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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 …

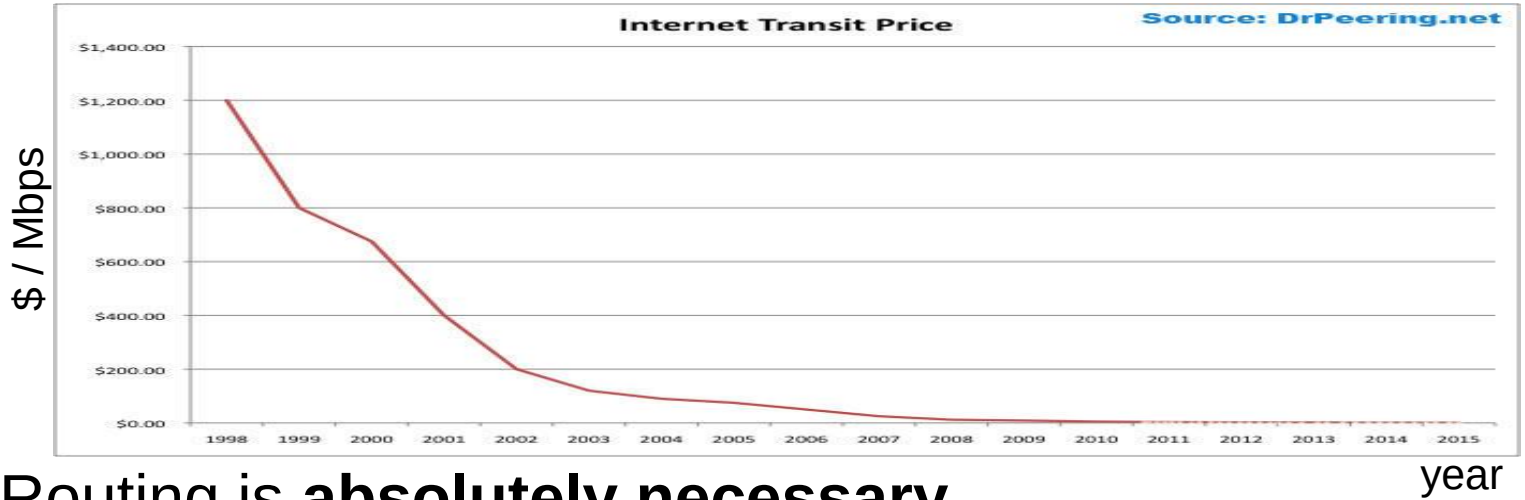
cumbersome, complex, error-prone

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

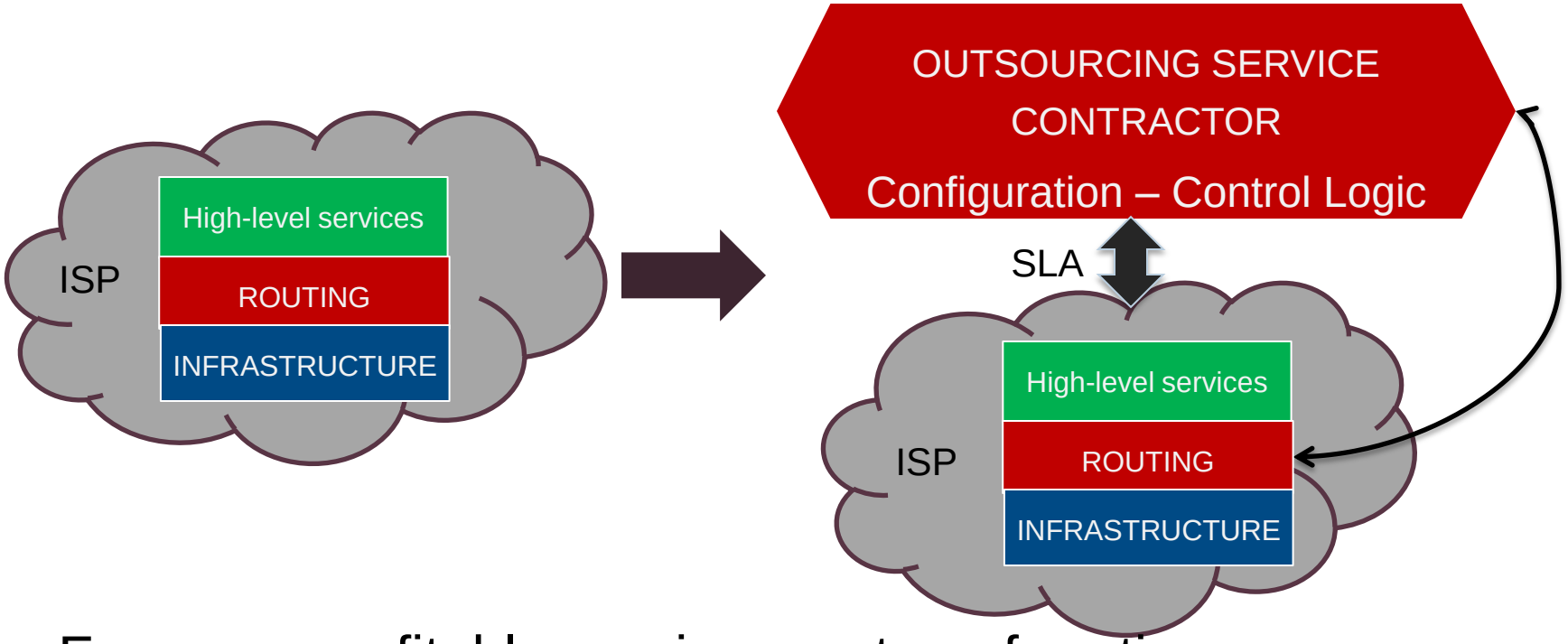
The case for Outsourcing

