

# Outsourcing the Routing Control Logic: Better Internet Routing Based on SDN Principles

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# Routing management is hard

- Requirements:
  - Map policies to low-level, distributed configuration
  - Maintain extensive configuration code-base
  - Optimize traffic engineering
  - Debug errors
  - Secure network
  - Scale-up infrastructure
- As a result managing routing is ...  
**cumbersome, complex, error-prone**

# BGP makes it even harder

- ➔ Designed to handle inter-domain routing interactions but:
  - As the Internet grew, so did the complexity
  - Technical drawbacks have become prevalent
    - Policy disputes
    - Route Oscillation, Flapping
    - Convergence time
    - Scalability, Churn
    - Security, Authentication
  - It is very difficult to evolve


# Routing is needed, but is **NOT** core business for many Internet organizations



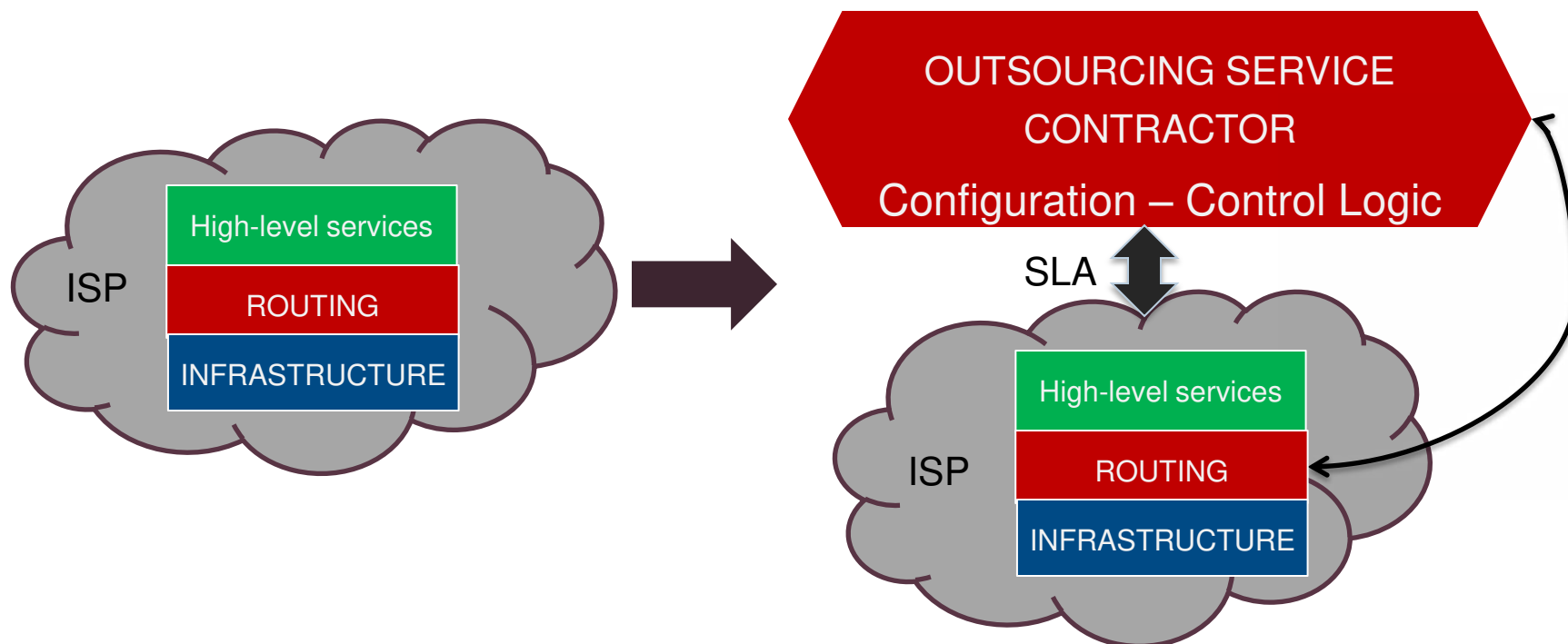
- Routing is **absolutely necessary**
- Does it pay? → **NO...**
  - E.g.: profits in pure transit drop (\$/Mbps)\*
  - “Bit pipe” ISP model under revision
  - Pressure for reduced costs (OPEX)
- Higher-margin services: IPTV, VoIP, cloud-hosting

\*<http://drpeering.net/white-papers/Internet-Transit-Pricing-Historical-And-Projected.php>

