hosts

Names: 32 bit address

Allocation: Multi-level, location-based

Lookup:

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Network Layer Names for Global Packet Delivery

- ARP: Address Resolution Protocol briefly
  - Broadcast Request: Who has 128.112.7.156?
  - Broadcast Response: 00:15:C5:49:04:A9 has 128.112.7.156
  - Hosts cache responses, lookup in local table

Values: Hosts

Names: 32 bit address

Allocation: Multi-level, location-based

Lookup: Routing table for next-hop IP; ARP next-hop IP -> MAC address

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Host Names for Applications {Websites}

- *What are we naming?*
- Hosts
  - CS department webserver
  - COS316 webserver
  - …

Values:

Names:

Allocation:

Lookup:

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Host Names for Applications {Websites}

- *Who will use the names?*
- People
- *Goals for name?*
  - Memorable
  - Reflect organizational hierarchical
    - e.g., educational?, princeton?
- Hostnames are variable length, hierarchical strings
  - www.cs.**princeton.edu** vs cos316.**princeton.edu**

Values: Hosts

Names:

Allocation:

Lookup:

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Host Names for Applications {Websites}

- *Globally unique and organizational-hierarchy-based names?*
- Multi-level allocation? √
  - IANA assigns top-level domains
    - .com, .edu, …
  - Registries assigns second-level domains
    - princeton.edu
  - Organizations assign subdomains
    - cs.princeton.edu OR cos316.princeton.edu
  - And so on…
    - www.cs.princeton.edu

Values: Hosts

Names: hierarchical variable-length strings

Allocation:

Lookup:

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Host Names for Applications {Websites}

- *How to map cos316.princeton.edu to host?*
- Map to IP address, give to networking layer
  - Domain Name System (DNS) maps a hostname to an IP address

Values: Hosts

Names: hierarchical variable-length strings

Allocation: Multi-level, organization based

Lookup: DNS maps hostname to IP

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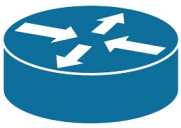
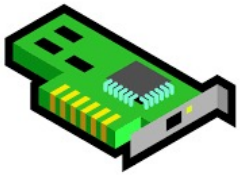
Different Layers, Different Names

- **Host name** (e.g., www.cs.princeton.edu)
  - Mnemonic, variable-length, appreciated *by humans*
  - Hierarchical, based on organizations

- **IP address** (e.g., 128.112.136.61)
  - Numerical 32-bit address appreciated *by routers*
  - Hierarchical, based on organizations and location



- **MAC address** (e.g., 00:15:C5:49:04:A9)
  - Numerical 48-bit address appreciated *by adapters*
  - Hierarchical, based on vendors, unrelated to location



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Hierarchical Allocation Processes

- **Host name:** www.cs.princeton.edu
  - Domain: registries for each top-level domain (e.g., .edu)
  - Host name: local administrator assigns to each host
- **IP addresses:** 128.112.136.61
  - Prefixes: ICANN, regional Internet registries, and ISPs
  - Hosts: static configuration, or dynamic using DHCP
- **MAC addresses:** 00:15:C5:49:04:A9
  - Blocks: assigned to equipment vendors by the IEEE
  - Adapters: assigned by the vendor from its block

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Different Layers, Different Lookup Protocols

- Host name -> IP address via Domain Name System (DNS)
- Destination IP address to next-hop address via routing table (populated by network routing protocols)
- Next-hop IP address to MAC address via ARP
- MAC address to network interface via local broadcast

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Network Naming Conclusion

- Network names identify remote endpoints
- Different layers, different names
  - *Who will use the name?*
- Multi-level hierarchical allocation
  - Goals: Unique √, reflect organizations √, location-based?
- Different layers, different lookup protocols
  - We covered ARP, COS 461 covers them all ☺
- More on network **layers** in a few weeks

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