Mutually Controlled Routing with Independent ISPs

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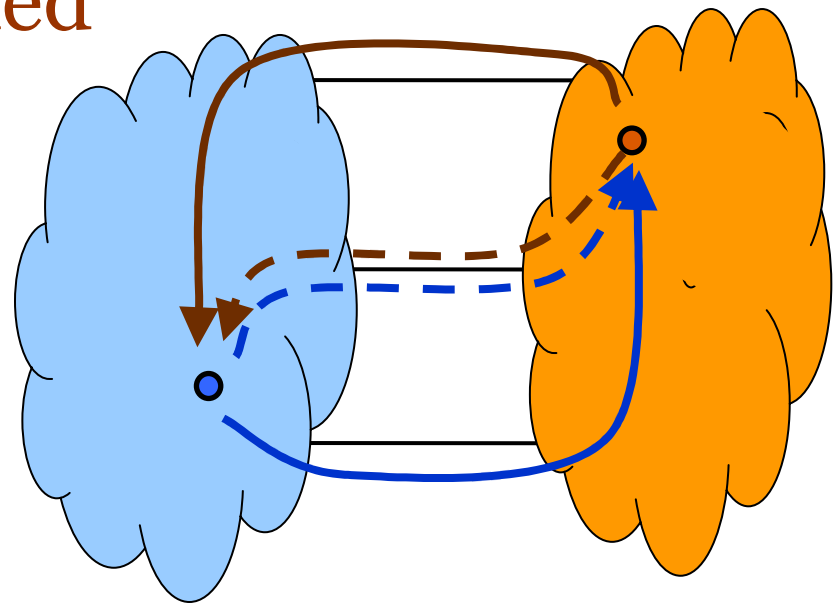
Conflict in Internet routing today

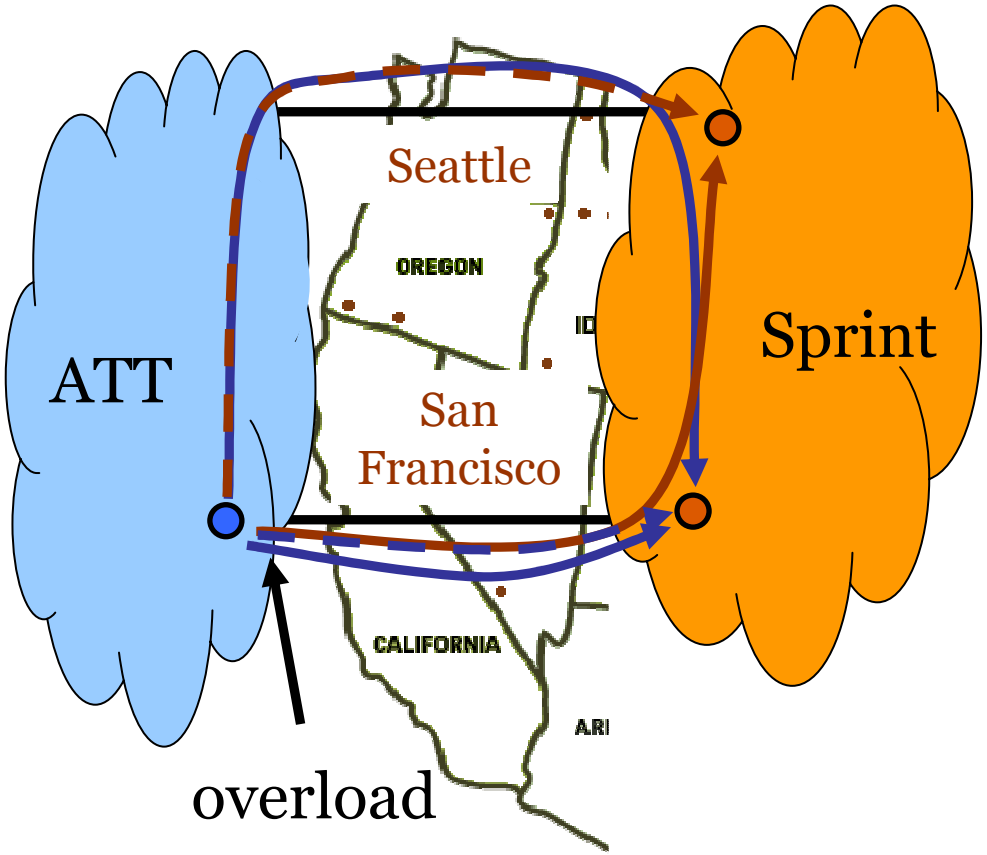
ISPs simultaneously cooperate and compete in a contractual framework