# The case for Outsourcing

- Well-known practice to reduce-streamline OPEX
    - Benefits from economy of scale
    - Supports ecosystem of managed networking services
    - Already applied to multiple Enterprise networks
  - Claim → it makes sense for ISPs and larger Internet organizations because:
    - Internet Routing is hard
    - Gets harder as the service requirements grow
    - Large effort – Small payoff
- 
- Routing Logic Outsourcing

# Outsourcing the Routing Logic



- Focus on profitable services on top of routing
- Buy expertise from specialized contractor
- Form interactive business relationship

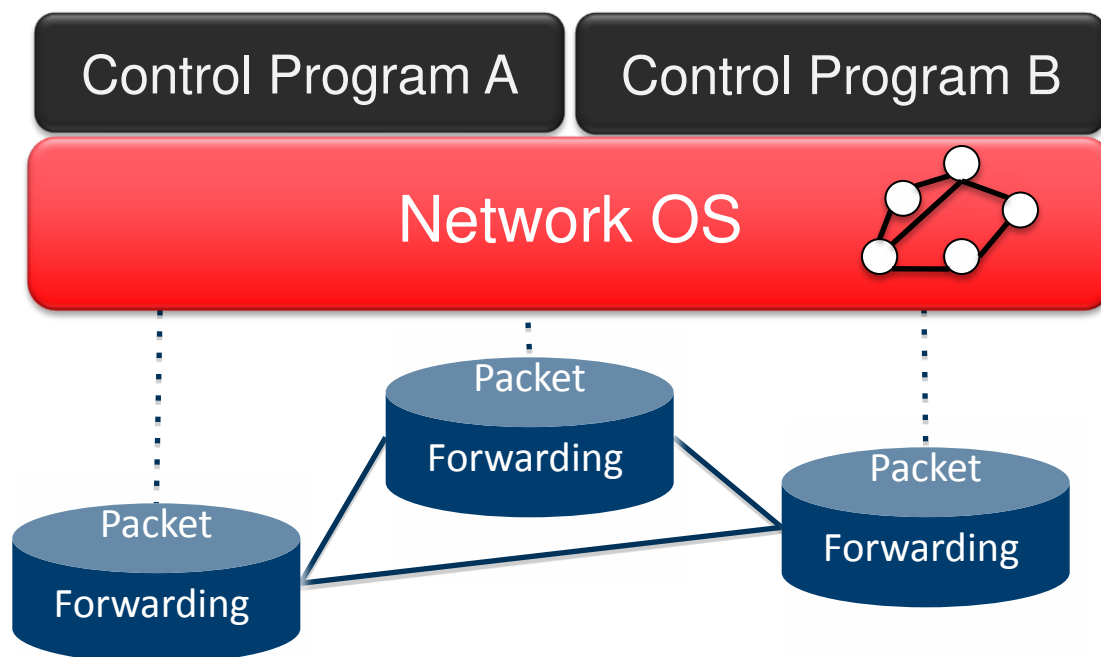
# Outsourcing: smooth transition

- Transition stages:



- During the transition we:
  - Shape **our own** Policies (based on business model)
  - **Propagate our requirements** to the contractor
  - Keep our **Privacy**: Trusted party model, SLAs
- If not satisfied → backtrack

# The case for SDN



**Decouple Control  
from Data Plane:**

→ **Abstractions**



**Logical  
Centralization**

But:

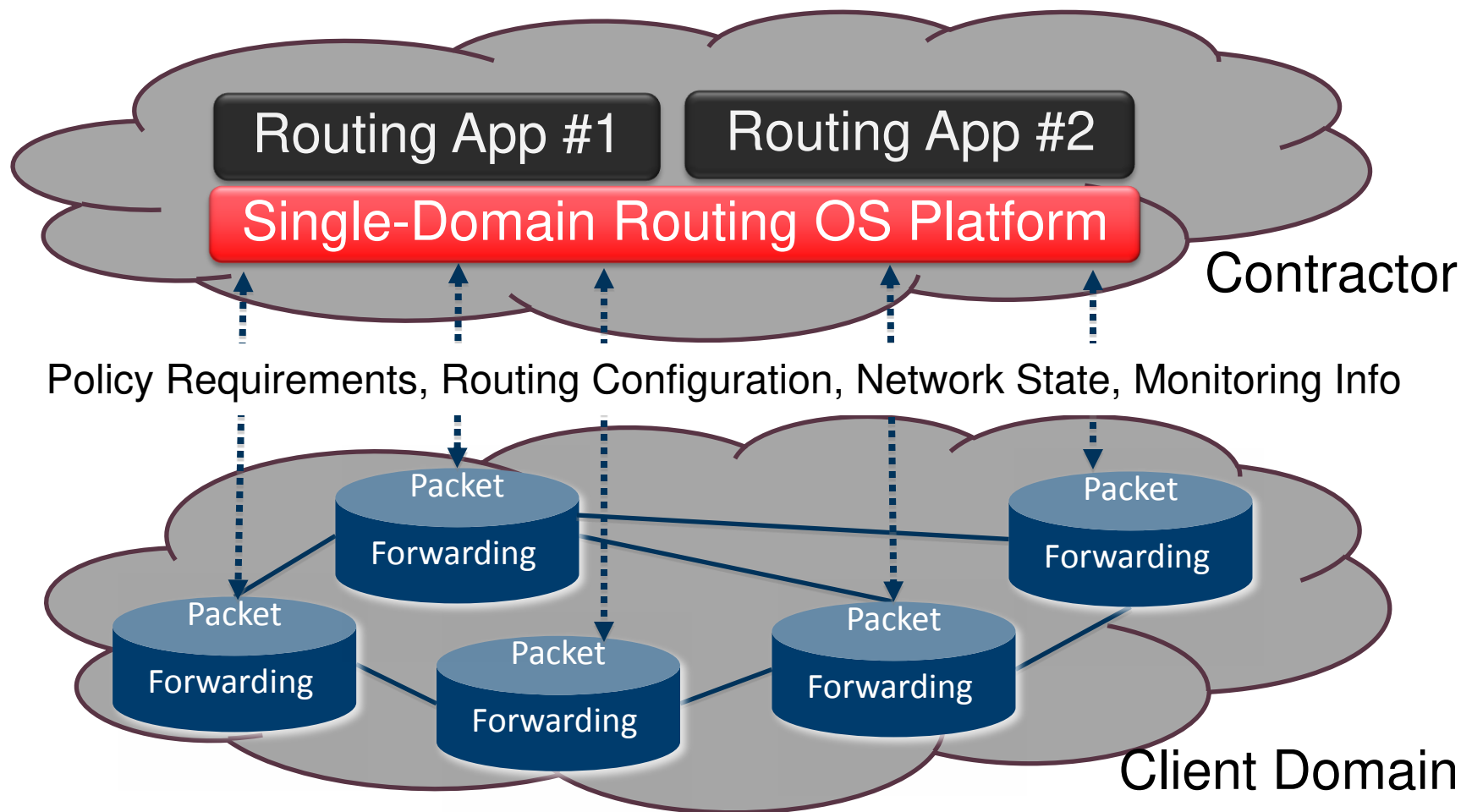
- Physical Distribution
- Redundancy

- **Examples:**
  - Centralized Routing Applications
  - RCP, Morpheus, RouteFlow

