

Towards Coordinated Interdomain Traffic Engineering

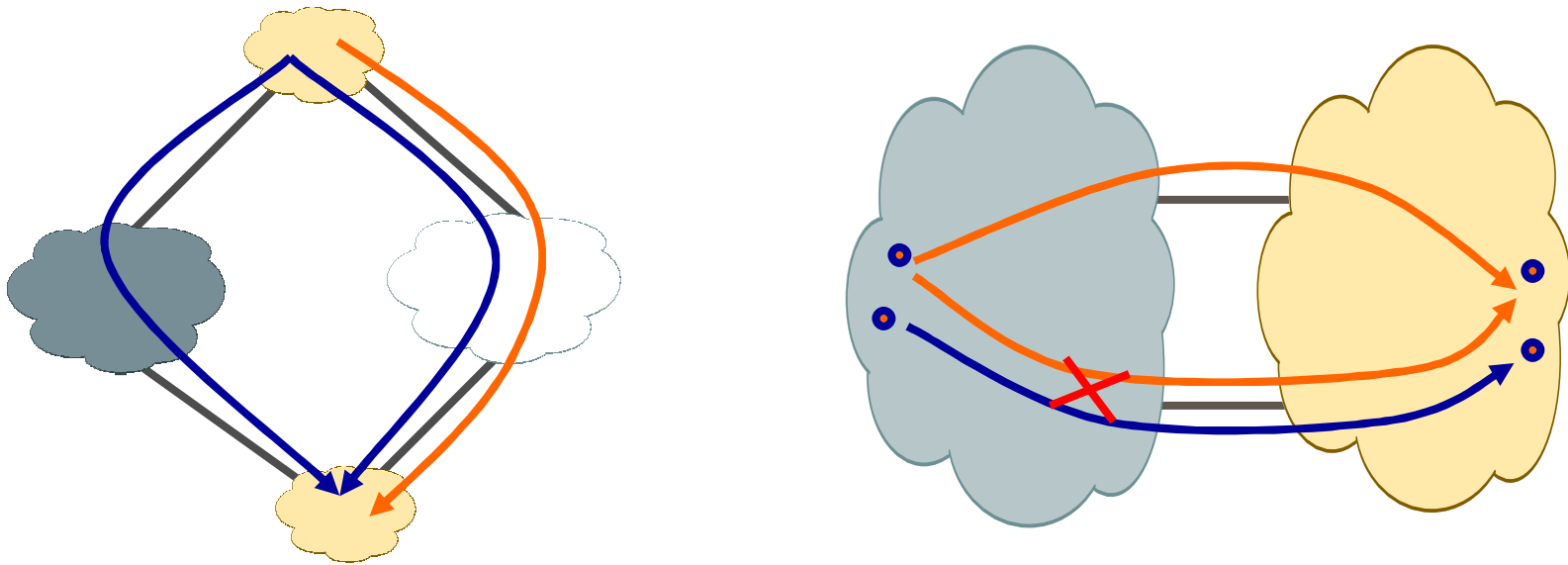
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ISPs need interdomain TE



