Routers and ASes

- A router is a device with multiple ports that connects to multiple devices to form a network
- Each router has a chip inside that determines how to route
- The overall network is very complicated with many different sizes

Autonomous System

A set of routers that all belong to some owner (i.e. AT&T or MIT)

- These ids used to just fit in 16 bits but at some point they didn't so now we use 32 bits

Competitive Cooperation

- Entities must cooperate for global connectivity
- But each one wants to make money

- Routers advertise to each other:
  - They tell each other about which other servers it can reach so the other servers know to send packets to them
- Currently, there is no central authority, it's all through these bilateral connections
  - In the beginning of the internet (ARPANET), there was a large national backbone network with smaller regional networks connecting to them to form a hierarichal structure

- This was gradually replaced with multiple backbone providers
- As there became more interconnection, we get to modern day
  - A lot flatter, more interconnected
  - Rise of CDN's (content distribution networks) that do a lot of caching on the Internet

Routing Prefix

A range of IP addresses based on addresses with the same bistring prefix

- Routers have forwarding table entries that correspond to an address of prefix
- I.e. `18.0.0.0/8` stands for all IP addresses where the first 8 bits are just 18
  - `18.31.0.0/17` stands for all IP addresses where the first 17 correspond to `18.31`

- Forwarding rules commonly use the longest matching prefix

Subnetworks

Ranges coresponding to routing prefixes that are a power of two size

Internet Business Model

- Money flows from customers to providers
  - When customers pay providers, they get to view the providers' routing tables in exchange for money
  - Since providers want to increase their customers usage (so the customers pay more money), they will provide their entire routing table to the customer
- Why have peering?
  - You want to collaborate and give each other's routes to get more visibility without having to pay money
    - These are typically with contracts that say things like can't be to imbalanced
  - At the very top, we need peering relationships

Transit

Technical word for the customer / provider relationship (a service provided for a fee)

- Can be "partial" or "full" depending on whether the customer receives every route

- When a router receives advertisements, it filters what it advertises
  - When it receives advertisement from a customer:
    - It will always advertise to everyone
    - It will increase likelihood of using the customer
  - When it receives routes from provider:
    - It will only advertise to customers
    - Announcing to peers will cause them to lose money
  - When it receives routes from peers:
    - Same as above
- The incentive to peer is to avoid paying providers to get to the route (this also makes the number of hops lower)
  - There is only incentive if it is somewhat symmetric (i.e. MIT and YouTube will not peer)

BGP

- BGP provides capabilities for enforcing various policies, but they are not a part of BGP
- BGP allows you to choose from multiple paths
- Import policy:
  - How to select best paths
- Export policy:
  - What routes to announce (what we just covered)

Interconnection

- Interconnecting two networks requires both physical and network connectivity
- Could be done through either:
  - Direct, dedicated physical connection
  - Public connection where all networks connect to a public Internet Exchange switch