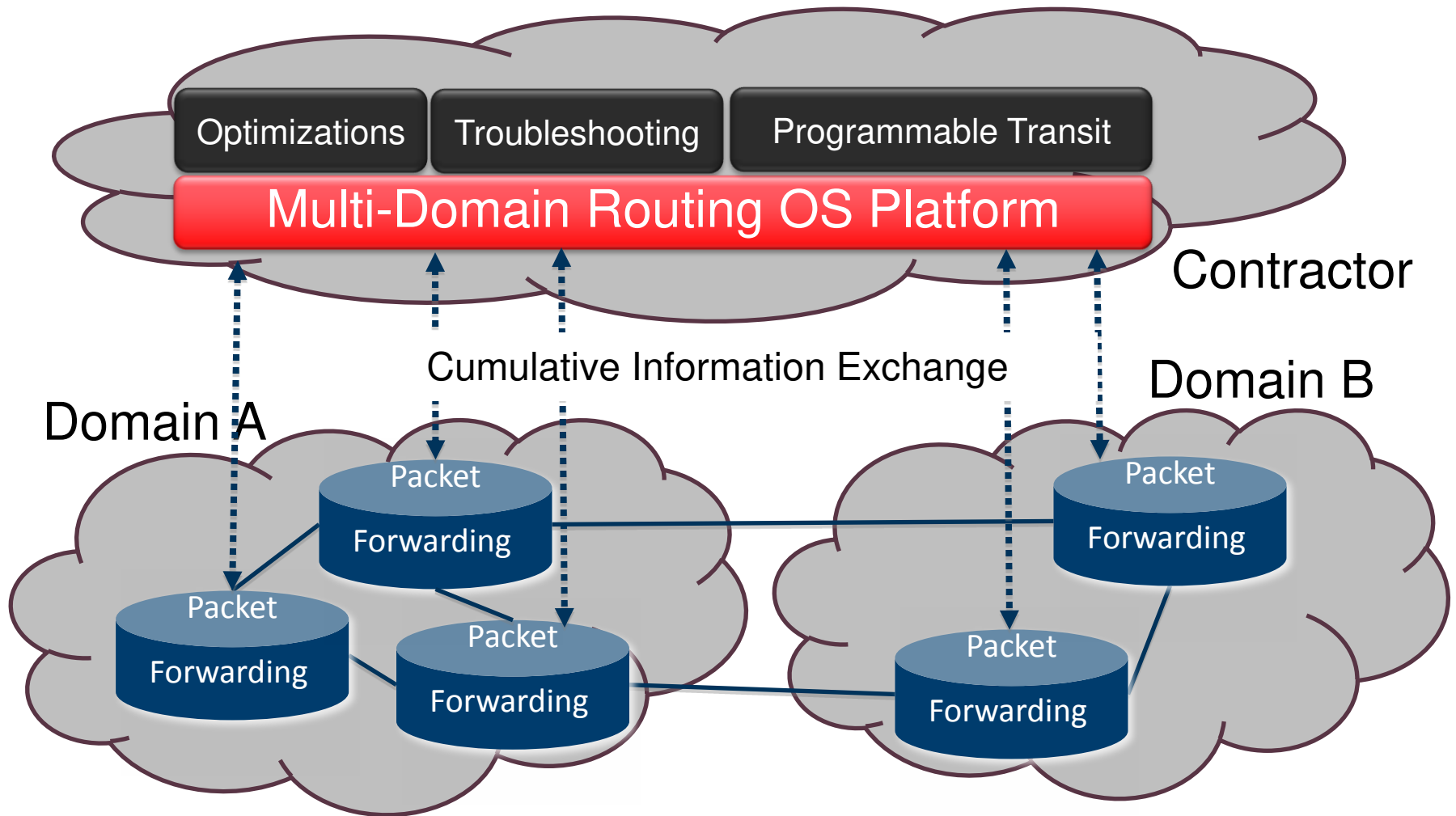
(Picture borrowed from Nick McKeown)