Paths are usually decided by upstream ISPs

- ISPs have little control over incoming traffic
- End-to-end paths can be longer than necessary

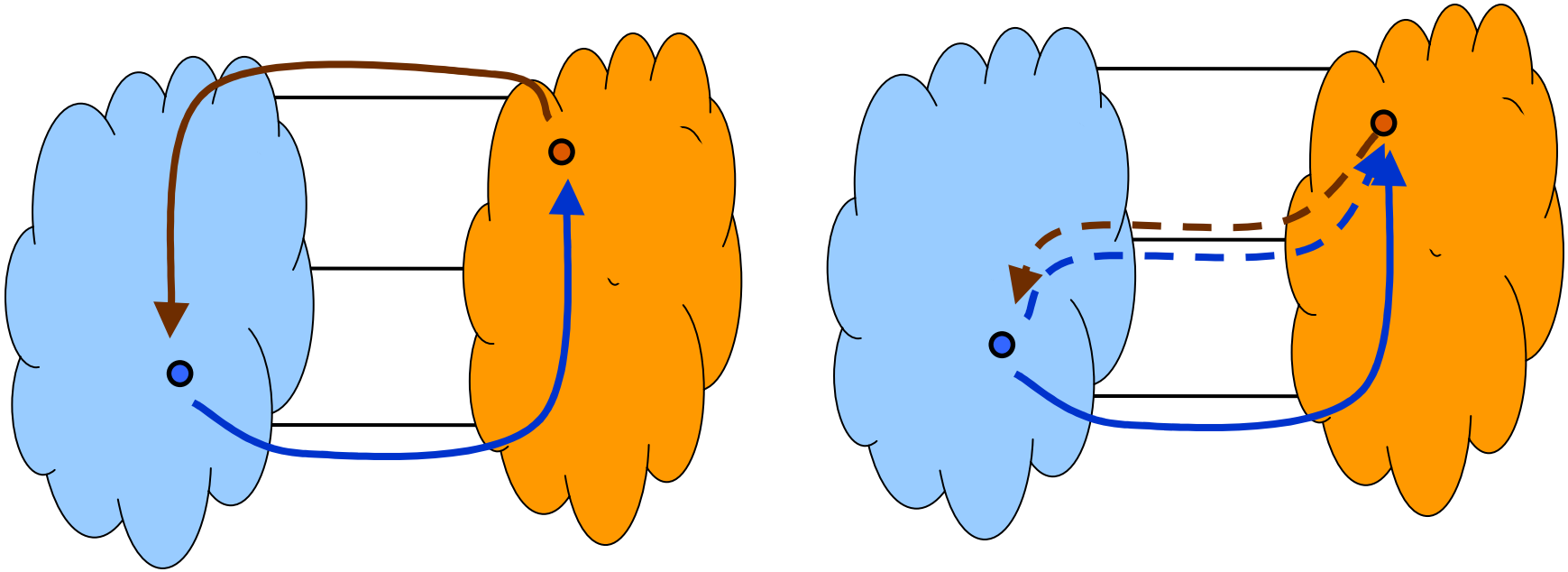


A real incident



Paths are longer than necessary because ATT unilaterally controls paths

Goal: Provide joint control over routing



Constraints due to ISP independence

- Be individually beneficial ("win-win")
- Not require ISPs to disclose sensitive info
- Enable ISPs to optimize for their criteria

