Unison: Enabling Content Provider/ISP Collaboration using a vSwitch Abstraction

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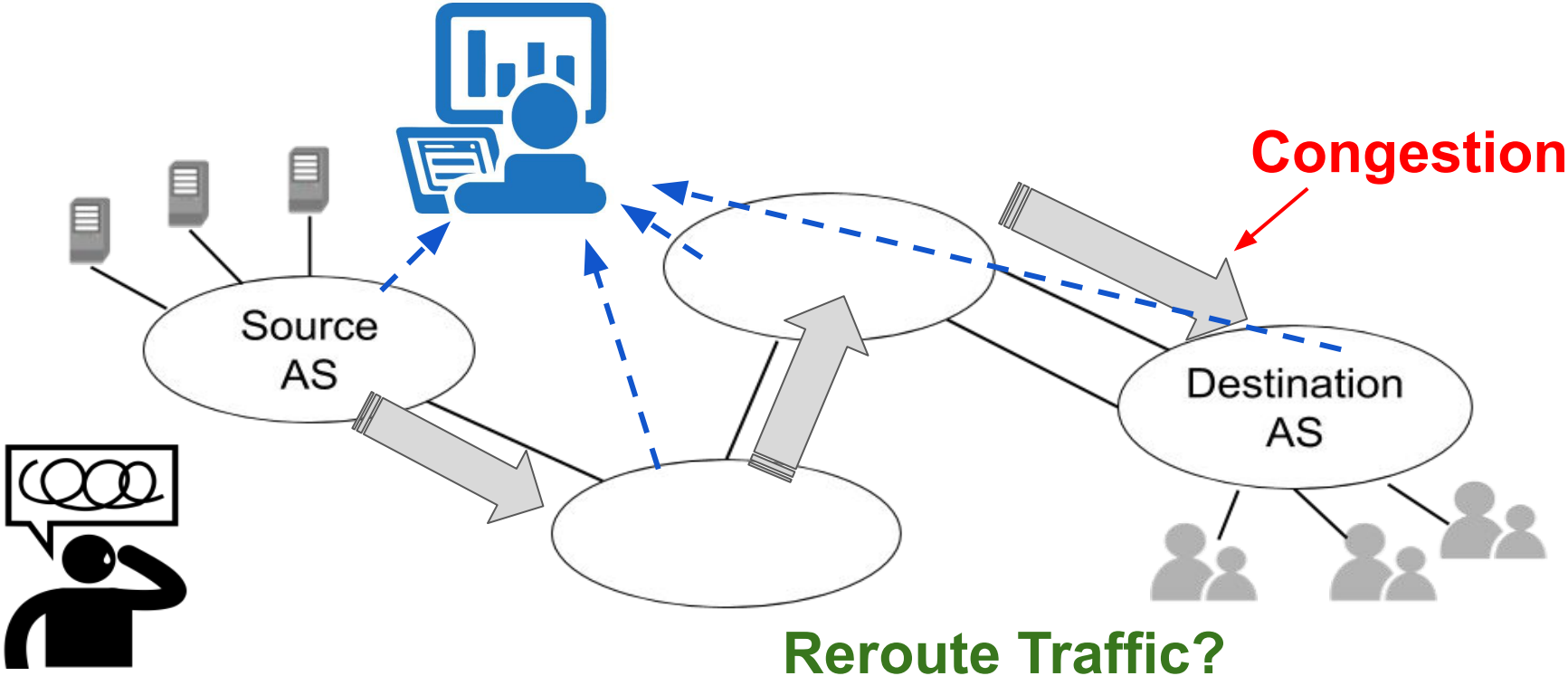


Lower Transmission Rate?

Reroute Traffic?

