XCP: The eXplicit Control Protocol

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XCP in a Nutshell

- XCP is a new congestion control protocol developed by Dina Katabi, MIT
- End-systems use explicit signaling to tell routers their preferred send rate
XCP in a Nutshell

- With XCP, routers...
  - ...make a per-flow allocation (without keeping per-flow state),
  - ...inspect incoming packets, and
  - ...reduce the throughput request to match the allocation (if necessary)
Explicit signaling happens via the congestion header.
XCP Feedback Loop

1. Sender wants to increase send rate by X, currently sending N packets per RTT

2. \( \delta_{throughput} \) initialized to the per-packet request
   \[ d_t = \frac{X}{N} \]

3. Router compares this flow's allocation (R1) to \( d_t \):
   \[ R1 > d_t \]

4. Header unchanged
   \[ d_t = \frac{X}{N} \]

5. Router compares this flow's allocation (R2) to \( d_t \):
   \[ R2 < d_t \]

6. Header modified
   \[ d_t = R2 \]

7. Receiver copies \( d_t \) into packets destined to Sender
XCP Feedback Loop

7. Receiver copies $d_t$ into packets destined to Sender

8. $r_f = R2$

9. Sender learns about bottleneck allocation in one round trip
XCP Routers Run Two Independent Controllers

An instance of these controllers operate on each output queue in a router.
Router feedback is allocated to flows using AIMD.

Positive feedback is allocated evenly to each flow (allocated per packet).

- 8 units of feedback for 4X kBps flow
- 8 units of feedback for 4X kBps flow
- 8 units of feedback for 2X kBps flow
- 8 units of feedback for X kBps flow
Router feedback is allocated to flows using AIMD.

Negative feedback is allocated based on bandwidth used (again allocated per packet).

- 8 units of feedback for 4X kBps flow
- 8 units of feedback for 4X kBps flow
- 4 units of feedback for 2X kBps flow
- 2 units of feedback for X kBps flow
What’s So Cool About XCP?

- Relative to Reno, XCP simulations show it...
  - Fills the bottleneck pipe much more rapidly
  - Rapidly converges to fairness
  - Gets better bottleneck link utilization for large BDP flows
  - Maintains tiny queues
  - Is more stable at long RTTs
What’s So Cool About XCP?

- XCP is a general resource management framework capable of:
  - Unfair allocations (e.g., QoS, low priority)
  - CC for other protocols (e.g., dccp)
Current Development

- Fair capacity sharing with TCP
- Moving line-rate divisions out of routers
- XCP PEP
- Detecting congestion at non-XCP queues
Plans

- Revise draft-falk-xcp-spec and publish as an Experimental RFC
XCP Project Info

• http://www.isi.edu/isi-xcp
• experimental results
• source code
• draft specification
• mailing list information
• .....and much, much more!!
The End