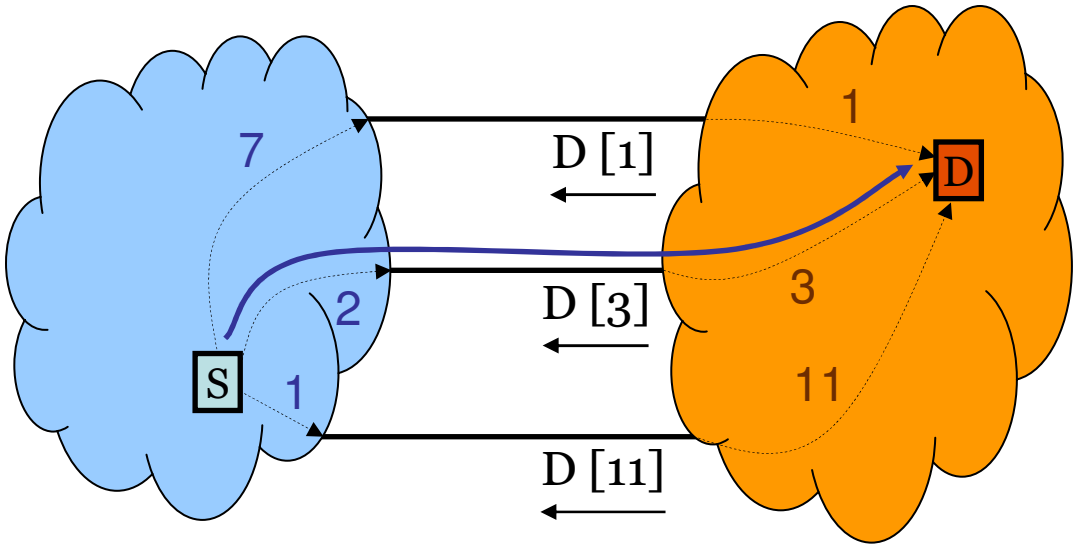
Retain contractual framework and low overhead

On protocol design in systems with competing interests

"*The most important change in the Internet architecture over the next few years will probably be the development of a new generation of tools for management of resources in the context of multiple administrations.*"

-- David Clark, 1988

Our solution: *Wiser*



Operates in shortest-path routing framework

- Downstream ISPs advertise "agnostic" costs
- Upstream ISPs select paths based on their own *and* received costs