Broker-based pathlet stitching is difficult to scale

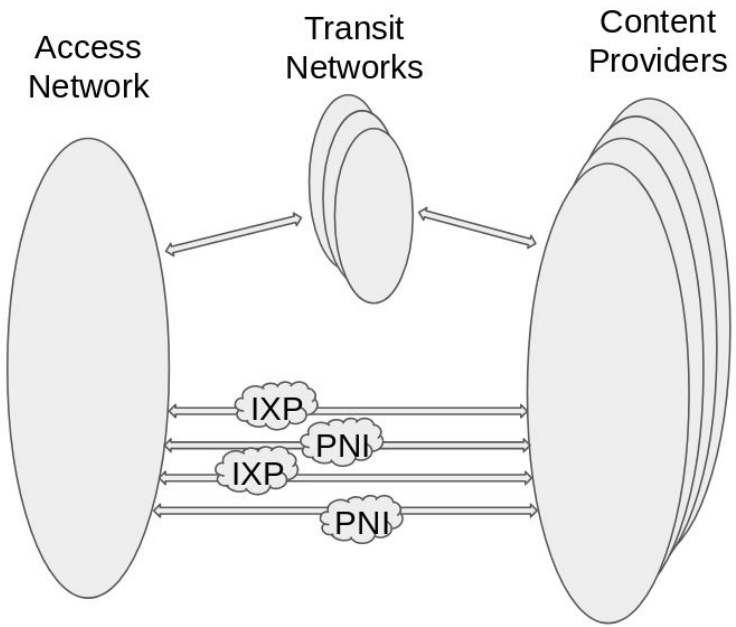
- require all ASes to coordinate

What changed?

Trend #1: Direct Peering between ISP and CP

- Interdomain ecosystem is evolving: hierarchical structure to flatter structure
- Large content providers have been engaging in direct peering with access ISP

