Local Area Networking

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The Internet

A set of many, many networks

- Individual networks are privately owned
- Individual networks are self-managed
- Individual networks are connected to a common Internet "backbone"

Consider:

- your home network
- Eduroam



What made the Internet successful?



- the Internet forwards traffic to IP addresses - nothing else

Many responsibilities are delegated to individuals

- individual networks have to get their users connected
- individual networks have to secure themselves
- this **isn't** the job of the central Internet

How do these smaller networks work?





Devices at the edge of the network that send and receive Internet data

Ex. laptops, phones, PCs, printers (the things we're using right now!)

the Internet was made for connecting hosts together

Important subset: Servers A PC that provides some useful Internet function







Main function: routing data across the Internet

routing ≈ postal service

each router is like a postal facility – determines how to move packages **closer** to destination

<u>Purpose</u>: move data (packets) from facility to facility en route to its destination



the role of Routers

Hosts don't know how to use the Internet

Hosts are connected to the Internet via routers

- To access a website, your laptop sends all of its traffic to the router
- The router forwards the traffic on





Switches

Main function: forward packets from device to device

forwarding ≈ delivery truck w/ a package

Each switch is a road intersection in a city

 package is carried from intersection to intersection until it reaches next postal facility (or final dest.)

<u>Purpose</u>: carry packets to next router, or to destination





Routers vs. Switches

Routers connect different networks together





Each device on each router port is on a different network

Switches connect devices within one network

All devices on each switch port are on the same network



Network Interfaces

The part of a device's hardware which allows it to connect to a network

Ex. on laptops, a WiFi card Ex. on other devices, an Ethernet port

Links: the connection between interfaces

 E.g. the WiFi connection between your laptop and the Eduroam access point





Network Interfaces (cont.)





Network Data - Packets



Packets ≈ Packages

- Packages are moved from facility to facility, towards destination
 - Packets are moved from router to router towards destination
- At each router, the packet's destination address is read
 - \rightarrow next router to send it to is decided

Routing: step-by-step sending across networks that gets a packet closer to its destination



How are our devices connected to the Internet?

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Main components:

- 1. Discovering devices on network
- 2. Getting an IP address
- 3. Learning who your router is

If your computer is connected to a router on the Internet...

You are now on the Internet!

Simulating networks

https://akhilguntur.com/scones

(unscripted)

- connecting devices
- ping
- recording traffic





Discovering Devices





Every device on the Internet has an IP address

Packets are delivered based on IP addresses

Used for communication between different networks

run ipconfig (Win) or ifconfig (Mac/Linux)



IP Addresses (Cont.)

Designed to be hierarchical \rightarrow they are routable





Address Hierarchy

Addresses are only routable if they are hierarchical

Ex. home addresses

- Home Number << Street << City << State << Country

what if it wasn't hierarchical? \rightarrow what if we **only** used street name?







A hardware ID burned onto your network card

Essentially randomly generated \rightarrow impossible to route to

BUT it CAN be used for local communication







MAC-level communication





MAC-level communication







MAC vs IP



Recall: networks use IP addresses for routing

- Every device has a unique MAC address
- Every device has a unique IP address

IP addresses are used for routing \rightarrow communicating **between** networks MAC addresses are used for local communication \rightarrow **within** a network

What if two hosts on the same network only know each other's IP addresses?

the Address Resolution Protocol



(aka ARP)

Used for finding MAC address from IP addresses

- 1. Host A sends a broadcast, asking who has <IP address>
- 2. Host B with <IP address> will respond
- 3. Host A will store (Host B IP address, Host B MAC) as a pair

Whenever Host A needs to reach Host B, it will send packets to Host B's MAC





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(I'll upload the JSON file to our announcements channel)



Getting an IP address

Getting an IP



What if you don't already have an IP address?

How can we request one?



(aka DHCP)

Allows hosts to request an IP address from an DHCP server

- 1. Host sends a broadcast in order to find a DHCP server
- 2. A DHCP server responds, stating it is a DHCP server
- 3. Host requests an IP address from the DHCP server
- 4. The DHCP server responds with an IP address for the host

DHCP (Cont.)

DHCP responses can also include the IP address of the local router

 \rightarrow while requesting an IP address from a DHCP server, the server can tell the host where the router is



Try it out! again.

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Upload JSON file again

Thanks!

Any questions?

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