Problems with vanilla shortest-path routing

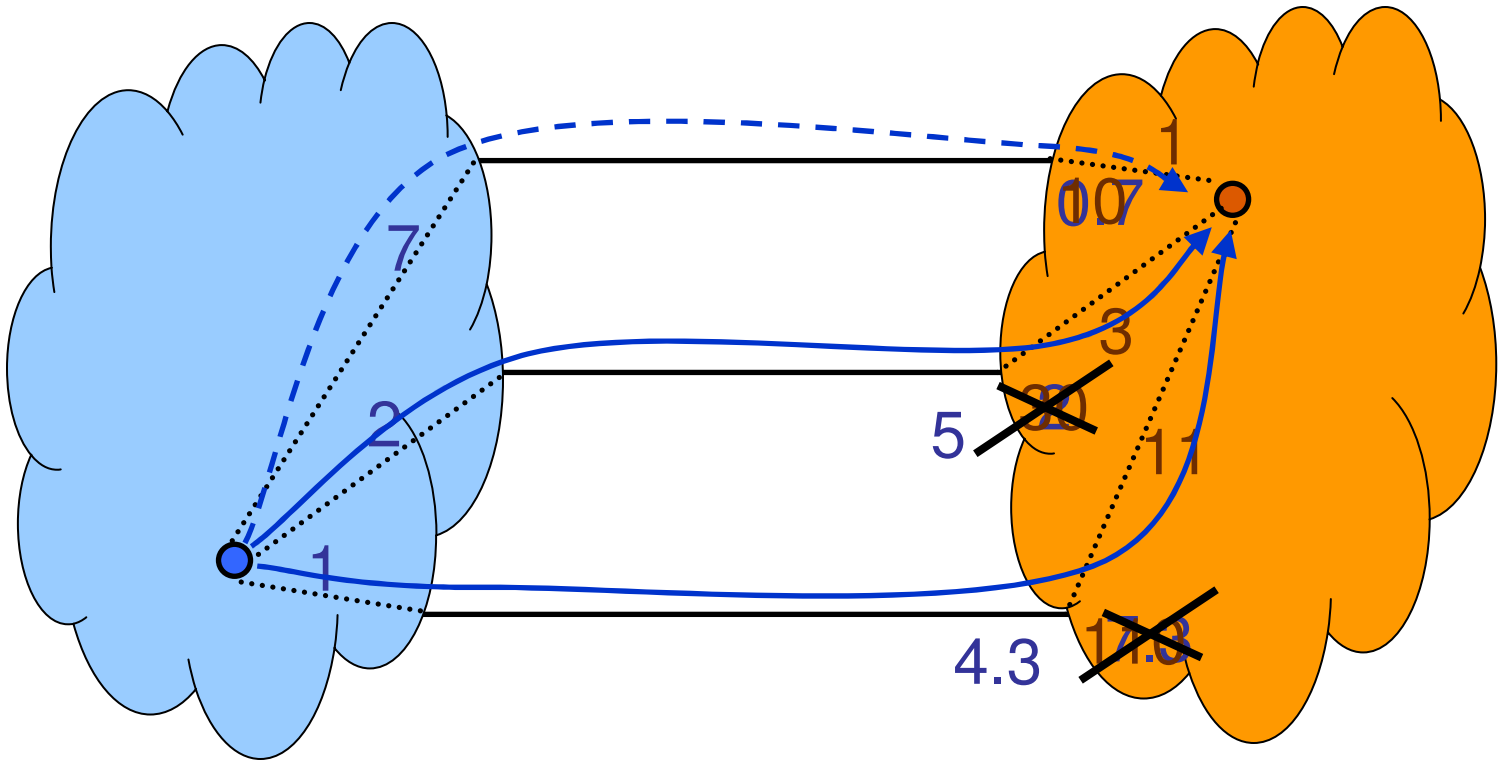
Can be easily gamed

- ISPs can lie about their costs
- ISPs may ignore others' costs

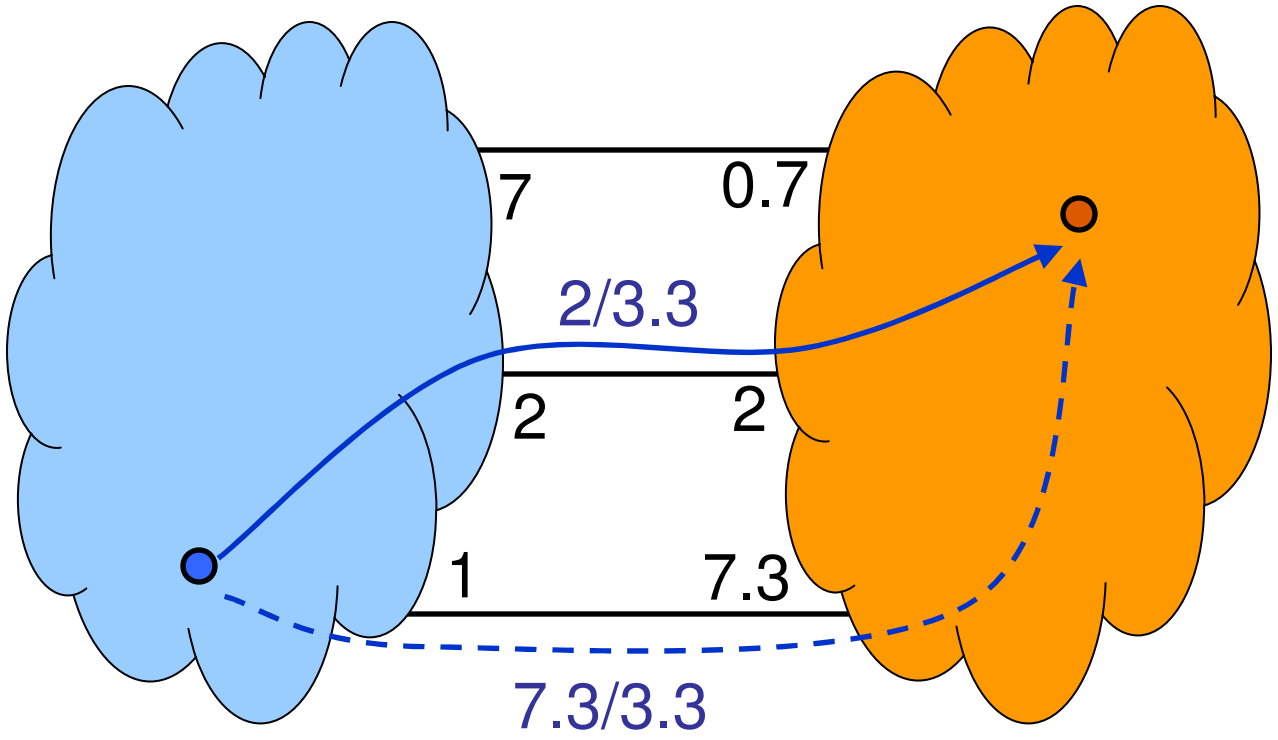