Trend #2: Advancement in SDN Techniques



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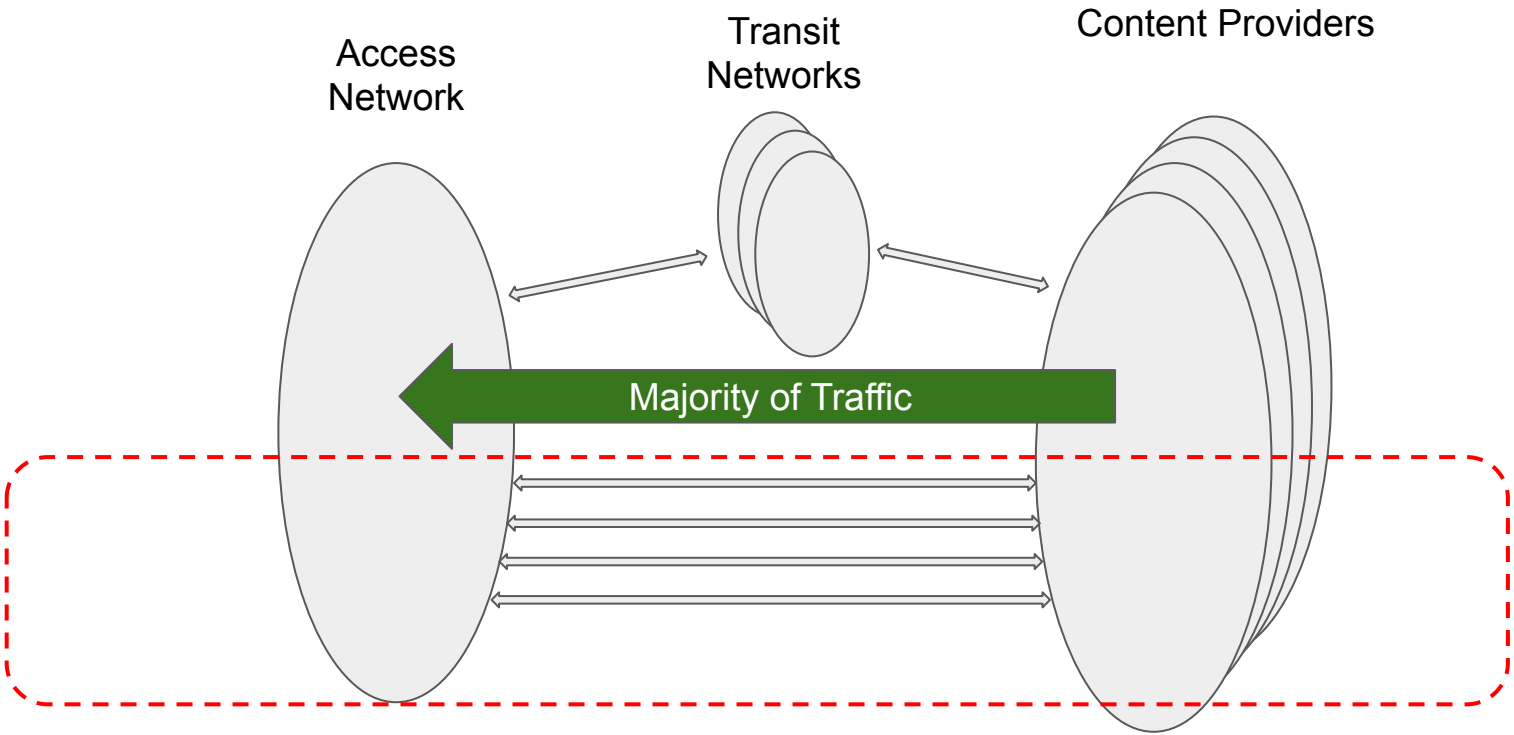
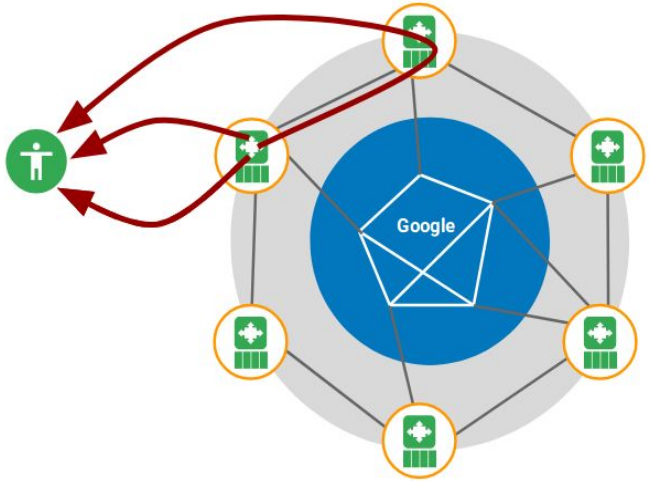
Revisit: Reroute Traffic



Content Provider's Solution: Good First Step

- Large content providers have deployed SDN-based infrastructure to reroute traffic to uncongested links in response to network congestion
  - Route selection can be done per PoP (Facebook)
  - Route selection can be done centrally across AS (Google)



Yap, Kok-Kiong, et al. "Taking the edge off with Espresso: Scale, reliability and programmability for global internet peering.", SIGCOMM 2017

Is it good enough?

