

Naming in Networking



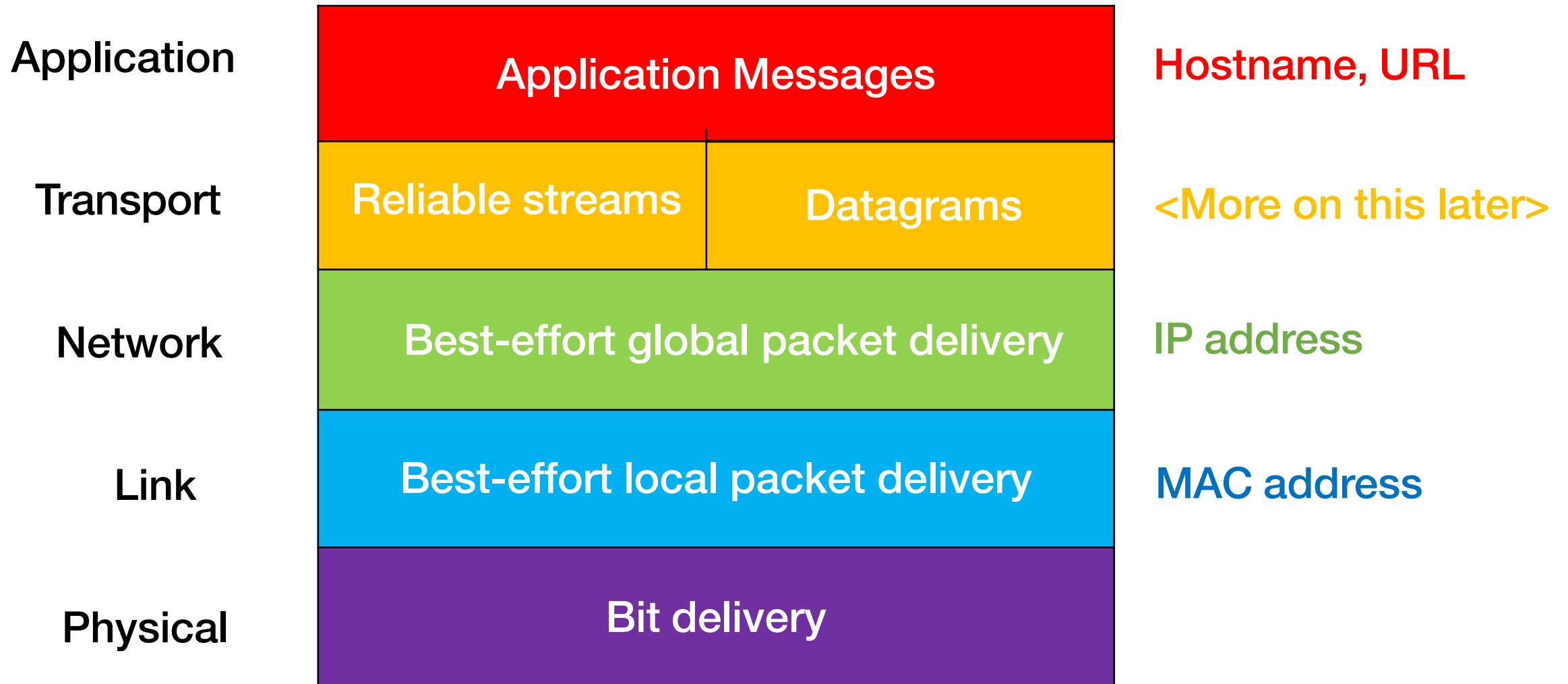
COS 316: Principles of Computer System Design
Lecture 6