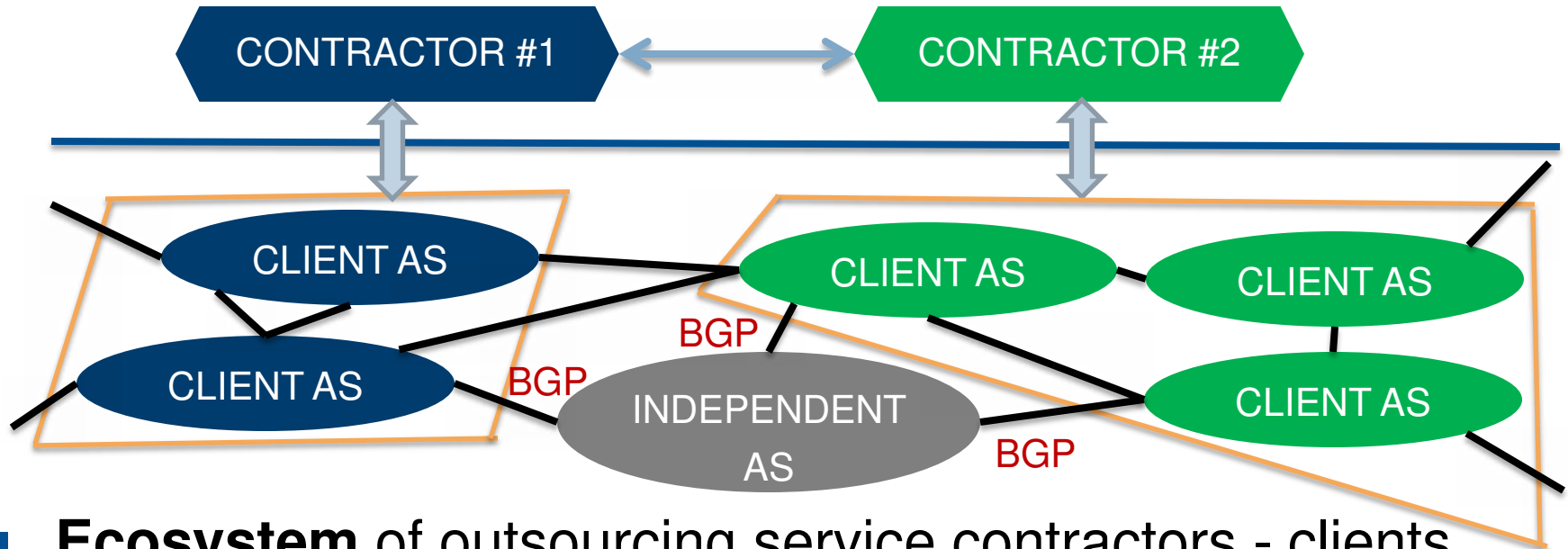
# SDN: enabling simpler outsourcing



# Thinking bigger: cumulative outsourcing

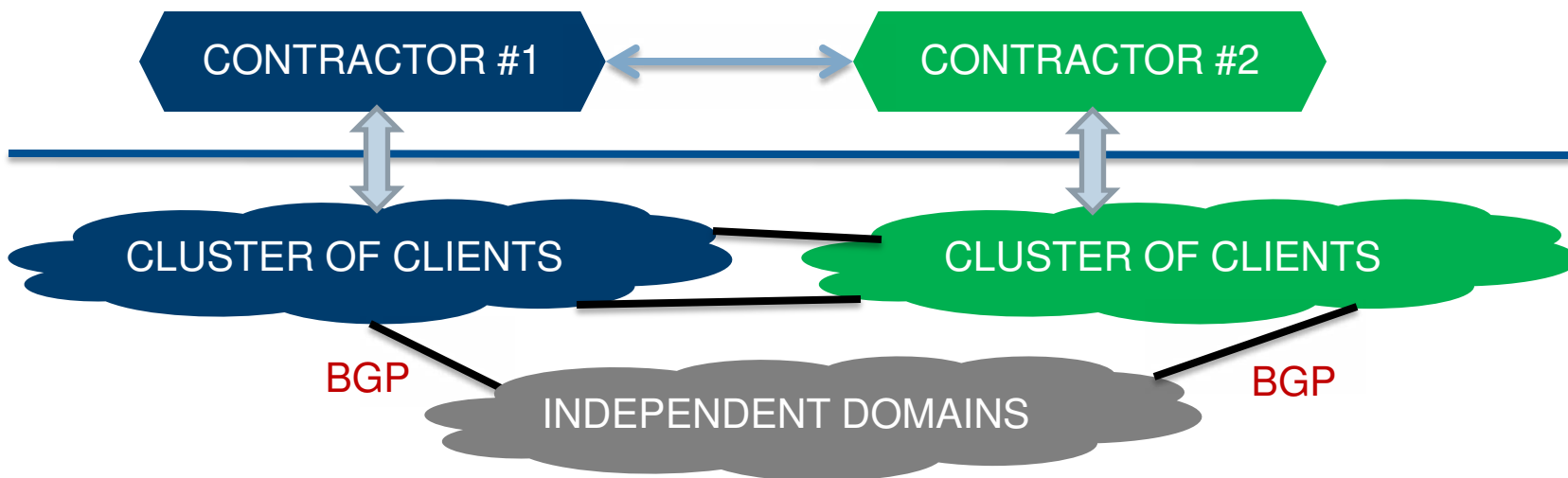


# Additional benefit: legacy-compatible evolution



- **Ecosystem** of outsourcing service contractors - clients
- New routing-signaling protocols **within** the clusters
- New protocols for contractor **interoperability**
- **Legacy Compatibility** (BGP)

## Recap: the benefits of the contractor's global view



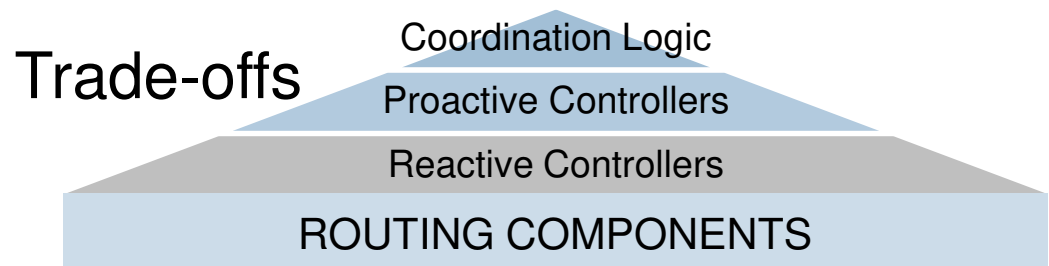
- Inter-Domain Routing **Optimizations**
- **Collaborative Security and Troubleshooting** (mediation)
  - Debugging of Inter-Domain policy conflicts
  - Centralized identification of routing problems
- **New protocols** to handle Intra-Cluster Routing