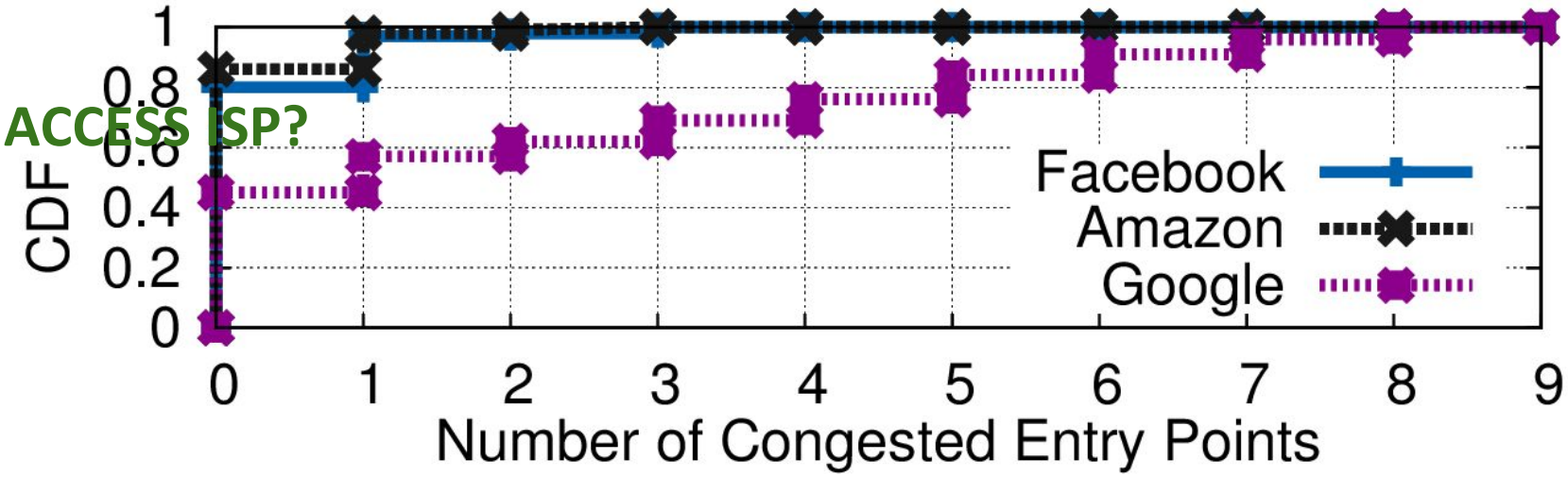
- Content providers choose entry points to ISP based on limited information
  - no visibility into ISPs' network

- ISP has better information about its own network

The Access Network can help the Content Provider choose between alternative routes and even optimize its own network to react to such choices

How to make joint decision?