Wyatt Lloyd & Rob Fish

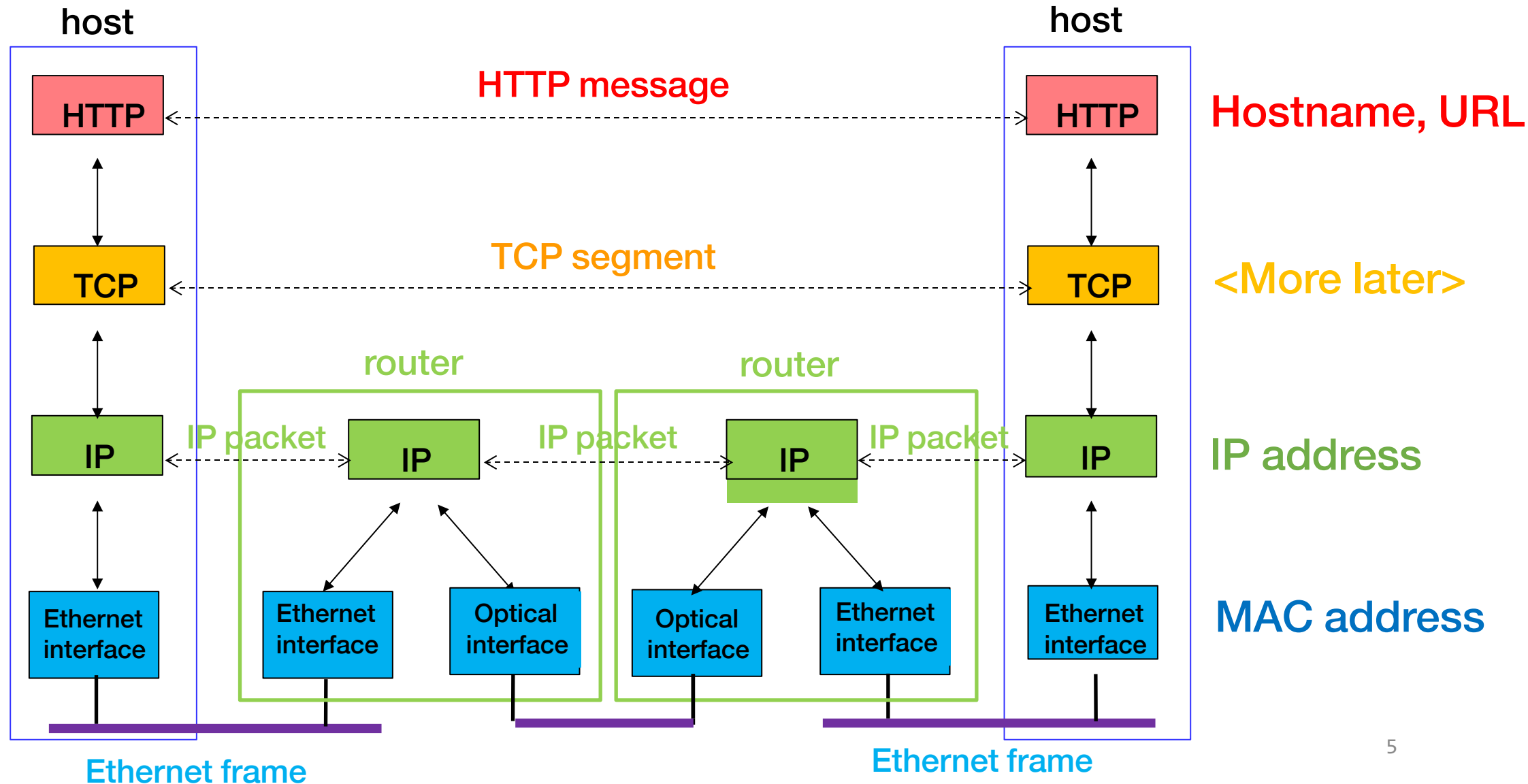
Network Naming

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

Internet Protocol Stack



Internet Protocol Stack



MAC Layer Names for Local Packet Delivery

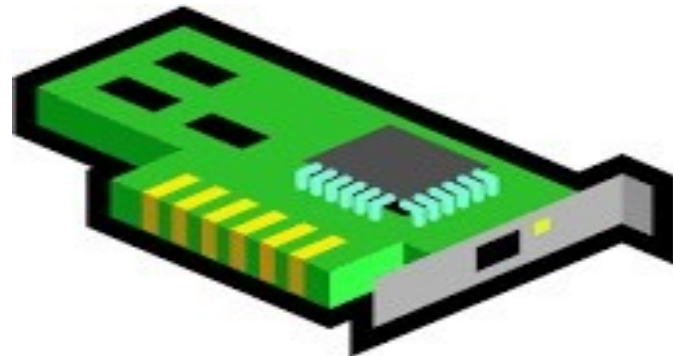
- What are we naming?
- Network interfaces
 - Ethernet interface
 - WiFi interface
 - ...