# Summary of incentives

- Contractor:
  - Offer **better service** to clients (efficiency, stability, availability)
  - **Build** upon their **requirements**
  - Achieve economy of **scale**
- Client:
  - **Invest** in high-margin services
  - **Outsource** a significant portion of complexity
- ➔ Interplay between entities:
  - **Incremental Optimizations** in Routing (inter-AS level)
  - New **opportunities-services**: programmable transit

# Research directions

- Logical Centralization
- Physical Distribution
- Resiliency
- Delay/Overheads



- Communication between client – contractor
  - What information needs to be exchanged? How?
  - Security – Privacy?
  - What happens if severed? → fail-over mechanisms
- How to quantify the gains from cumulative outsourcing?
  - Data, comparison with status quo (aggregation vs distribution)

# Contributions

- **Proposal** of SDN-based Routing Logic Outsourcing
- Technical + Financial **Incentives** for ASes (focus = ISPs)
  
- **Exploration** of what we gain at the inter-AS level:
  - Logical centralization of routing control plane
  - Fostering optimizations and innovative protocols
  - Implicit collaboration through mediation
  
- **Identification** of future research directions:
  - Hierarchical routing schemes
  - New interfaces-protocols between entities
  - Comparison with today's state

Thank you!  
Questions?





# BACKUP

# Candidate Clients

## → Small or medium sized network providers

- Why? Global trend:
  - Higher and higher interconnectivity
  - “Flattening” of the AS topology graph\*
  - Need for sophisticated Traffic Engineering

→ Complexity increases

## Who should handle the complexity?

- Observation: Large number of potential clients out there (~10s of thousands)

\*C. Labovitz et al. Internet Inter-Domain Traffic. SIGCOMM 2010.