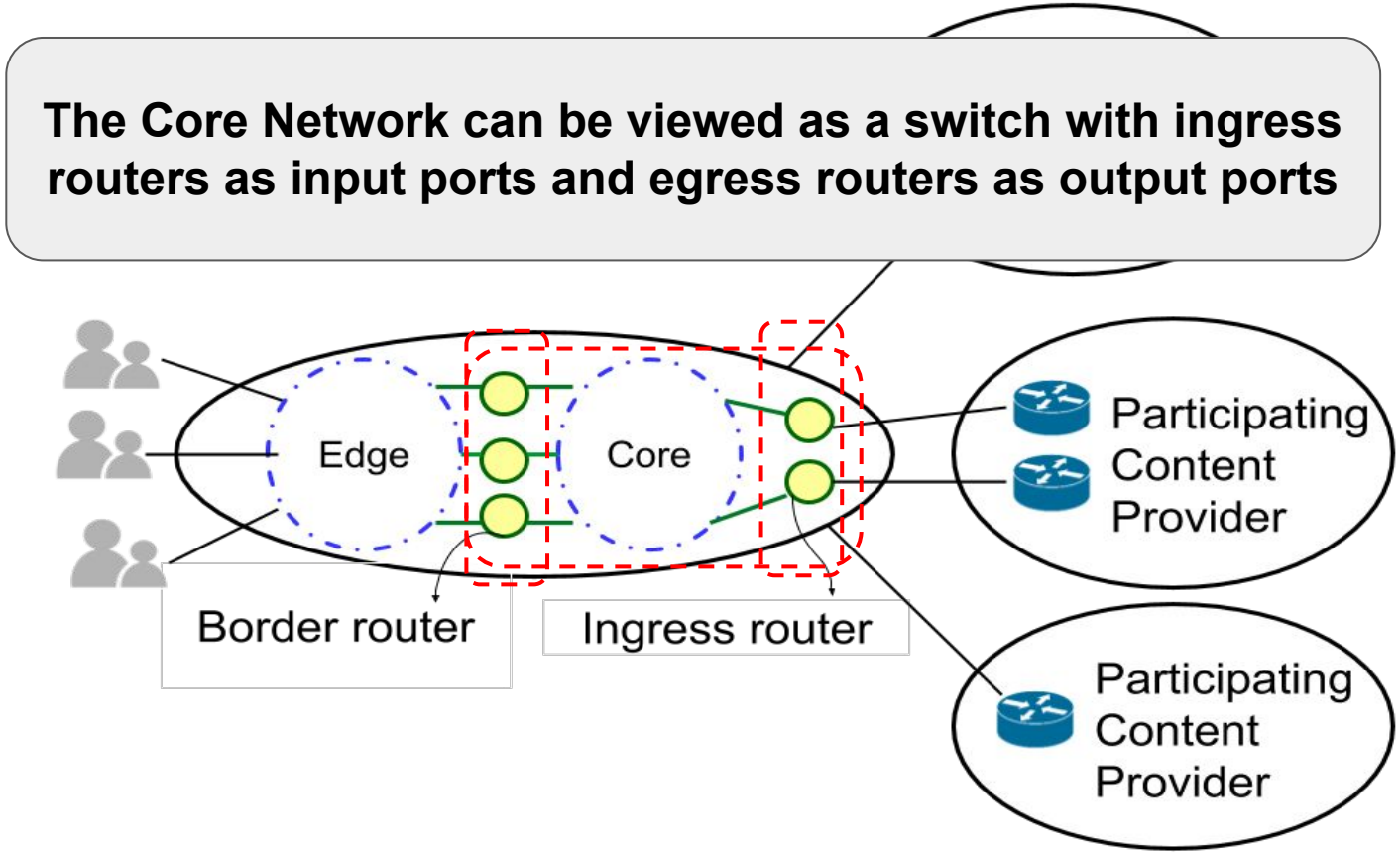
- **Content Providers**: Software-defined interconnects system makes it feasible to control inter-domain traffic dynamically
- **Alternative entry points exist**:
  - (source: https://www.caida.org/projects/manic/)



Unison: Enabling ISP/CP Collaboration

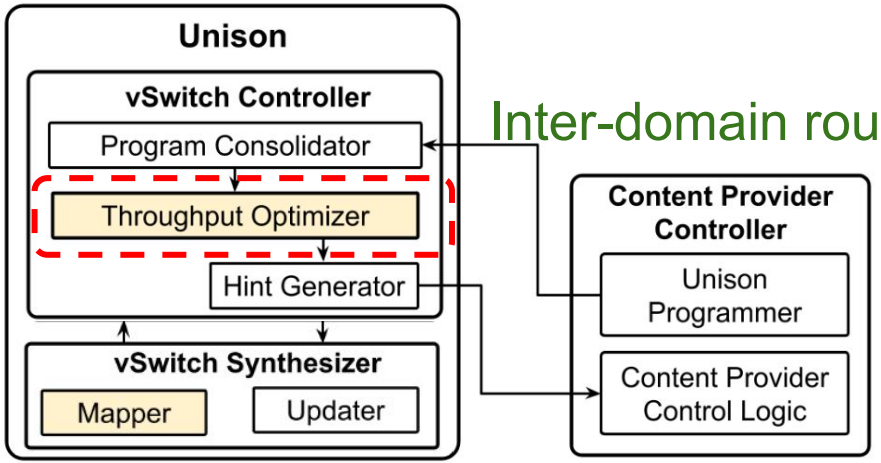
- Goals
  - Benefit both CPs and ISP
  - Limited info disclosure
  - Incremental deployment
- Solution:
  - Provide a vSwitch abstraction of the ISP network to neighboring CPs to express their prefered routing policies
  - ISP provides hint to guide CP routing decisions

