Achieving good end-to-end service using Bill-Pay

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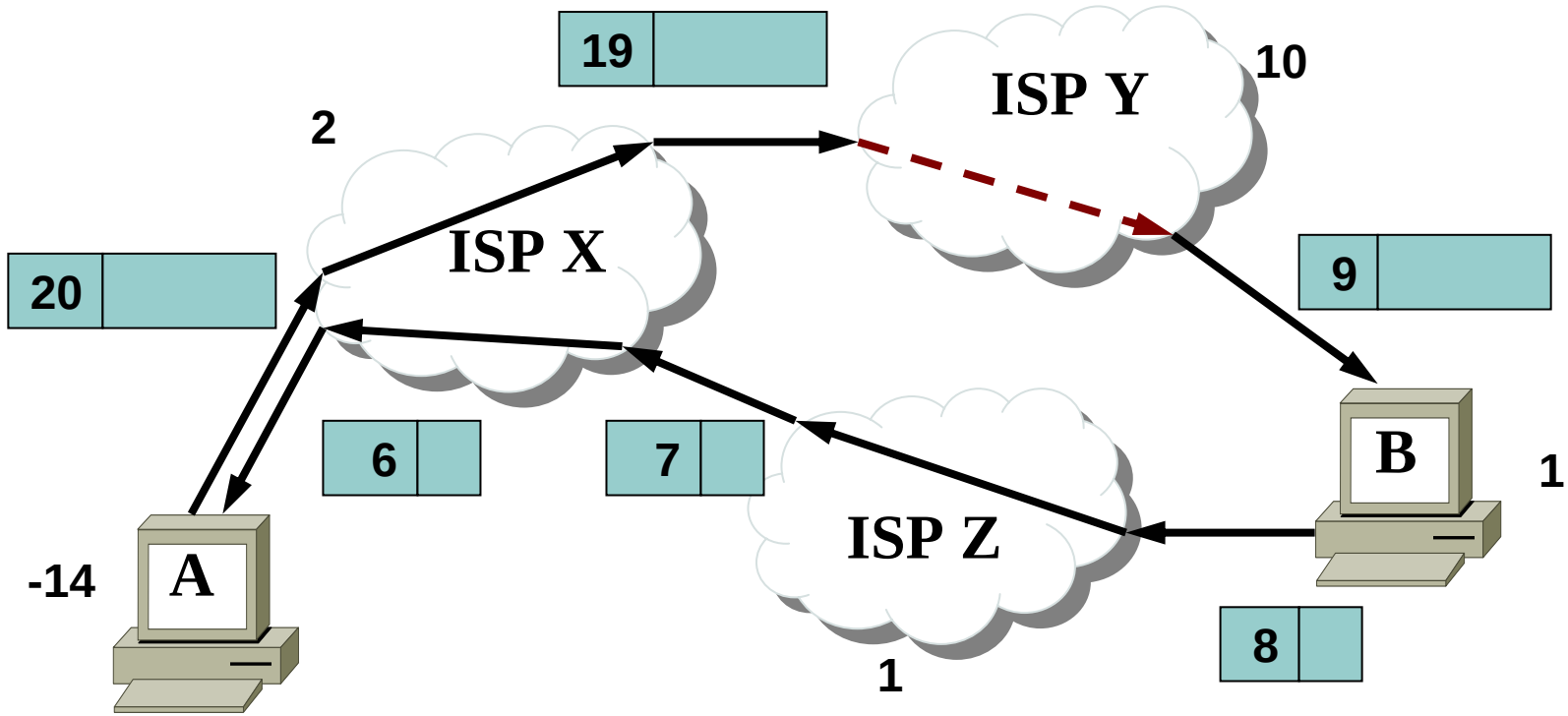
QoS today

- ISPs offer SLAs to customers
- SLAs do not apply for multi-ISP paths
- Core problem: end users cannot pay intermediate ISPs
- Bill-Pay allows such payments

Overview

- What is the Bill-Pay mechanism?
- What can we build on top of it?
- What were they thinking?