- 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

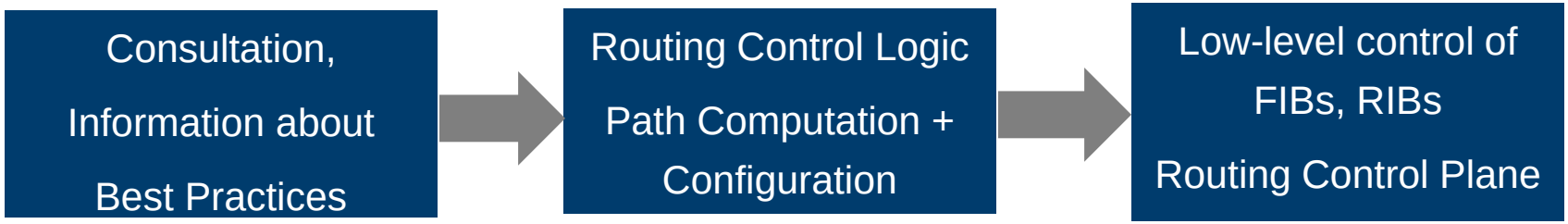
Outsourcing the Routing Logic



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

Outsourcing: smooth transition

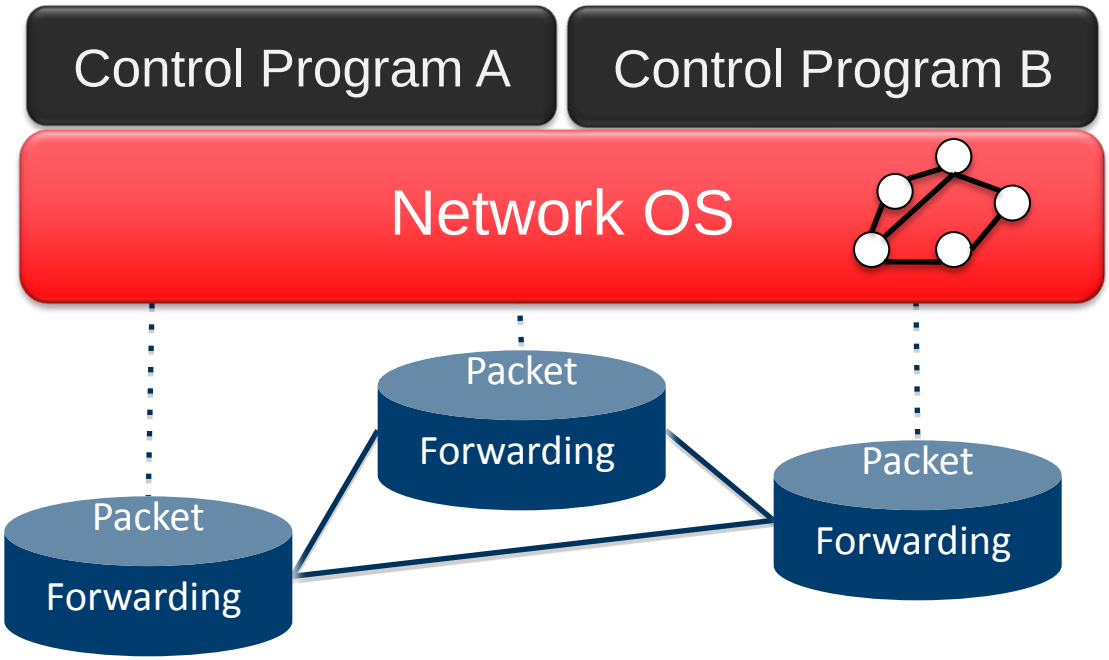
- Transition stages:



- 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

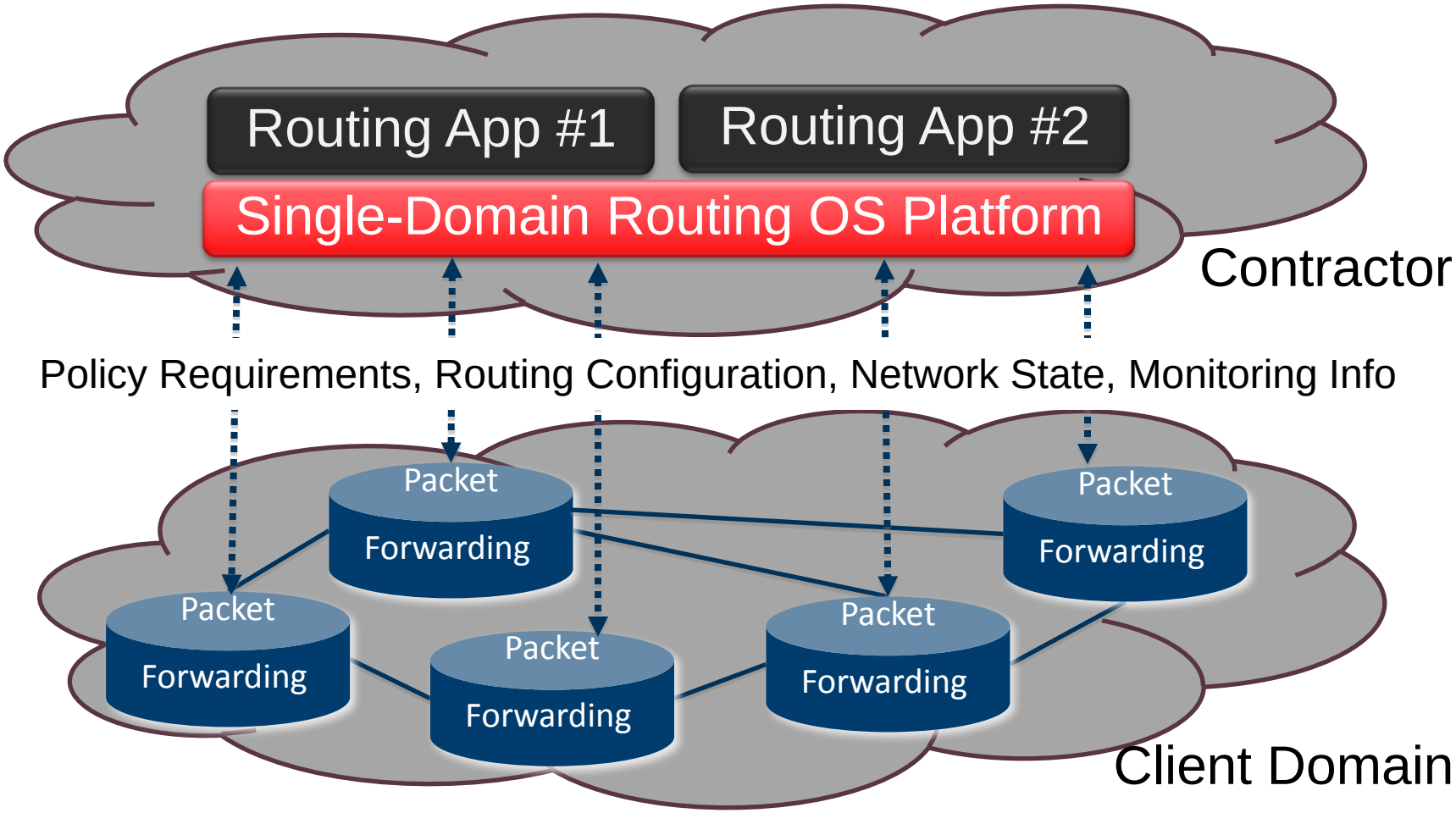
But:

- Physical Distribution
- Redundancy

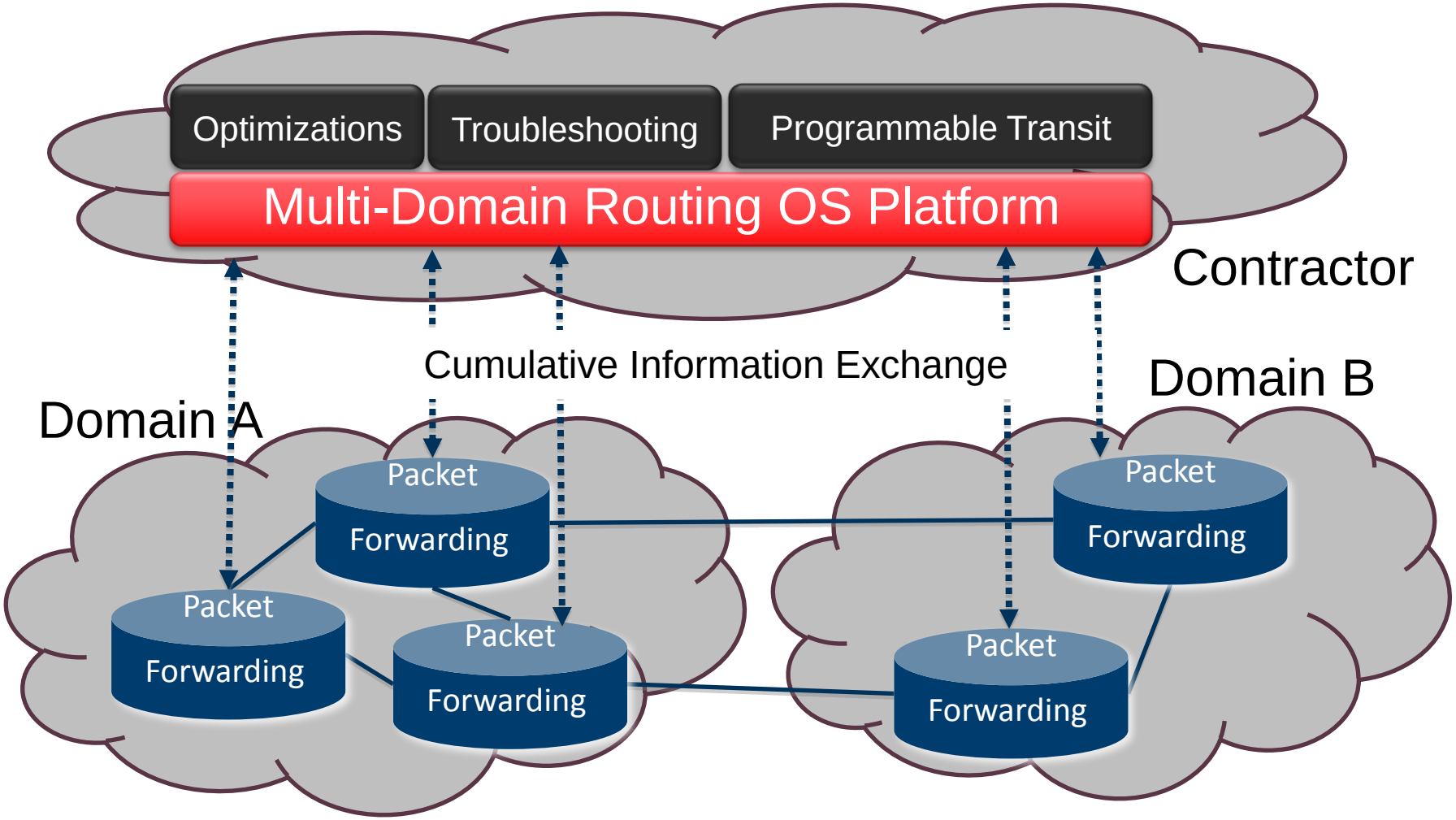
- Examples:
  - Centralized Routing Applications
  - RCP, Morpheus, RouteFlow

(Picture borrowed from Nick McKeown)