May not be win-win

- ISPs' costs may be incomparable

Normalize costs so no ISP dominates



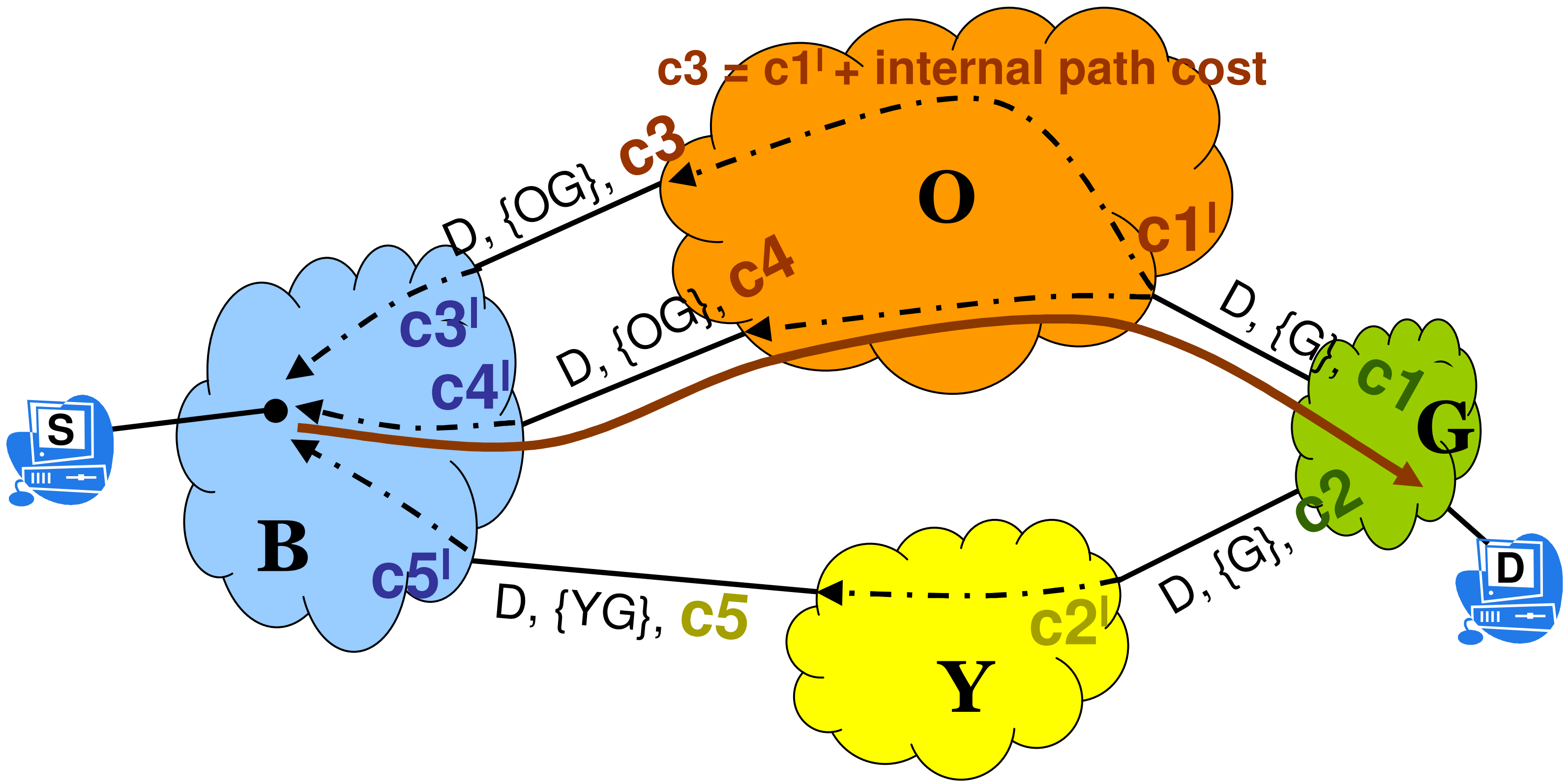
Monitoring the behavior of upstream ISPs