Bill-Pay example

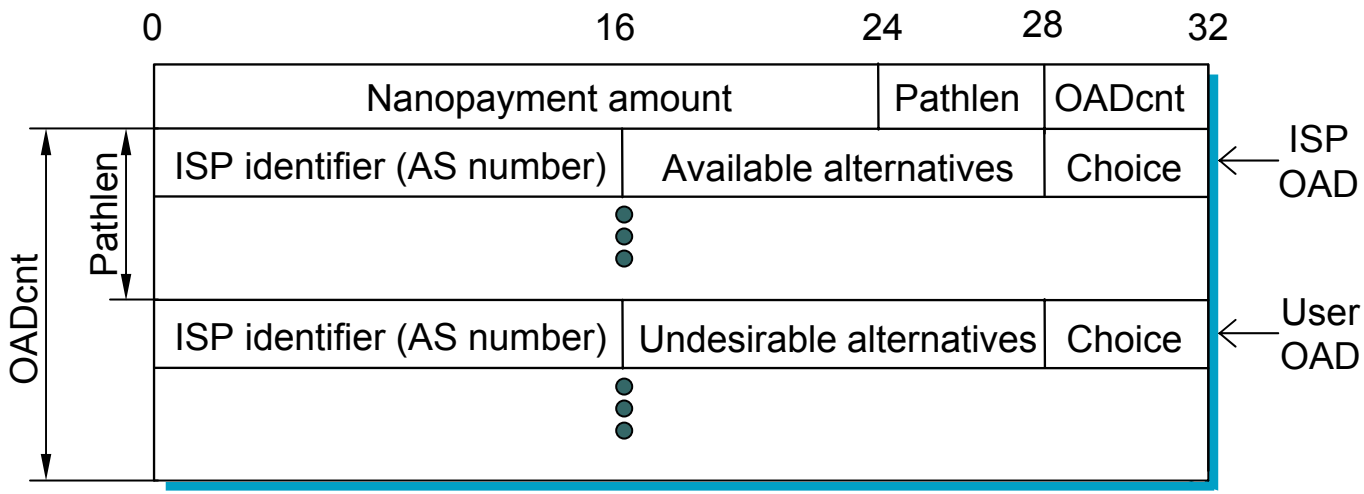


Core ideas

- Nanopayments associated with packets
  - Sender sets initial nanopayment
- Easy-to-enforce **local bilateral** contract
  - Upstream must pay (at the end of month)
  - Downstream has no contractual obligation
- Downstream has **incentive** to provide good service, pay next ISP
  - Sender has some control over path

Protocol mechanics

- ISPs offer a few “opaque alternatives”
  - Can mean: next hop, diffserv class, internal route
- Sender OAD = desired treatment by an ISP



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Solutions using Bill-Pay

- Better e2e delay, throughput, loss rate
- Handling floods and flash crowds
  - The users valuing the service the most get through, the other traffic is dropped
- Micropayments (between any 2 hosts)
  - Requiring micropayments with emails will kill the spammers' business model

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ISPs will jack up prices!

- Justifiable fees
  - Fixed per byte/per packet
  - Congestion pricing
- Avoiding “unjustifiable” fees
  - If there is path diversity, users will direct traffic through cheaper paths
  - With chokepoints/unregulated monopolies, users pay a lot even with flat prices

Too costly for ISPs to deploy!

- Potential benefits are huge
  - Users in industrialized countries spend on average extra $10/year → $10 billion/year
  - Backbones running at higher link utilization → savings of ?? billions/year
  - Skimming 1% of all micropayments (<$5) in the U.S. → $10 billion/year

Mapping is expensive!

- Can share information w/ other hosts on the same campus (or p2p network)
- Can use non-critical traffic (instead of probes) to measure new paths
- Typical AS path length is 3
- Sender does not need full information
  - One good path is enough

Hackers will steal the money!

- Hijack computer, leak nanopayments, get money at the end of the month
- Solution: “digital secretary” running on trusted hardware must certify packets
  - Network verifies signatures at edge
  - Limited functionality → unhackable
  - Increases cost of solution

Hard to judge a packet's worth!

- Can talk to the user directly
- Trade-off between intrusiveness and cost of guessing wrong
- If user (or digital secretary) cannot tell apart important traffic from excessive junk, he cannot expect quality service!

Open questions

- Optimal behavior for rational ISP?
- How to “modulate” nanopayments?
- Interactions with congestion control?
- Effect on network topology?
- Path selection and stability?

The end

Fire at will!

We hate usage-based pricing!

1. Not if we get a good deal!
2. User can refuse to add nanopayments

Load-aware routes = instability

- IP routing: all packets to a destination take the same path → flapping
- Bill-Pay: senders make desynchronized decisions → load balancing