

The Case for a Multi-Domain Routing Operating System

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Motivation

1. Internet routing is complex and expensive:

- Requires significant expertise and knowledge
- Service requirements grow: IPTV, cloud computing
- Misconfigurations can have widespread effects
- Very difficult to change (BGP ossification)
- Demanding in terms of man-hours and OPEX

2. Transit doesn't pay:

- Profits in pure transit drop (\$/Mbps)
- "Bit pipe" ISP model under revision

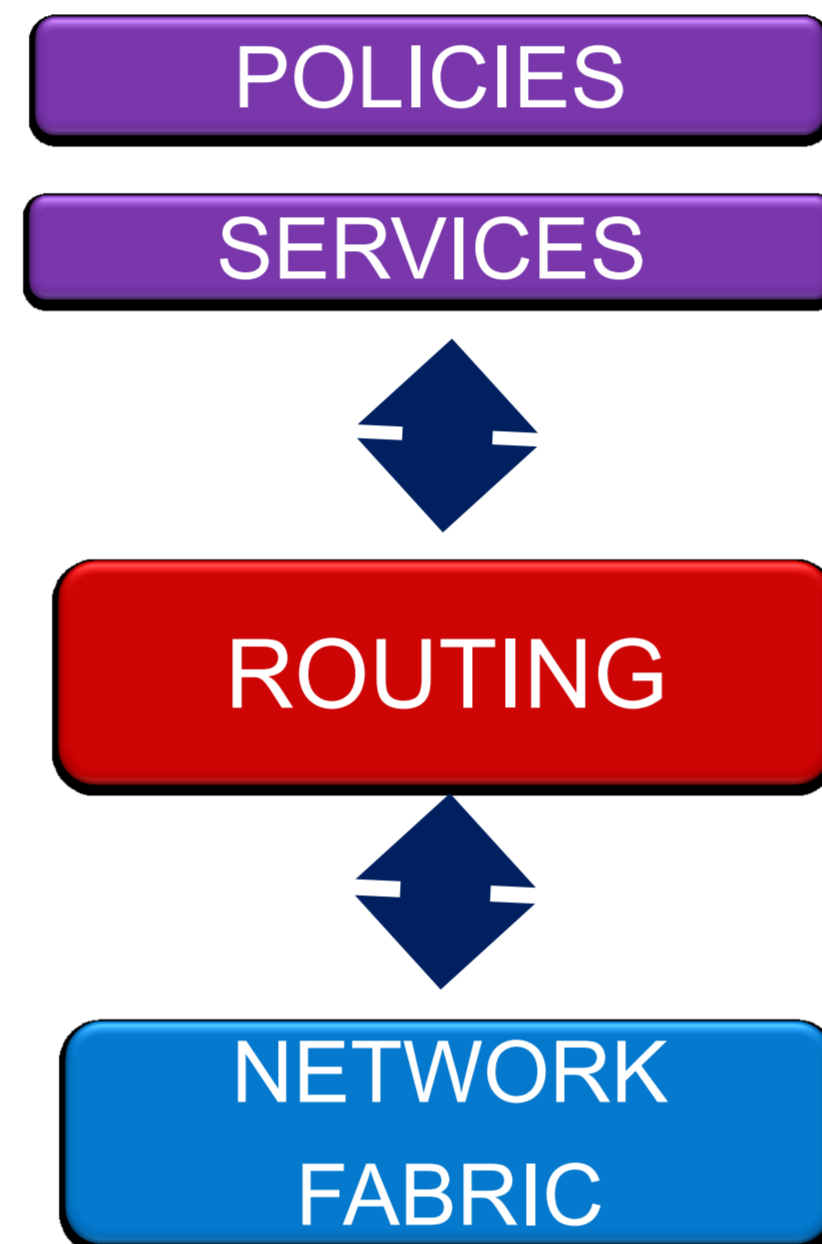
Routing is a layer of network functionality which is:

expensive, crucial for operations and **difficult** to get right.