Downstream ISPs monitor the ratio of average cost of paths used and average announced cost

Contractually limit this ratio

Wiser across multiple ISPs



Conv [illegible] actor

Going from BGP to *Wiser*

Simple, backward-compatible extensions

- Embed costs in non-transitive BGP communities
- Border routers jointly compute normalization factors and log cost usage
- Slightly modified path selection decision

Retains today's contractual framework

Benefits even the first two ISPs that deploy it

A prototype in XORP is publicly available

Evaluation

What is the benefit of *Wiser*?

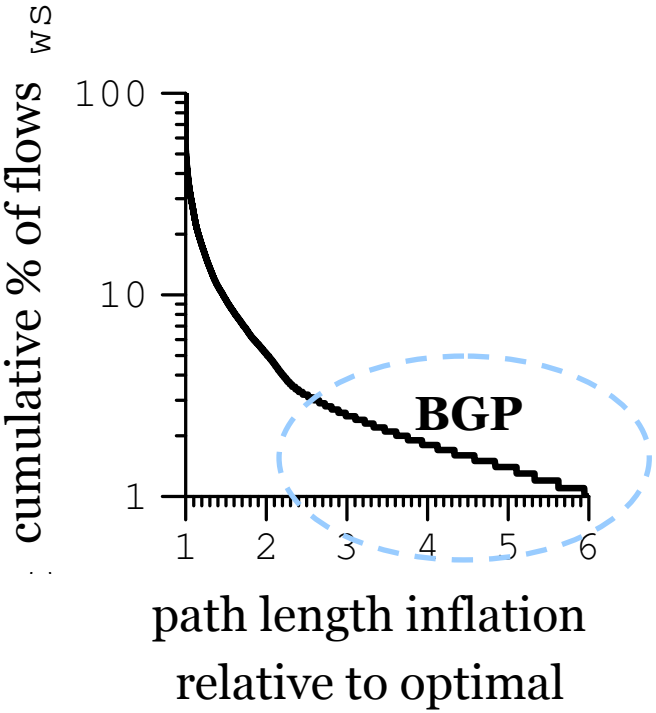
How much can ISPs gain by cheating?

