

Naming in Networking



COS 316: Principles of Computer System Design

Lecture 6

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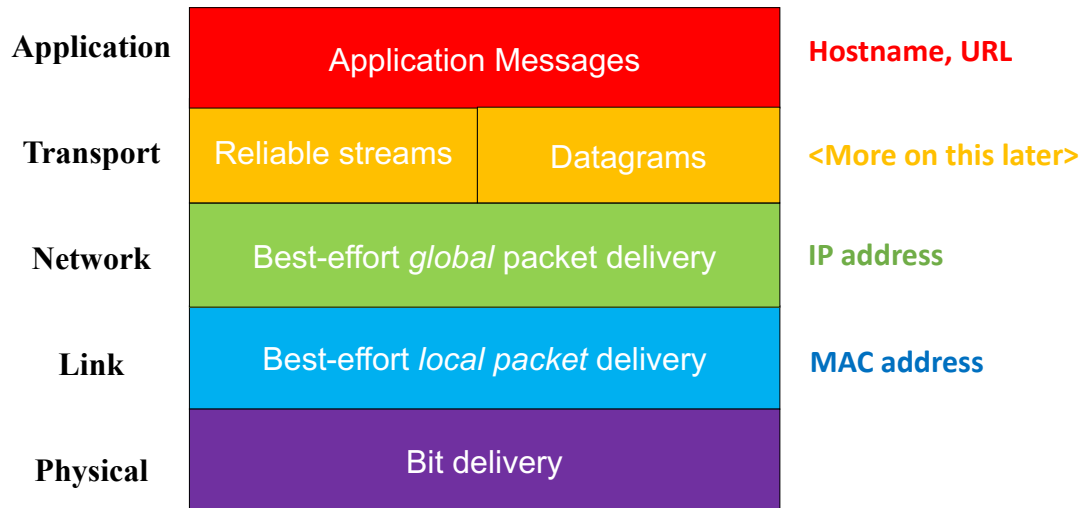
Network Naming

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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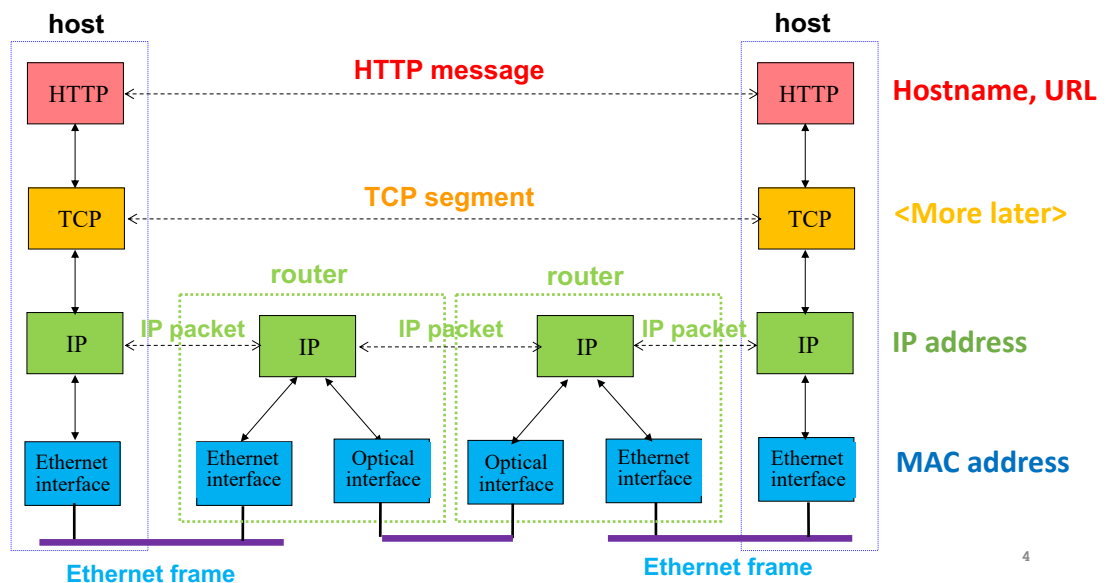
Internet Protocol Stack



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Internet Protocol Stack



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MAC Layer Names for Local Packet Delivery

- *What are we naming?*

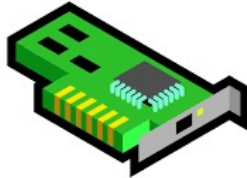
Values:

- Network interfaces
 - Ethernet interface
 - Optical interface
 - ...