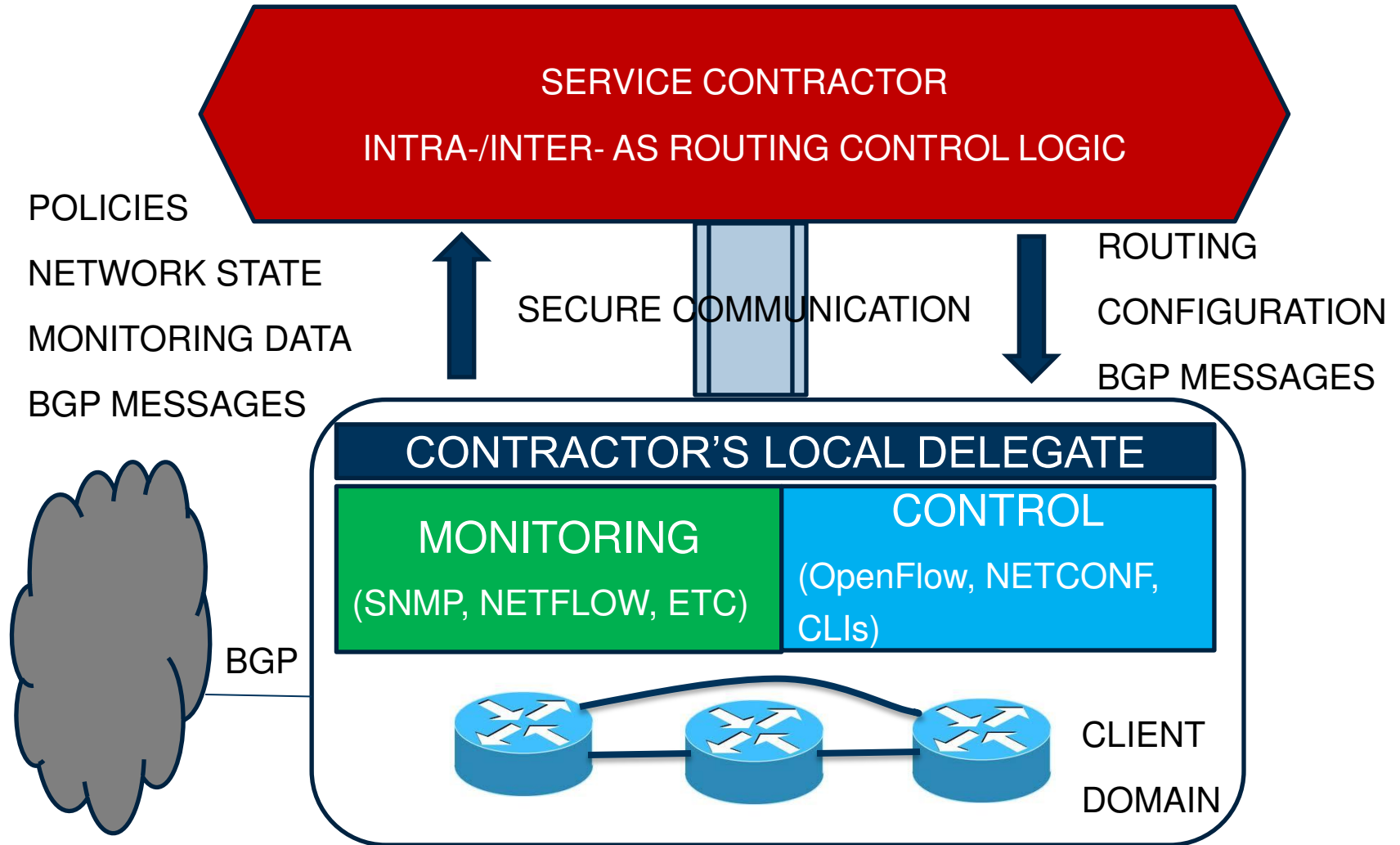
# Candidate Contractors

→ Larger and tier-1 ISPs

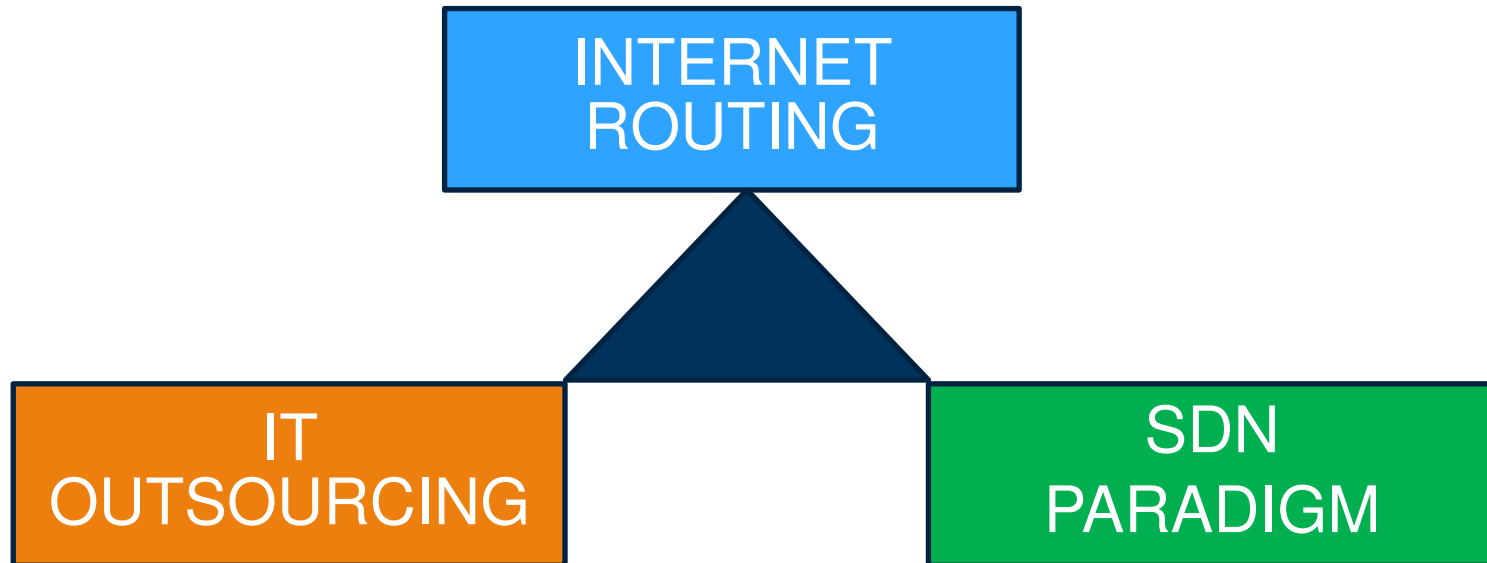
→ External specialized parties

- Why?
  - Considerable expertise in routing
  - Incentive for a new service type provision (outsourcing)
  - Opportunity for an economy of scale
  
- Example: AT&T
  - Tier-1 ISP
  - Market leader in handling outsourced network services