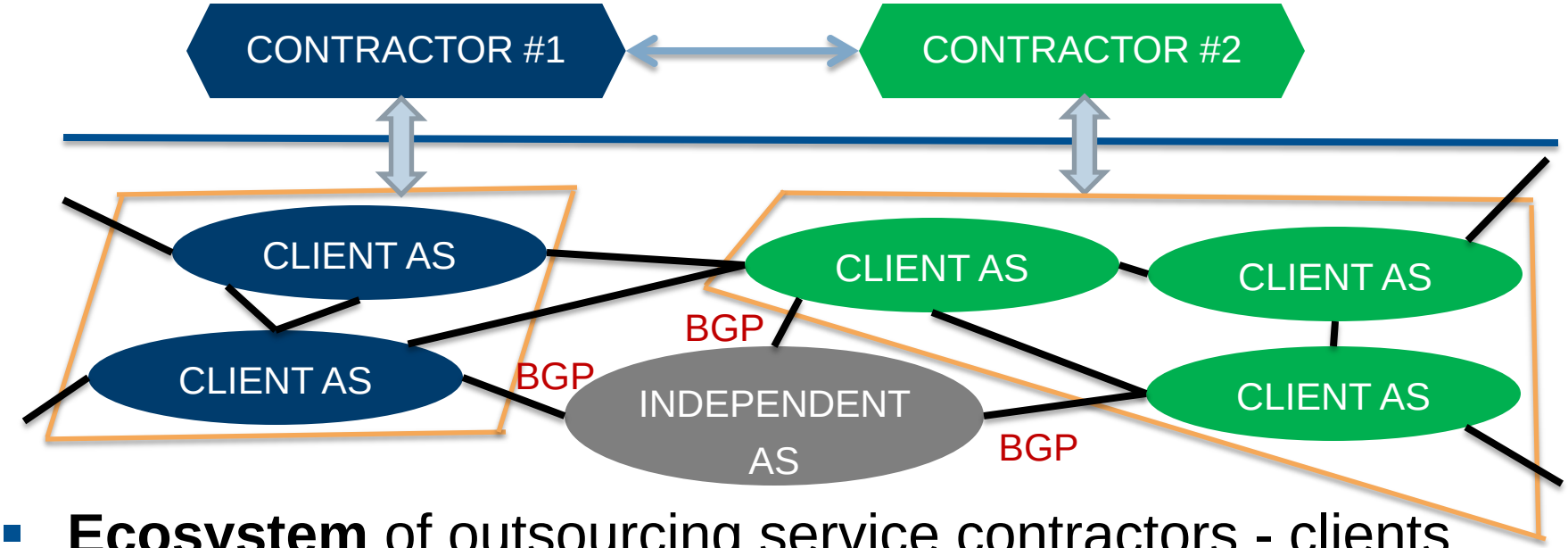
SDN: enabling simpler outsourcing



Thinking bigger: cumulative outsourcing

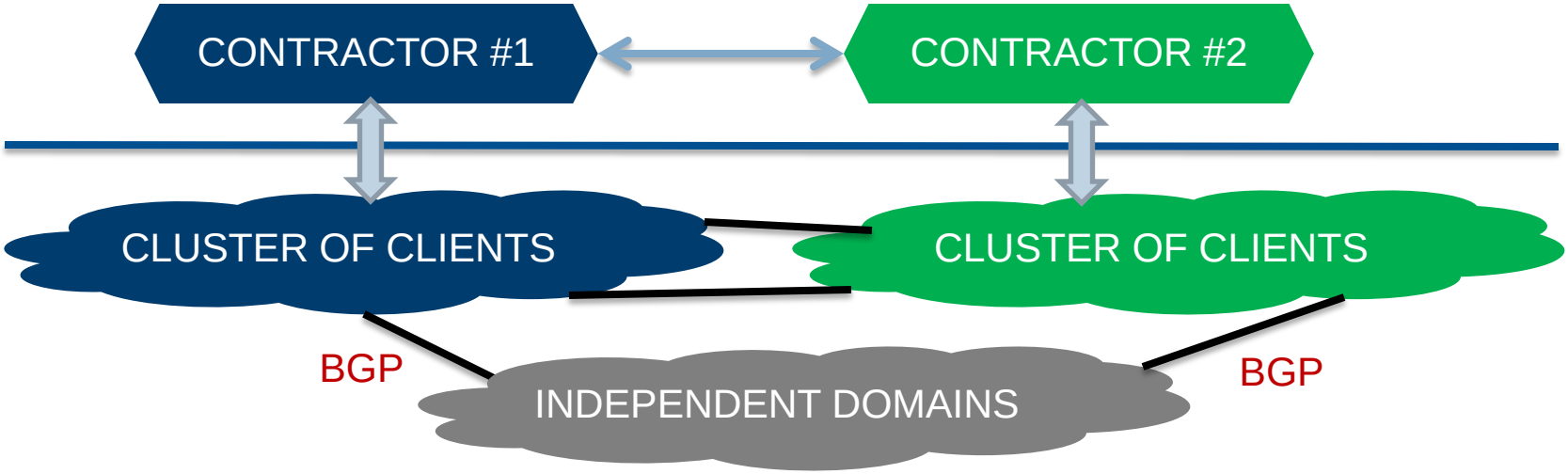


Additional benefit: legacy-compatible evolution



- **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

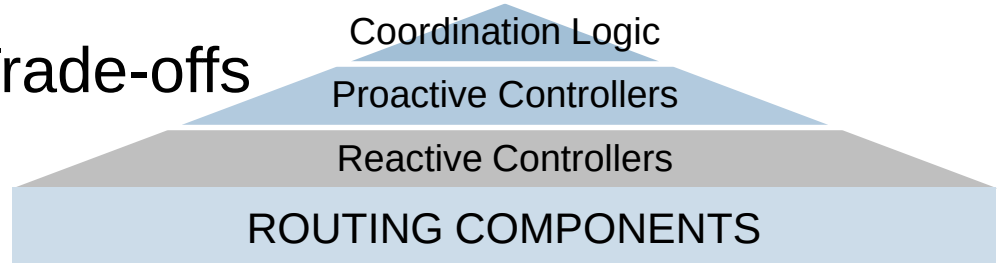
- Contractor:
  - Offer **better service** to clients (efficiency, stability, availability)
  - **Build** upon their **requirements**
  - Achieve economy of **scale**
- Client:
  - **Invest** in high-margin services
  - **Outsource** a significant portion of complexity

➔ Interplay between entities:
  - **Incremental Optimizations** in Routing (inter-AS level)
  - New **opportunities-services**: programmable transit

Research directions

- Logical Centralization
  Physical Distribution
  - Resiliency
  - Delay/Overheads