Values:

Names:

Allocation:

Lookup:



MAC Layer Names for Local Packet Delivery

- Who will use the names?
- Network adaptors
 - This packet is for you.
 - Is this packet for me?
- Goals for name?
 - Fast and easy for adaptors to check

Ethernet
interface

Values: Network
Interfaces

Names:

Allocation:

Lookup:

MAC Layer Names for Local Packet Delivery

- Who will use the names?
- Network adaptors
 - This packet is for you.
 - Is this packet for me?
- Goals for name?
 - Fast and easy for adaptors to check
 - Globally unique
- MAC addresses are 48-bit addresses
 - 00:15:C5:49:04:A9

Ethernet
interface

Values: Network
Interfaces

Names:

Allocation:

Lookup:

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? **✓**
• Central authority allocates blocks to vendors
• Vendors assigns address for its blocks
• 00:15:C5:49:04:A9
Dell
Lookup:

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

Network Layer Names for Global Packet Delivery

- What are we naming?

Values:

- Hosts

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

Names:

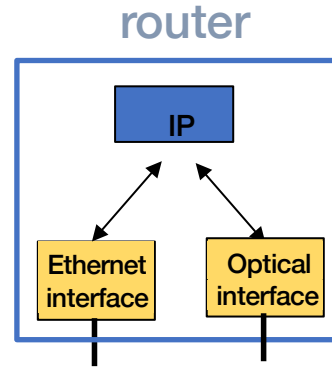
Allocation:

Lookup:



Network Layer Names for Global Packet Delivery

- Who will use the names?
- Routers
 - Where is this packet headed?



Values: Hosts

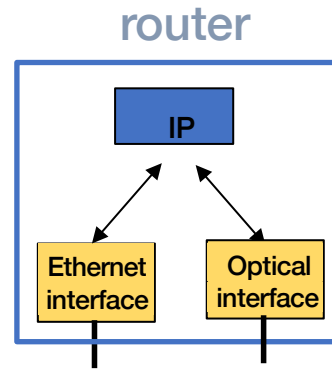
Names:

Allocation:

Lookup:

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:

Network Layer Names for Global Packet Delivery

- Globally unique and location-based names? Values: Hosts
 - 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
- Names: 32 bit address
- Allocation:
- Lookup:

Network Layer Names for Global Packet Delivery

- How to map 128.112.7.156 to host?

Values: Hosts

- 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

Names: 32 bit address

Allocation: Multi-level,
location-based

Lookup:

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

Host Names for Applications {Websites}

- What are we naming?

Values:

- Hosts

Names:

- CS department
webservice
- COS316 webservice
- ...

Allocation:

Lookup:

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:

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:

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:

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

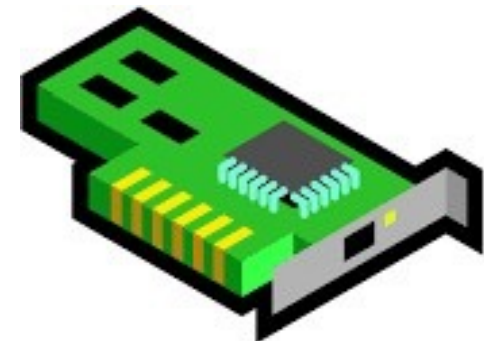
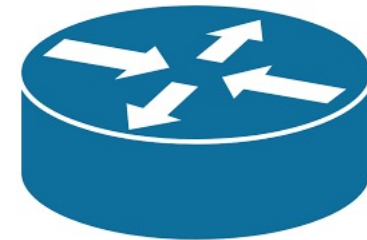
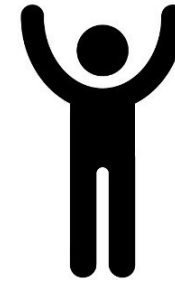
Names: hierarchical variable-length strings

Allocation: Multi-level, organization based

Lookup: DNS maps hostname to IP

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



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

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)

Network Naming Conclusion

- Network names identify remote endpoints
- Different layers, different names
 - Who will use the name?
- Multi-level hierarchical allocation
 - Goals: Unique \checkmark , reflect organizations \checkmark , location-based?
- Different layers, different lookup protocols
 - We covered ARP, COS 461 covers them all 😊
- More on network layers next time