Unison Overview



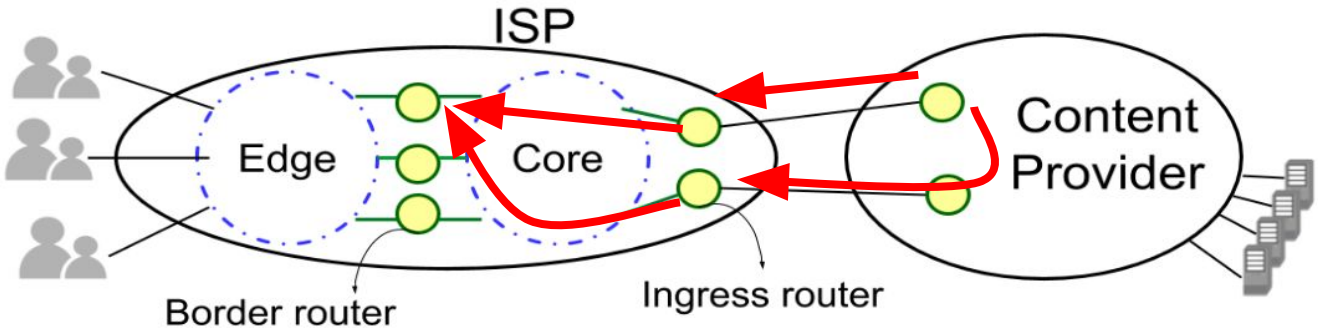
Unison Overview

Operate in t ; an interface to CPs



Inter-domain routing

Intra-domain routing



Optimization

- Unison can be used to achieve a wide range of objectives:
  - Reduce latency
  - Minimize cost
  - **Maximize ISP throughput**