Routing tasks from an operator's point of view

- Map SLAs to high-level policies
- Map policies to network behavior
- Satisfy increasing network requirements
- Counter errors and scalability issues
- Secure the network
- Deal with the outside world via BGP

All-in-all: Satisfy multiple objectives, both operational + economic



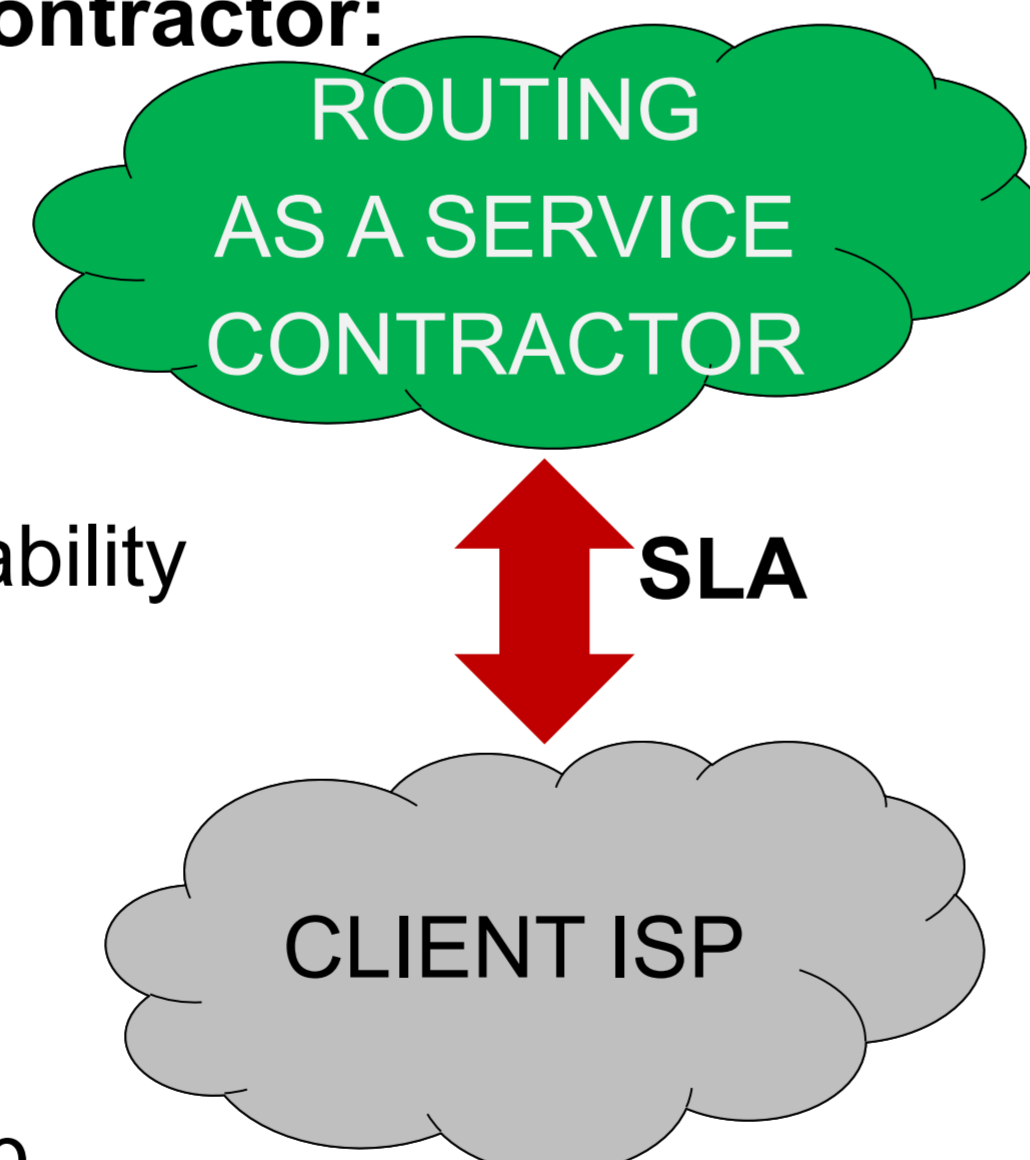
New Techno-Economic Model: Outsource the Routing Control Logic

Outsourcing ("Routing as a Service") contractor:

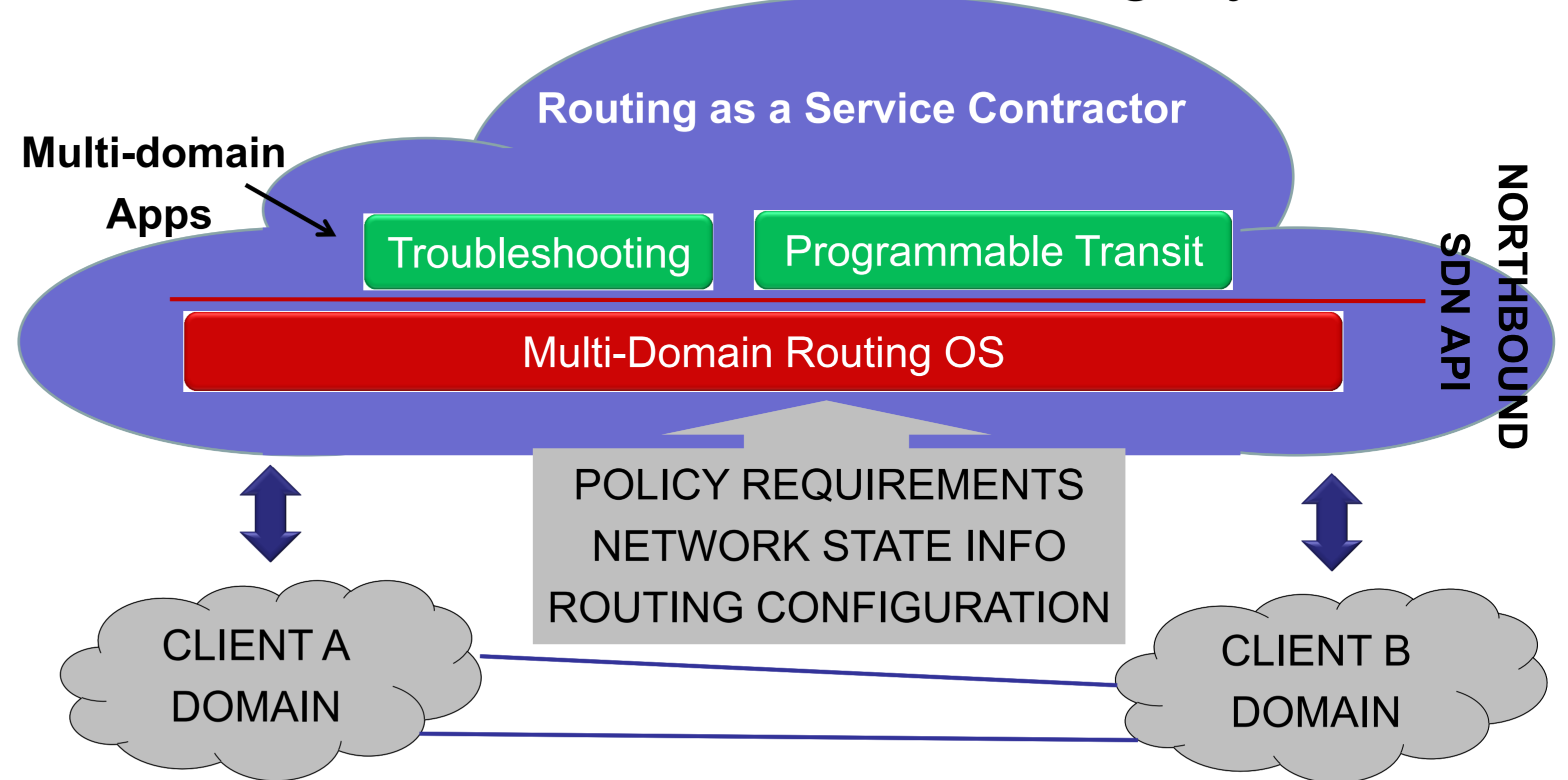
- Specializes in routing management
- Relieves the ISPs of the complex routing configuration process
- Offers better service to its clients in terms of efficiency, stability and availability
- Achieves an economy of scale