Trade-offs



- 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

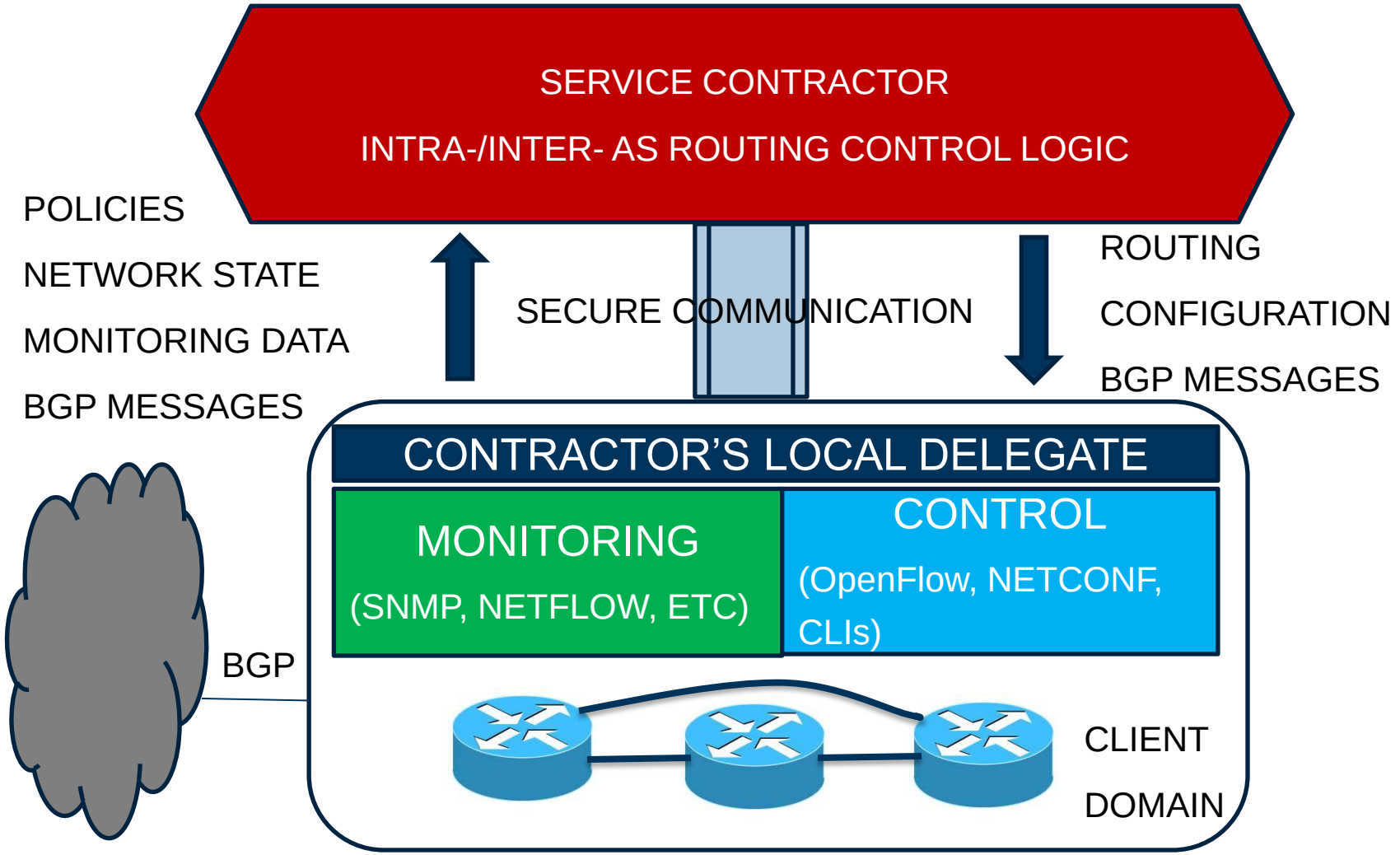
➔ **Larger and tier-1 ISPs**

➔ **External specialized parties**