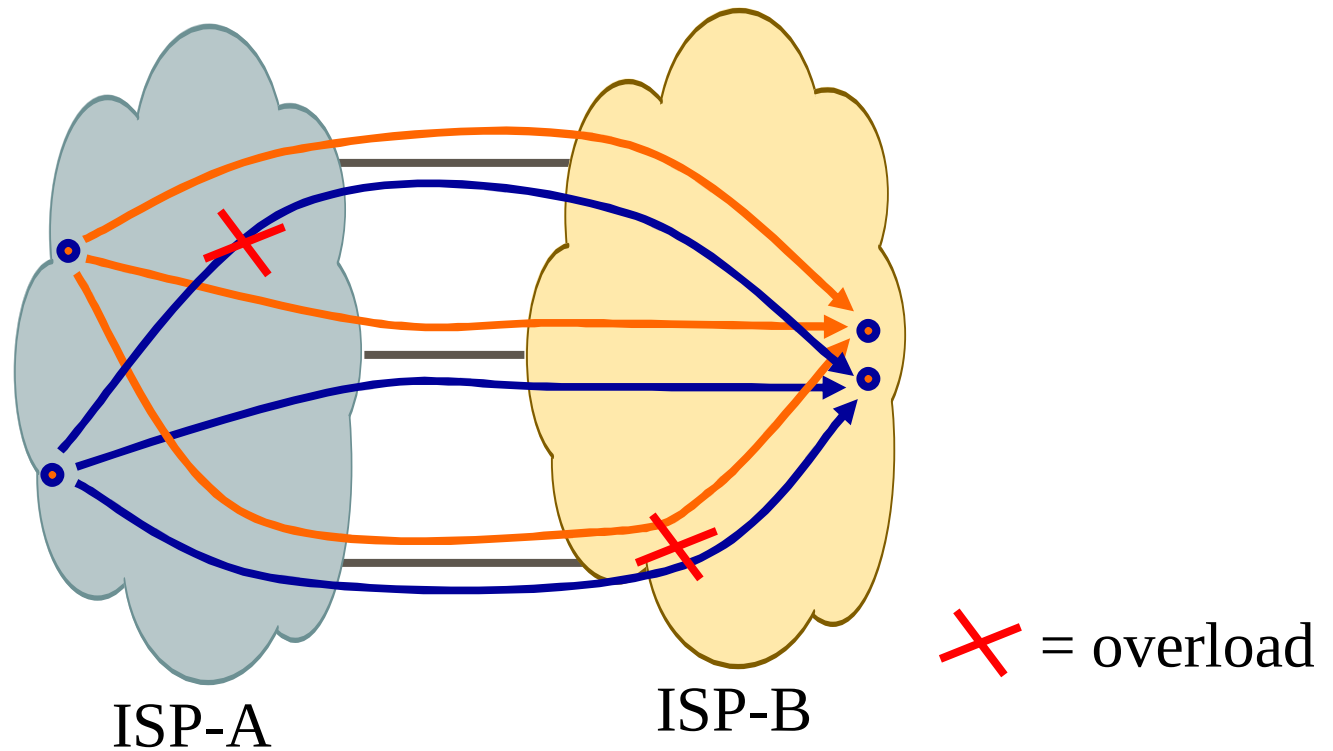
- ◆ Change how traffic enters or exits an ISP
 - to reduce resource usage, improve performance, balance load
 - deal with unforeseen events, e.g., failure and overload