Outsourcing clients:

- "Buy" routing as an external service
- Reduce OPEX
- Form interactive business relationship



Centralizing beyond AS boundaries: towards a Multi-domain Routing System



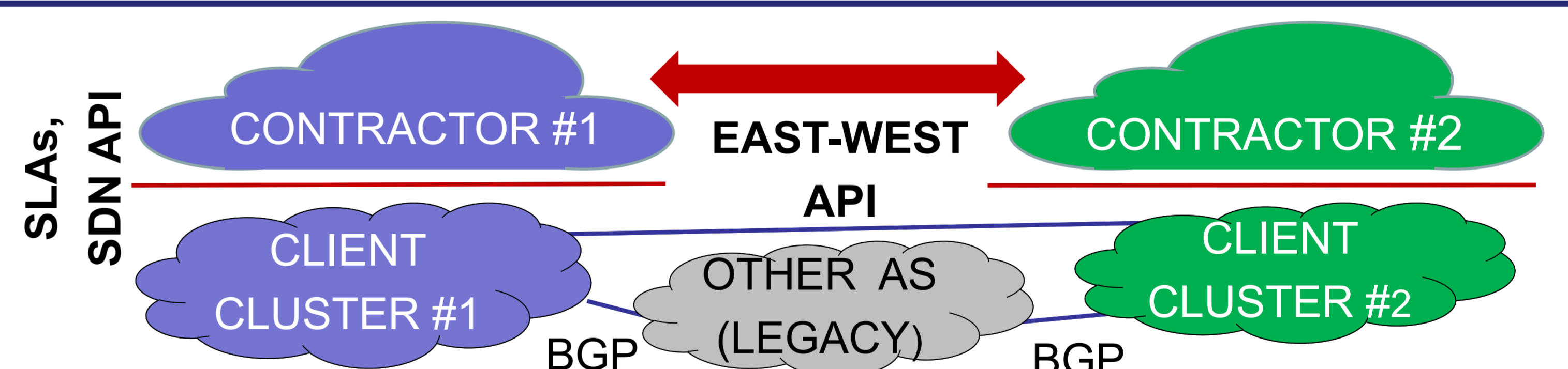
Opportunities

- More efficient routing
- Novel routing protocols
- New inter-ISP services:
 - Collaborative security
 - Cooperative troubleshooting
 - Programmable transit
 - Global IPTV
- Contractor can mediate policy tussles

VS

Challenges

- Privacy and Security
- Market models and issues
- Resilience
- Interoperability
- Scalability
- Extensibility
- Policy conflicts
 - Identification
 - Resolution



How to achieve?

- Identify the proper abstraction layer for routing control
- Define interface between client and contractor
- Define northbound API between OS and SDN routing services
- Define east-west interface between contractors
- Use algebraic frameworks for centralized routing algorithms
- Develop routing framework, test ([2]), compare with status quo

References

- [1] V. Kotronis, X. Dimitropoulos, and B. Ager. *Outsourcing the routing control logic: better Internet routing based on SDN principles*. In Proc. of ACM HotNets-XI, 2012.
- [2] *OFELIA*: <http://www.fp7-ofelia.eu/>.
- [3] M. Caesar, D. Caldwell, N. Feamster, J. Rexford, A. Shaikh, and J. van der Merwe. *Design and implementation of a routing control platform*. In Proc. of NSDI, 2005.
- [4] C. E. Rothenberg, M. R. Nascimento, M. R. Salvador, C. N. A. Corrêa, S. Cunha de Lucena, and R. Raszuk. *Revisiting routing control platforms with the eyes and muscles of software-defined networking*. In Proc. of HotSDN, 2012.
- [5] G. Gibb, H. Zeng, and N. McKeown. *Outsourcing network functionality*. In Proc. of HotSDN, 2012.

Summary of Key Ideas

- Internet routing is **hard to manage and evolve**
 - ➔ **Our goal is to overcome these obstacles**
- Outsource routing to **external contractor**
- Build on SDN** to outsource routing control plane
- Centralize routing **beyond AS boundaries**
- Investigate market and **identify win-win scenarios**
- Provide technical + financial incentives ([1])**