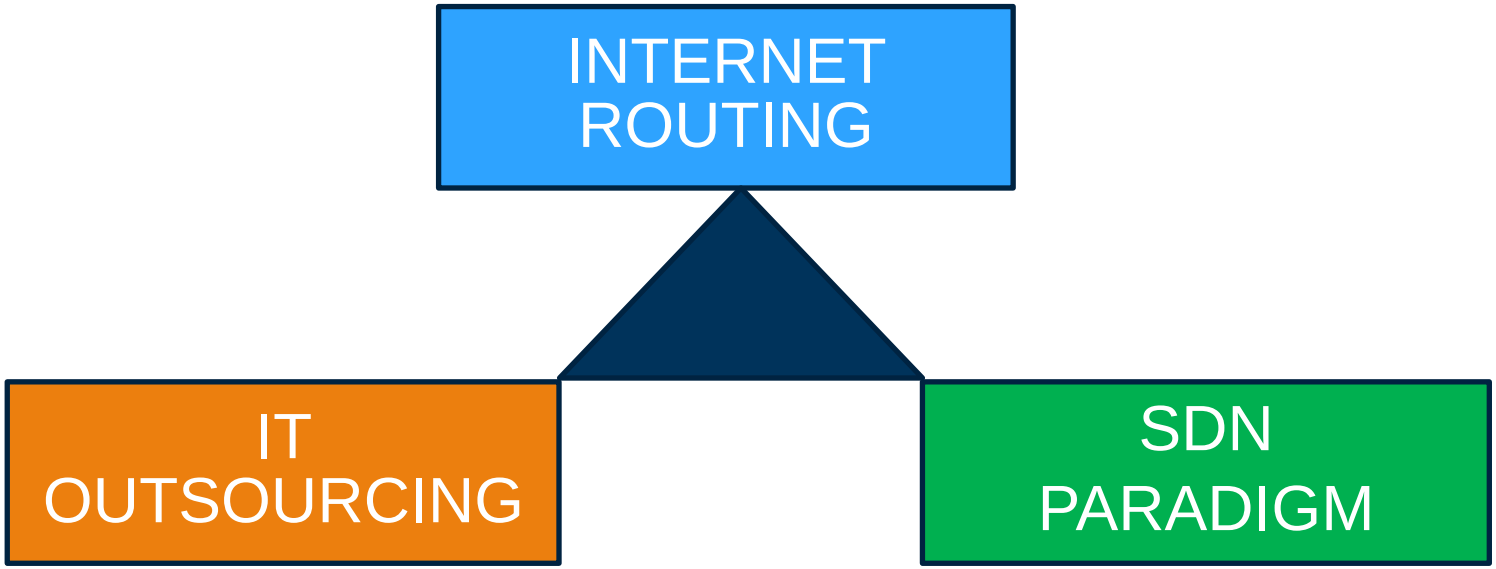
- Why?
  - Considerable expertise in routing
  - Incentive for a new service type provision (outsourcing)
  - Opportunity for an economy of scale