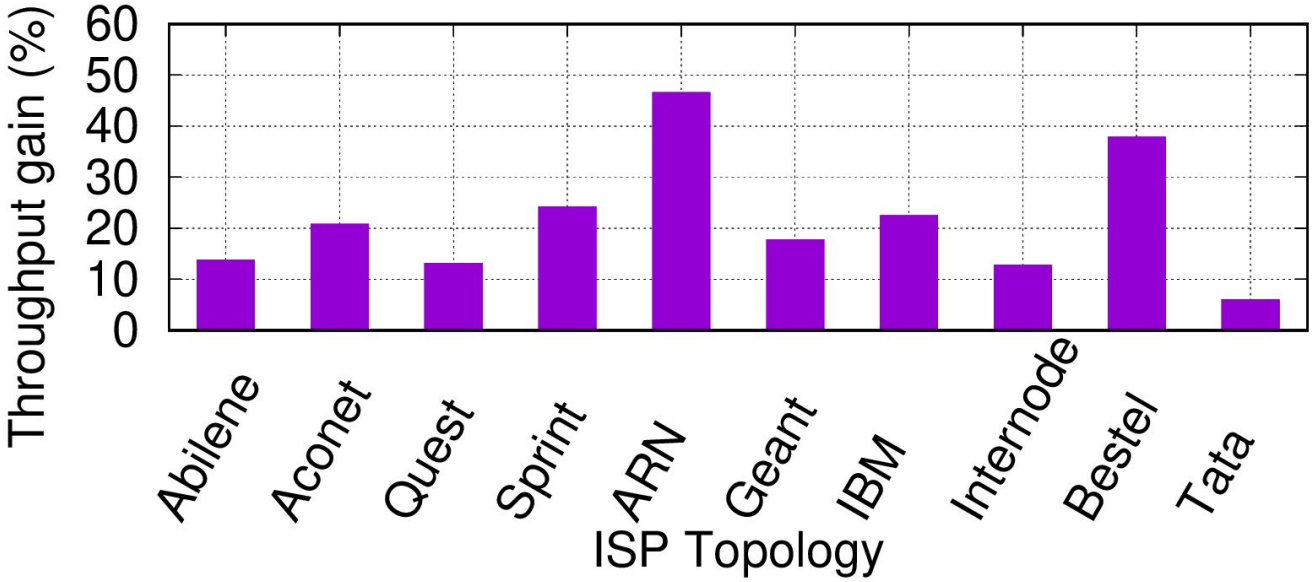
Example: Throughput Optimization

- Path-based ILP formulation
- Objective: maximize total throughput of an ISP
- Constraints:
  - No link capacity is exceed
  - Routing path length
  - Weighted fairness among CP allocation
  - Handle non-cooperating CPs
    - Estimate traffic demand
- Heuristic algorithm for weighted bandwidth allocation

Evaluation

- Implement proof-of-concept Optimizer with python that calls CPLEX solver APIs
- Simulation
  - Performance metrics
    - ISP and CP throughput
    - Fairness
  - Evaluation parameters
    - Topologies
    - Number of participating CPs
    - Estimation accuracy
    - Level of traffic aggregation