What is the overhead of *Wiser*?

Methodology:

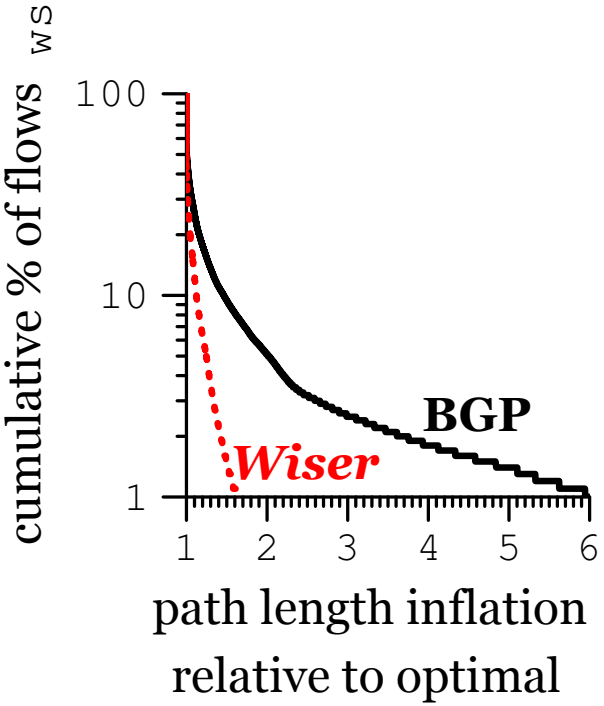
- Combine measured data and realistic models
- Topology: city-level maps of 65 ISPs

Some paths are very long with BGP



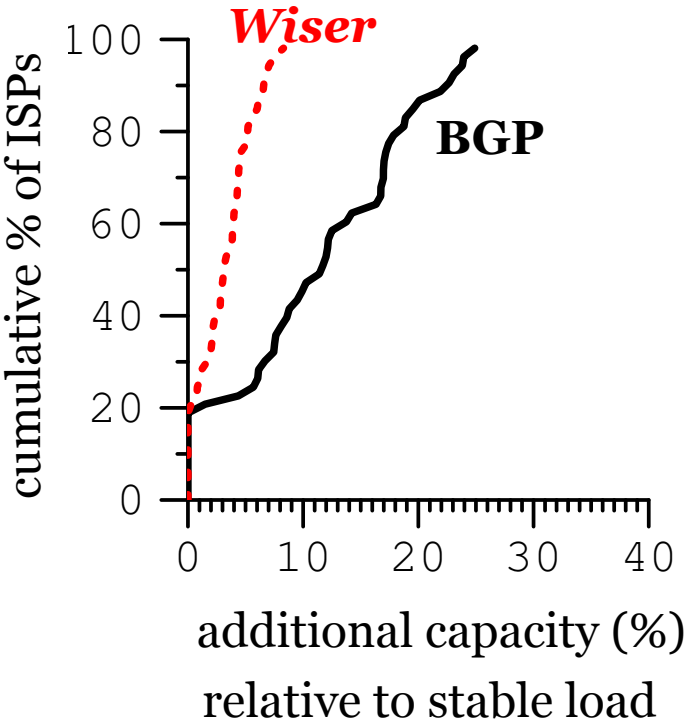
%	length inflation
50	1.0
10	1.4
5	2.0
1	5.9