- 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

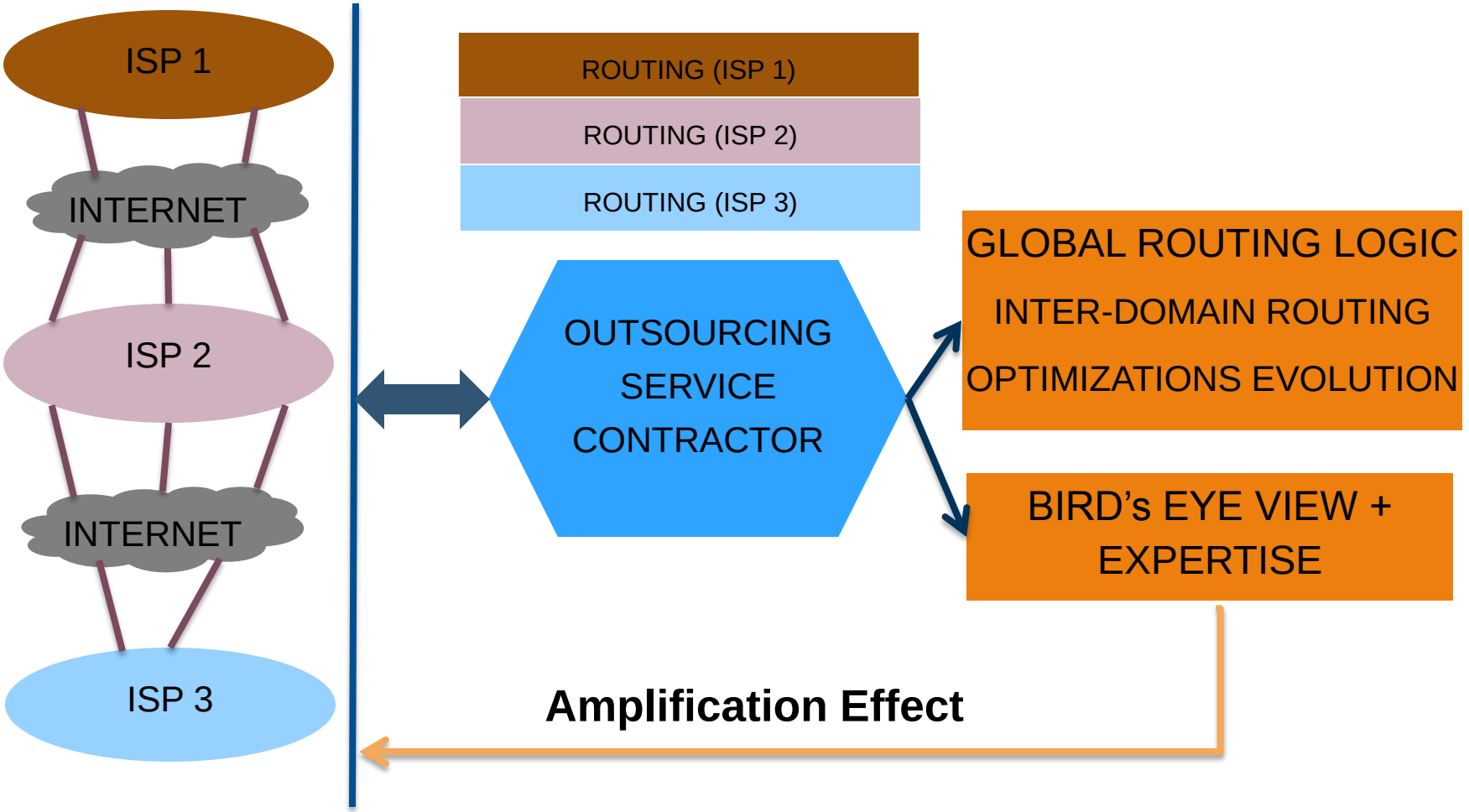
- How can we kick-start this kind of market?
- New economic dynamics: economy of scale?
- Tussles between outsourcing entities
- Auditors: verification of SLAs, parallel ecosystem

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)

Thinking bigger: Cumulative Outsourcing



Today's world (pre-SDN)