A Marketplace for Interdomain Routing and Its Economic Outcomes

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ABSTRACT

Internet Exchange Points (IXPs) play an important role in the Internet, where it provides a common physical facility for network operators to exchange traffic. Large IXPs can host hundreds of providers, including Internet Service Providers (ISPs), Tier-1 (or Transit) Providers, and Content Distribution Networks (CDNs). However, peering and settlements that take place at IXPs are configured based on BGP routes and are subjected to misconfigurations and route oscillations. The emergence of software defined networks (SDNs) made it possible to install a set of rules in the IXP switch to perform per flow actions, allowing network operators to have a better control of their egress and ingress traffic. The software-defined IXP – known as SDX – also enabled designs where dynamic settlements between ISPs are possible via a marketplace of interdomain routes. In this work, we describe an agent-based simulator that implements a Coin-Operated SDX where network operators can establish short-term fine-grained contracts. Finally, we compare the economic outcomes of network operators with the current coarse-grained settlements.

CCS CONCEPTS

• **Networks** → **Network economics**; *Network simulations*; *Wide area networks*; Public Internet; • **Hardware** → *Emerging architectures*;

KEYWORDS

Network Economics, Internet Exchange Points, Software Defined Networks

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1 INTRODUCTION

In the Internet, interconnection and settlements between autonomous systems (ASes) take place at Internet Exchange Points (IXPs). This process is generally complex, involving business relationship between multiple parties as IXPs host dozens to hundreds of ASes. Business agreements are then translated to BGP routes, the interdomain protocol that glues the Internet together. BGP, however, can be misconfigured and is subjected to route oscillations.

With the advent of software defined networks (SDN), that implements the control plane in software and decouples it from the data plane, some of the shortcomings in the IXP can be circumvented. By implementing a SDN-enabled switch at the IXP, network operators can have direct control over their egress and ingress traffic via a set of match/actions on packet headers. This concept was described by Gupta et al. [2].

A Software-Defined Internet Exchange Point (SDX) allows the implementation of other entities in the IXP ecosystem, such as a marketplace for interdomain routes where network operators can instantiate settlements and enforce rules on a a per-flow granularity. The SDX that facilitates the establishment of dynamic contracts was described in [1], where Griffioen et al. devised a Coin-Operated SDX prototype.

The creation of a marketplace where network providers are able to establish fine-grained dynamic contracts to sell

network services is part of the design of ChoiceNet [5]. ChoiceNet exposes to the users the underlying network parameters translated into quality and price metrics. The economic interactions of this new design was evaluated in [4], where the authors have shown that providers are more likely to offer innovative services to survive in this more dynamic ecosystem.

In the next section we describe in details our design and ongoing implementation of our agent-based simulator to evaluate the economic outcomes of a Coin-Operated SDX ecosystem.

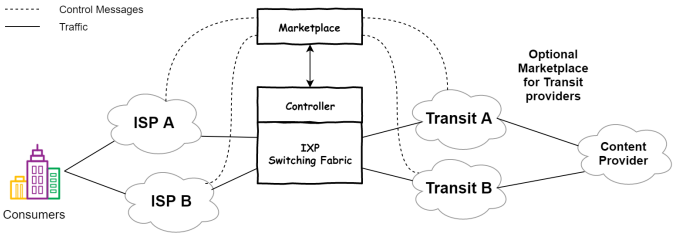

Figure 1: Simulation scenario showing the different entities in our ecosystem.

2 DESIGN AND IMPLEMENTATION

Figure 1 depicts our simulation scenario, where ISPs query the marketplace for the best available route to the destination. Once the agreement is established, the rule is installed on the IXP switch and data may flow between the end hosts. An optional marketplace may be implemented for content providers to send their traffic.

Our simulations agents are described as follows. **Consumer agents** are responsible for sending and receiving traffic to the content provider. Consumers are end-users, such as residential and enterprise customers from the ISPs. **ISP agents** provide the last mile connection to consumers and provide the interconnection with other ASes via the IXP. In our scenario, ISPs query the marketplace for the best route, in order to maximize its utility function. **Marketplace** is responsible for receiving and storing service offers from network providers, and communicating settlements to the SDN controller. Moreover, the marketplace acts as a clearing house of network services, enforcing that contracts are executed. **IXP Switch** implements the SDN controller and data plane. It is the entity responsible for installing the rules and forwarding packets to the destination. **Transit providers** are responsible for carrying traffic towards the content provider. They advertise their routes and quality parameters (such as link capacity, utilization, and latency) to the marketplace. **Content providers** are data custodians that send their traffic via the transit carriers. We plan to evaluate the case where the content provider can select the best route for its egress traffic on the marketplace.

We chose to implement our simulation agents in Mininet [3] due to its process-based virtualization technique, ease to create customized topologies, and support for SDN. Moreover, because Mininet uses Linux Containers, it creates a good approximation to a real system.

3 EXPECTED SIMULATION OUTCOMES

An architecture that allows consumers to choose their communication path based on their desired quality and price desires ultimately foster innovative services from ISPs, transit, and content providers, while possibly driving prices down to consumers. Moreover, our architecture helps to address the issue of monopoly of services (76% of census blocks in the United States are served by only one broadband provider[1]). We also plan to evaluate the economic outcomes of the entities in our ecosystem and whether they are able to maintain profitable business models.

4 CONCLUSION

Recent advances in networking research enabled an easier installation of rules in IXPs and per flow enforcement of these rules. Recent proposals in Internet economics depicted a marketplace of network services where users can select the service that maximizes their utility function. In this paper, we describe our ongoing implementation of a agent-based simulator that realizes a Coin-Operated SDX. Our simulator allows the creation of dynamic contracts for interdomain routes, studying the economic outcomes of the different interacting entities.

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