Interdomain TE today

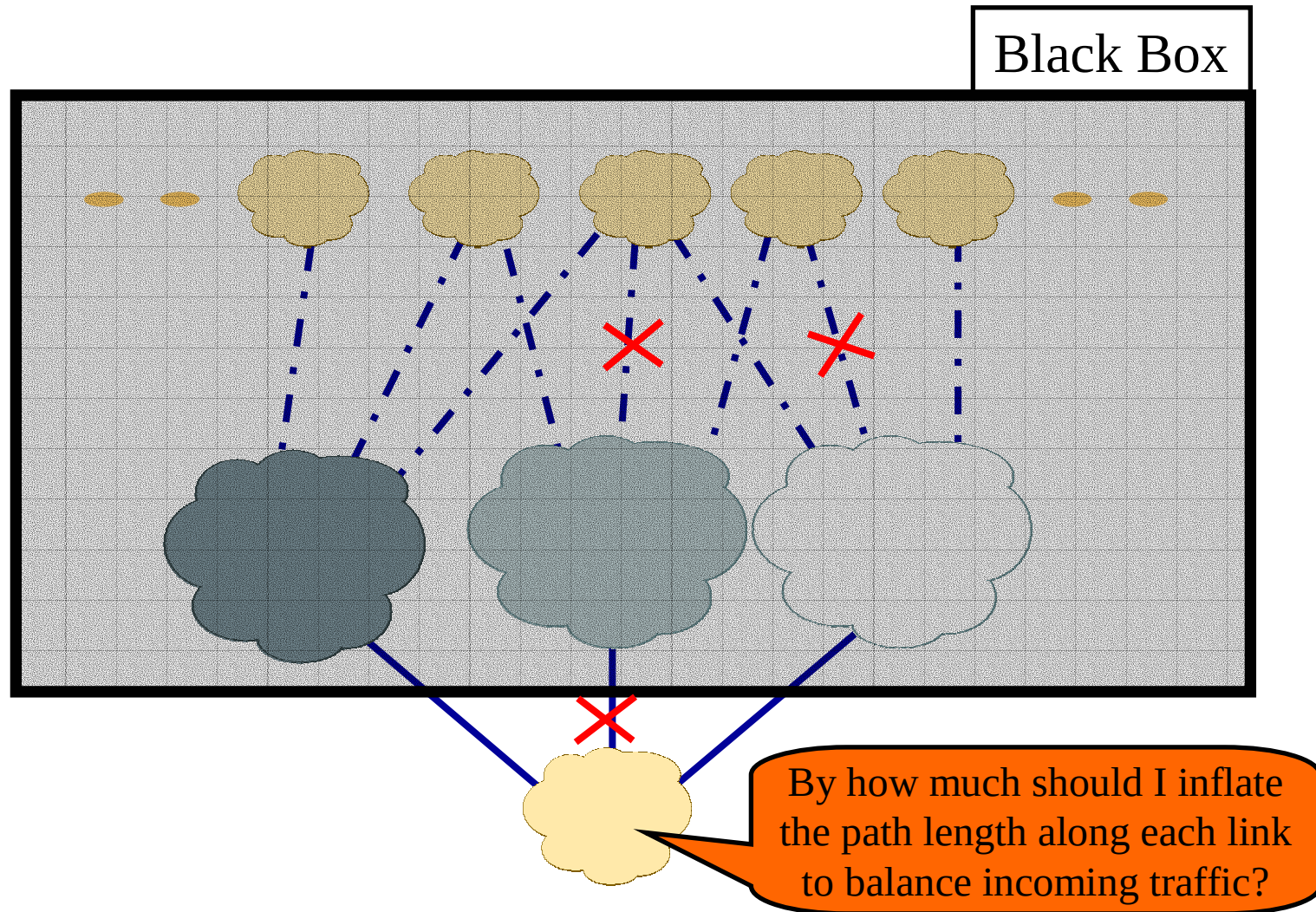
- ◆ The original design of BGP did not support TE
- ◆ A plethora of *post hoc* techniques
 - ❑ MEDs, communities, AS-path prepending, smart routing, prefix splitting, selective announcements, ...
- ◆ Unilateral, uncoordinated actions but non-local impact
 - ❑ instabilities due to conflicting control
 - ❑ unpredictable traffic control
- ◆ Complex network operations, much manual intervention and coordination



