Tag/Label Switching

CS598: Advanced Internet

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How to go from A to B?

• Broadcast:
  – Go everywhere, stop at B
  – Never ask for directions

• Hop by hop routing:
  – Ask who is closer to B, go there, repeat!
  – You better go to X first …

• Source routing:
  – Get a list before starting
  – Go straight 5 blocks, take a left, 4 more blocks, …
How to go from A to B?

- Let someone go ahead of you
- At every road reserve a lane for you
- At intersection, post a sign (turn + lane)
What is it good for?

- Enable IP capabilities on devices that cannot forward IP datagrams
- Explicit routing – pre-calculated routes that do not match normal IP routing paths
- Virtual Private Network (VPN) services
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One of the original goals is not on the list!
This Talk

• History

• Learn from Examples
  – Destination-based Forwarding
  – Explicit Routing
  – Virtual Private Networks and Tunnels

• Points to Ponder
  – What layer is MPLS?

• Where is MPLS now?
History

• **Ipsilon Networks**
  – IP switching, defined to work on ATM

• **Cisco Systems, Inc.**
  – Tag switching, proprietary proposal
  – Renamed label switching
  – Handed over to IETF

• **IETF**
  – Proposals from other vendors (Toshiba, IBM)
Destination-Based Forwarding
Benefits

• Exact match, as opposed to longest match
  – Simple to implement in hardware

• Forwarding Equivalence Class (FEC)
  – Set of packets that receive same forwarding treatment

• Devices not supporting IP can forward IP traffic
  – Example: carry IP traffic over ATM switches
  – How and Why?
How?

• Provide switches with:
  – IP routing protocols
  – A method to distribute label bindings (LDP)
• Result: IP control protocols with label-swapping forwarding
Why?

Set of routers connected over an ATM network (why?)

ATM switches are replaced with LSR (benefits?)
Explicit Routing

Questions:

- How to routers agree on what labels to use and how to forward packets with particular labels?
Applications of Explicit Routing

• Traffic Engineering
  – Controlling exactly which path the traffic flows

• Resilience in face of failure
  – Reroute traffic down a pre-calculated path
  – Known as Fast Reroute
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How to calculate the explicit routes?
Virtual Private Networks

- “Layer 2” VPN
  - Tunnel layer 2 data (Ethernet frames/ATM cells)
  - Pseudo-wire emulation
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What to do with non-IP traffic when it reaches the EOT?
VPN: ATM over IP

- Labels may be stacked on a packet to any depth
- A single tunnel can carry potentially large number of emulated circuits
- Same technique to provided hierarchy of routing knowledge
What Layer is MPLS?

• Layer 2.5

• Layer 2

• Layer 3
What Layer is MPLS?

• Layer 2.5
  – MPLS header is found between layer 3 and layer 2 headers

• Layer 2
  – IP packets are encapsulated inside MPLS headers
  – MPLS must be below IP

• Layer 3
  – MPLS uses IP routing protocols and IP addressing
Where is MPLS Now?

• Sufficiently popular among service providers
  – Almost all high-end routers include MPLS capabilities

• Two main applications:
  – Layer 3 VPN: Provide “private” IP services to corporations
  – Explicit Routing: TE and/or Fast Reroute
    • Difficult to determine how many providers are actually using this technology
Questions?