Wiser paths are close to optimal

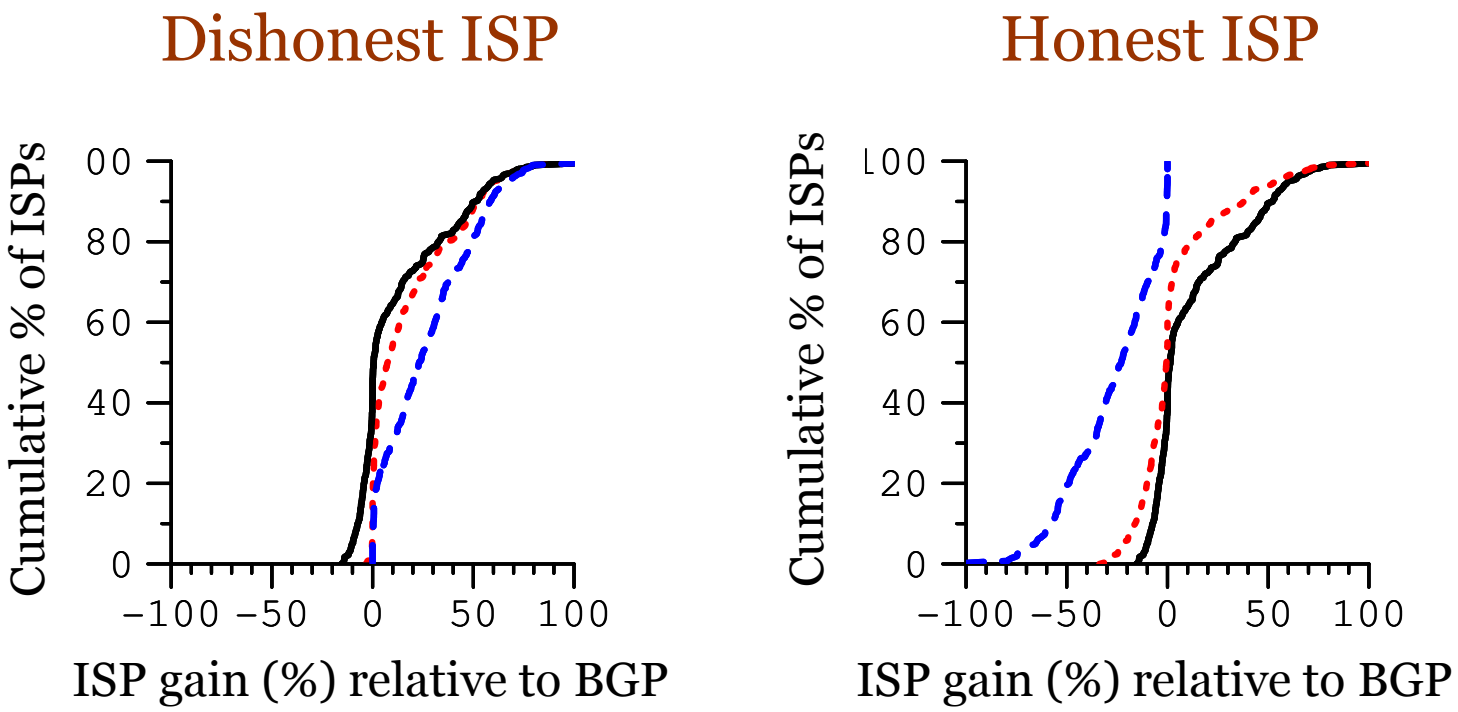


%	length inflation	
	BGP	*Wiser*
50	1.0	1.0
10	1.4	1.1
5	2.0	1.2
1	5.9	1.5

Wiser requires less capacity to handle failures



Wiser limits the impact of cheating



two honest ISPs (*Wiser*)
one dishonest ISP (no constraints)
one dishonest ISP (*Wiser*)

Overhead of *Wiser*

Implementation complexity

- Two implementations: XORP and SSFNet (simulator)
- Less than 6% additional LoC (base ~ 30k)

Computational requirements

- 15-25% higher than BGP for normal workload

Convergence time

- Higher than BGP but acceptable even for large failures

Routing message rate

- Comparable to BGP

Concluding thoughts

Wiser provides joint control over routing to ISPs

Competing interests don't lead to significant efficiency loss in Internet routing

Evidence that practical protocols can harness competing interests