Example of conflicting control



Example of unpredictable control



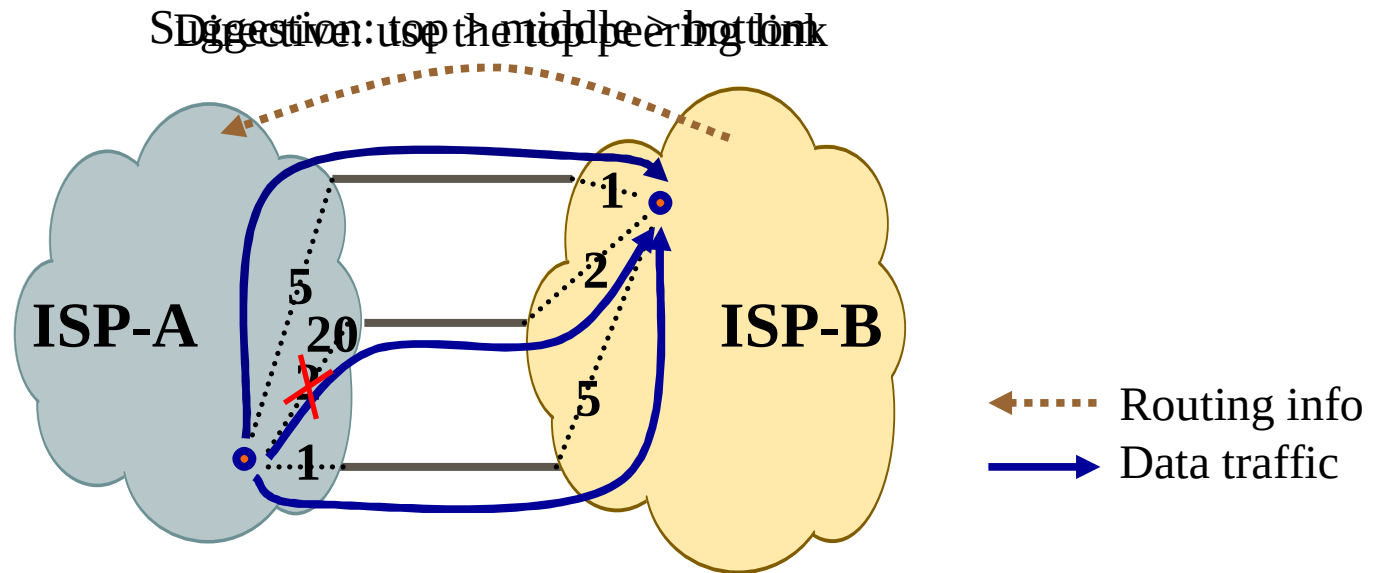
Coordinated TE

- ◆ Implement routing changes with the cooperation of impacted ISPs
 - precludes instability and unpredictability
- ◆ Properties of the coordination mechanism
 - provide predictable control over traffic
 - accommodate different optimization objectives
 - e.g., latency vs. utilization
 - accommodate different interests (“tussle”)
 - disclose little information

Towards a solution

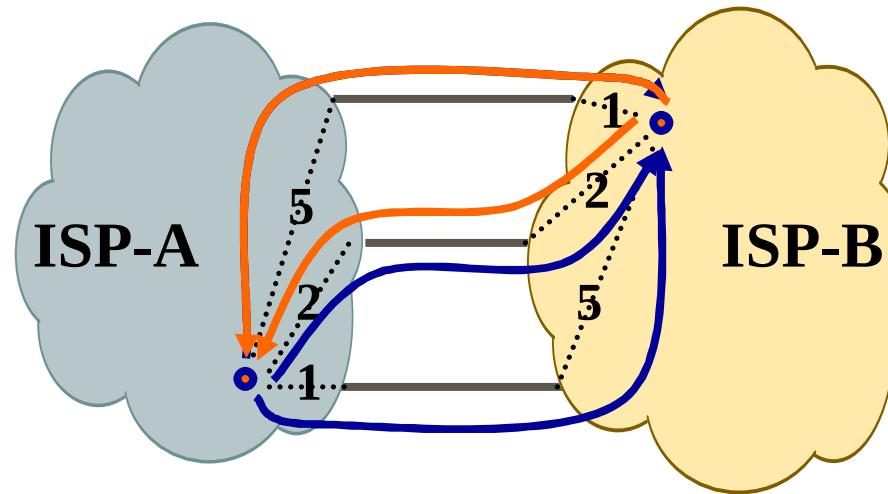
- ◆ Essential building blocks of the coordination mechanism
 - ▣ two-way routing information exchange for predictable control
 - ▣ route negotiation to effectively accommodate different interests(both are outside the confines of “BGP model” of routing)
- ◆ Coordination example: peering point selection

Two-way information exchange



- ◆ Limitations of one-way routing info exchange
 - *directives* disable upstream control
 - *suggestions* have an unpredictable impact
- ◆ Two-way exchange is essential for predictable, joint control

