Routing

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Dealing with difficult readings

• **Readings are difficult to understand**
  • Next time you read papers on this topic, they will make more sense
  • Ask questions!

• **Readings are difficult to criticize in the reviews**
  • Goal is to think critically about the paper, not to write the definitive judgement of the work
  • This is part of the process of understanding!

• But, we’ll introduce upcoming topics to provide some context before you read
Routing

Choosing paths along which messages will travel from source to destination.

- Often defined as the job of Layer 3 (IP). But...
  - Ethernet spanning tree protocol (Layer 2)
  - Distributed hash tables, content delivery overlays, ... (Layer 4+)
Problems for intradomain routing

• Distributed path finding
• Optimize link utilization
• React to dynamics
• High reliability even with failures
• Scale
Problems for interdomain routing

- All of intradomain’s problems
- Bigger scale
- Multiple parties
  - No central control
  - Conflicting interests
  - Attacks
- Harder to change architecture
  - Intradomain evolution: RIP, ISIS, OSPF, MPLS
  - Interdomain: BGP.
The two classic approaches

• Distance vector & Link State

• These are far from the only two approaches! We’ll see more later...
Distance vector routing

- Original ARPANET: distance vector routing
- Remember vector of distances to each destination and exchange this vector with neighbors
  - Initially: distance 0 from myself
  - Upon receipt of vector: my distance to each destination = min of all my neighbors’ distances + 1
- Send packet to neighbor with lowest dist.
- **Slow convergence** and **looping** problems
  - E.g., consider case of disconnection from destination
  - Fix for loops in BGP: store path instead of distance
Link-state routing

- New ARPANET algorithm: link state routing ("shortest path first (SPF)")
  - McQuillan, Richer, and Rosen 1980; Perlman 1983; led to OSPF
- Broadcast the entire topology to everyone
- Locally run shortest path algorithm
- Send packet to neighbor along computed shortest path
- How can this result in forwarding inconsistencies?
Interdomain routing

• BGP: Border Gateway Protocol

• Remember path instead of distance ("path vector" instead of "distance vector")

  • Avoid loops; but more importantly...
  • **Support policies:** can pick any path offered by neighbors, not necessarily the shortest
Common policies

• Route selection: prefer customer over peer over provider
• Route export: “valley-free”: to/from customer only
What’s to come

• Today: interdomain routing basics, and a radically different design

• Thursday: reliability

• Next Tuesday: scalability

• Next Thursday: selfishness & conflicting interests