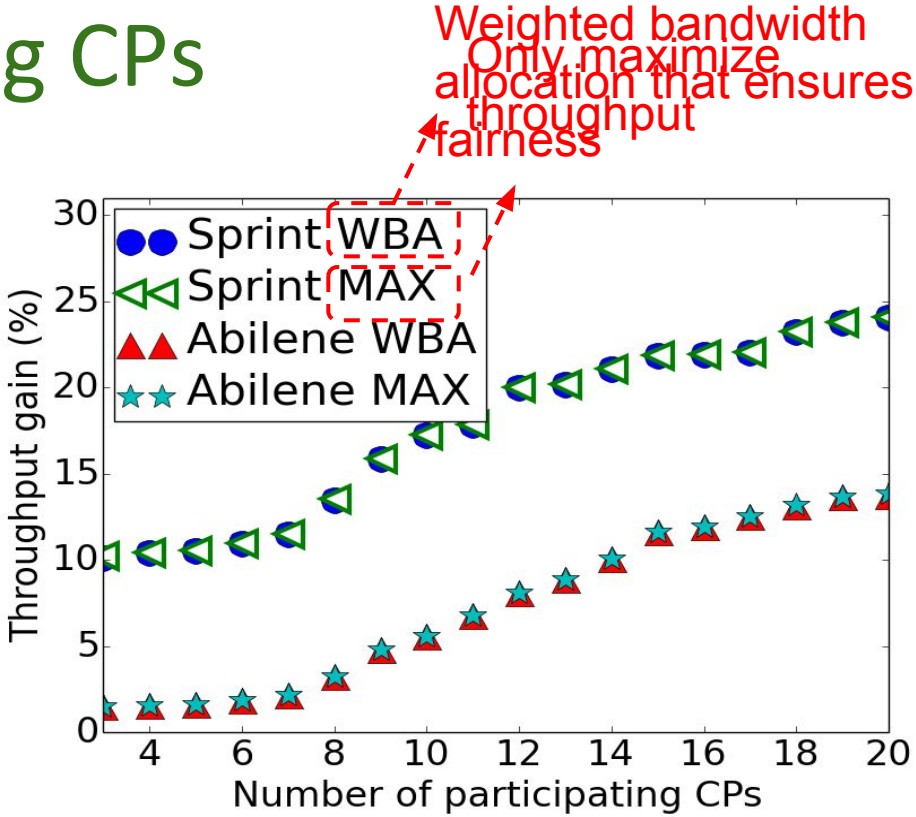
Benefit to ISPs



Jointly optimizing inter-intra-domain routing improves ISP throughput

Impact of participating CPs

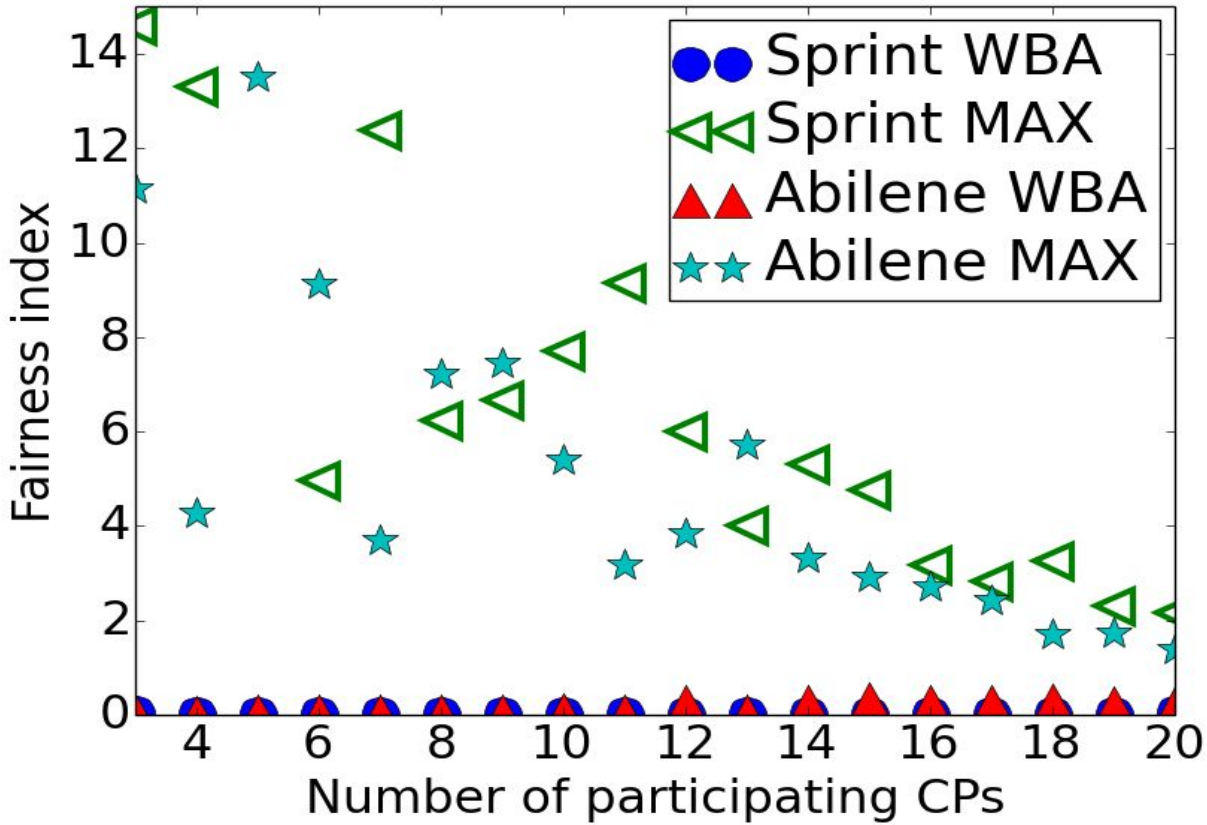
- Larger throughput gain if more CPs participate
- Achieves fairness with minor throughput impact



Conclusion

- It is not uncommon to have one point of entry to an ISP congested while there are still links that have available capacity
- We proposed a framework to be deployed in an access ISP network for jointly optimizing inter-intra-domain routing
  - Benefit both CPs and ISPs
  - Benefit even if a subset of CPs agree to cooperate
- We developed a resource allocation strategy
  - maximize the bandwidth allocation to CPs
  - insure fairness among CP allocation

Thank you!


Sprint WBA
Sprint MAX
Abilene WBA
Abilene MAX
Fairness index
Number of participating CPs
0
2
4
6
8
10
12
14
4
6
8
10
12
14
16
18
20