Route negotiation

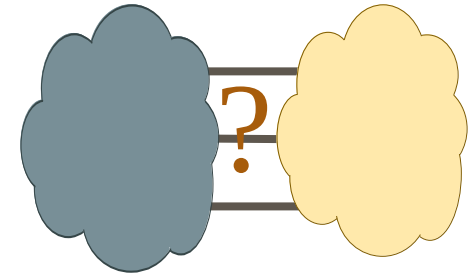


- ◆ Flow movement might present a conflict
 - ▣ one ISP loses and the other gains relative to unilateral routing
- ◆ Negotiate across flows and time
 - ▣ trade small losses for bigger gains
 - ▣ overall gain for all ISPs (“win-win”)

Coordination example

- ◆ Goal: select peering links between two ISPs

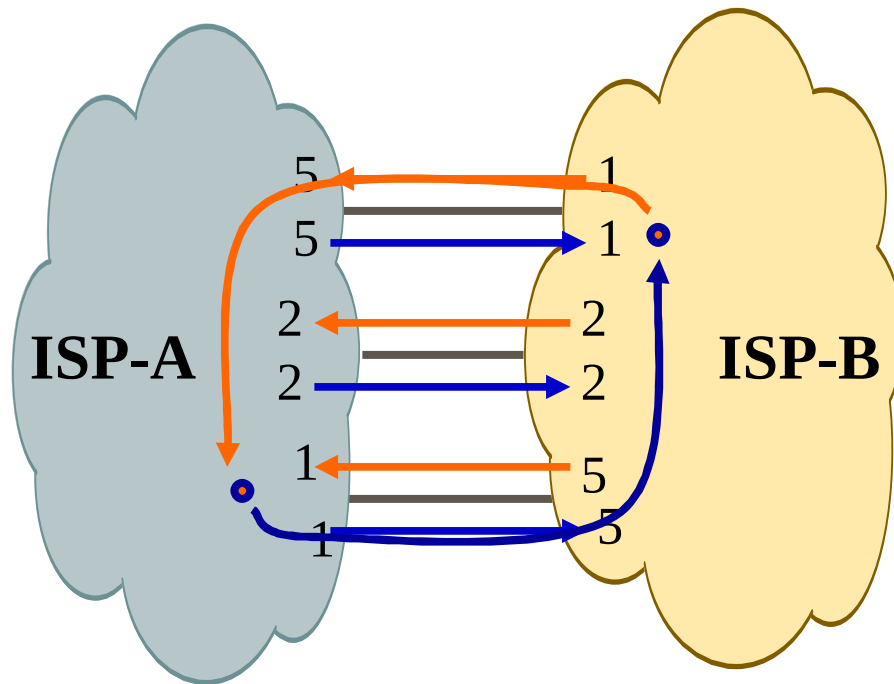
- to improve the performance and stability of traffic exchanged between them
- “base case” of the overall problem



- ◆ High-level methodology:

- ISPs share coarse preferences for receiving *and* sending each flow over each peering link
 - opaque (like MEDs); derived from respective optimization metrics
- negotiate routing patterns that lead to mutual gain
 - take turns to propose better routing paths for flows

Coordination example (2)



	A→B	B→A
t	(5, 1)	(5, 1)
m	(2, 2)	(2, 2)
b	(1, 5)	(1, 5)

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- ◆ Predictable traffic paths
- ◆ Better paths for both ISPs

Evaluation

- ◆ Compare three routing methodologies
 - unilateral, globally optimal, negotiated
 - two metrics: latency reduction, avoiding overload after failures
- ◆ Using inferred topologies and synthetic traffic demands
- ◆ Results:
 - negotiated routing closely approximates the globally optimal
 - negotiation is win-win; globally optimal can be win-lose

Summary

- ◆ Internet needs a principled interdomain TE architecture
 - replace the collection of ad hoc, unilateral techniques
- ◆ ISP coordination is essential
 - predictable control over traffic I/O
 - prevents inadvertent resource policy violations
 - win-win solutions provide an incentive to negotiate
- ◆ Future work:
 - the nature of Internet-wide ISP negotiation
 - scalability and gaming issues
 - the role of negotiation in the overall commercial relationship