Trauma support: caps.ucsd.edu
Abstract View of the Internet

- A bunch of servers/virtual machines connected by point-to-point physical links
- Point-to-point links between routers are physically as direct as possible
Reality Check

- Fibers and wires limited by physical constraints
  - You can’t just dig up the ground everywhere
  - Most fiber laid along railroad tracks
- Physical fiber topology often far from ideal
- IP Internet is overlaid on top of the physical fiber topology
  - IP Internet topology is only logical
- Key concept: IP Internet is an overlay network
National Lambda Rail Project

Made Possible By Layering

- Layering hides low level details from higher layers
  - IP is a logical, point-to-point overlay
  - ATM/SONET circuits on fibers

Diagram showing the layers of the network with IP Logical Link and Physical Circuit.
Overlays

- Overlay is a general concept
  - Networks are just about routing messages between named entities
- IP Internet overlays on top of physical topology
  - We assume that IP and IP addresses are the only names...
- Why stop there?
  - Overlay another network on top of IP

Example: VPN

- Virtual Private Network

- VPN is an IP over IP overlay
- Not all overlays need to be IP-based
VPN Layering

Advanced Reasons to Overlay

- IP provides best-effort, point-to-point datagram service
  - Maybe you want additional features not supported by IP or even TCP
- Like what?
  - Multicast
  - Security
  - Reliable, performance-based routing
  - Content addressing, reliable data storage
Unicast Streaming Video

• This does not scale

IP Multicast Streaming Video

• Much better scalability
• IP multicast not deployed in reality
  • Good luck trying to make it work on the Internet
  • People have been trying for 20 years

Source only sends one stream

IP routers forward to multiple destinations
End System Multicast Overlay

How to build an efficient tree?

- Enlist the help of end-hosts to distribute stream
- Scalable
- Overlay implemented in the application layer
  - No IP-level support necessary

Choosing multicast overlay paths

- Measurements
  - Time series of RTT measurements
  - Observed throughputs of transfers
- How to select overlay distribution tree edges?