Names:

Allocation:

Lookup:



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MAC Layer Names for Local Packet Delivery

- *Who will use the names?*

Values: Network Interfaces

- Network adaptors
 - This packet is for you.
 - Is this packet for me?

Ethernet
interface

Names:

- *Goals for name?*
 - Fast and easy for adaptors to check
 - Globally unique

Allocation:

- MAC addresses are 48-bit addresses
 - 00:15:C5:49:04:A9

Lookup:

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MAC Layer Names for Local Packet Delivery

- *Globally unique names?* **Values:** Network Interfaces
- Ask central authority for every name? **X** **Names:** 48-bit address
- Random allocation? **X** **Allocation:**
- Two-level allocation? **✓** **Lookup:**
 - Central authority allocates blocks to vendors
 - Vendors assigns address for its blocks
 - **00:15:C5:49:04:A9**
Dell

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MAC Layer Names for Local Packet Delivery

- Lookup **Values:** Network Interfaces
 - Flood packet to all hosts in the network
 - (Optionally) learn what direction to go
- 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?*

Values:

- Hosts

- My laptop
- Zoom server
- Your laptop
- ...



Names:

Allocation:

Lookup:

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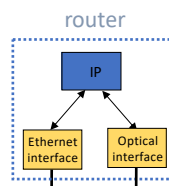
Network Layer Names for Global Packet Delivery

- *Who will use the names?*

Values: Hosts

- 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

Names:

Allocation:

Lookup:

- IP addresses are 32 or 128 bit addresses
 - 128.112.7.156

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Network Layer Names for Global Packet Delivery

- *Globally unique and location-based names?*

Values: Hosts

- Multi-level allocation? ✓

Names: 32 bit address

- ICANN assigns large blocks to
- Regional Internet registries assign sub-blocks to
- Internet Service Providers assign addresses to
- Hosts

Allocation:

- ISPs serve a group of nearby hosts
- ISPs can route to hosts in their sub-blocks

Lookup:

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Network Layer Names for Global Packet Delivery

- *How to map 128.112.7.156 to host?*

Values: Hosts

- Network Routing!

Names: 32 bit address

- 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

Allocation: Multi-level, location-based

Lookup:

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Network Layer Names for Global Packet Delivery

- ARP: Address Resolution Protocol briefly

Values: Hosts

- Broadcast Request: Who has 128.112.7.156?

Names: 32 bit address

- Broadcast Response: 00:15:C5:49:04:A9 has 128.112.7.156

Allocation: Multi-level, location-based

- Hosts cache responses, lookup in local table

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?*

Values:

- Hosts

Names:

- CS department webserver
- COS316 webserver
- ...

Allocation:

Lookup:

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Host Names for Applications {Websites}

- *Who will use the names?*

Values: Hosts

- People

Names:

- *Goals for name?*

- Memorable
- Reflect organizational hierarchical
 - e.g., educational?, princeton?

Allocation:

- Hostnames are variable length, hierarchical strings
 - `www.cs.princeton.edu` vs `cos316.princeton.edu`

Lookup:

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Host Names for Applications {Websites}

- *Globally unique and organizational-hierarchy-based names?*

Values: Hosts

- 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

Names: hierarchical variable-length strings

Allocation:

Lookup:

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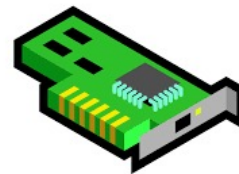
Host Names for Applications {Websites}

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

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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 v , reflect organizations v , location-based?
- Different layers, different lookup protocols
 - We covered ARP, COS 461 covers them all 😊
- More on network **layers** in a few weeks