# Sample Architecture (single client – contractor)



# What do we propose?



## Some thoughts about the economy of outsourcing

- How can we kick-start this kind of market?
- New economic dynamics: economy of scale?
- Tussles between outsourcing entities
- Auditors: verification of SLAs, parallel ecosystem

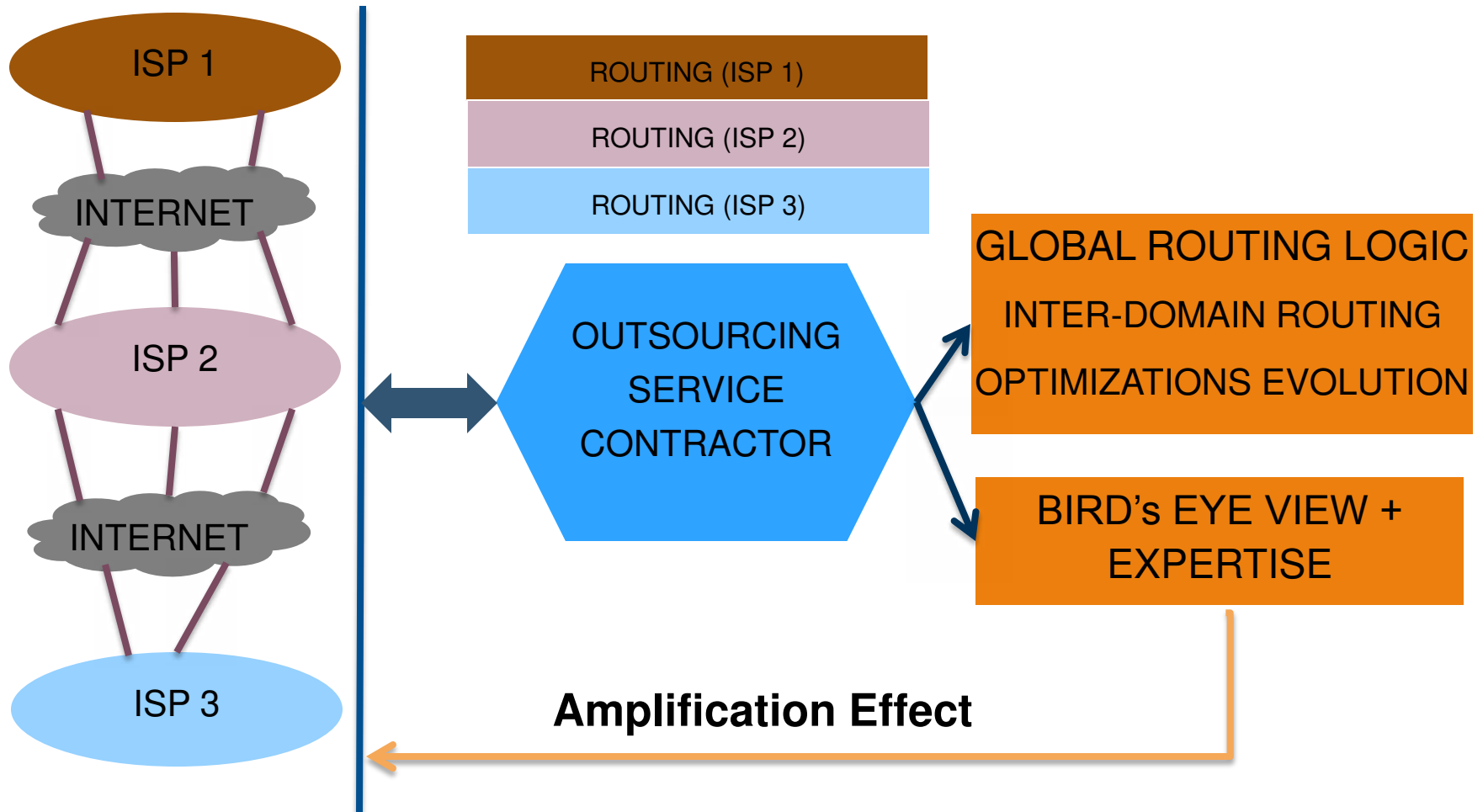
# Tussle handling?

- Bird's eye view → efficiency
- In general let the tussle run as today, but:
  - Efficient, accurate detection of problems
  - Capability of reconciliation through mediation
- New tussles between contractors



(Picture from: [niagarainflatables.com](http://niagarainflatables.com))

# Thinking bigger: Cumulative Outsourcing





# Today's world (pre-SDN)

