White Paper: A Market-Driven Broker Plane for Multi-Domain Software-Defined Infrastructures

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Motivation:

Recently, software defined networking (SDN) has introduced a centralized control plane to improve manageability of networks, leading to a new Software Defined Infrastructure (SDI). However, SDN faces difficulties in extending to multiple administrative domains. Hierarchical multi-domain SDNs, such as the SDN orchestrator and the Hierarchical Path Computation Element (H-PCE) architecture, employ another control plane at higher hierarchy to control lower-hierarchy control planes, but they unduly limit the autonomy of Autonomous Systems (ASes). Similarly, the recently adopted IETF's Path Computation Element Computation Protocol (PCEP) with PCE can support multi-domain networks but it fails to achieve coordinated resource management and end-to-end QoS across multi-domain networks. The challenges we face are becoming more serious as modern SDIs are increasingly becoming more heterogeneous in their nature, and as heterogeneous applications are demanding superior end-to-end performance.

New Approach using Market-Driven Broker Plane

We shall pursue a new market-driven broker plane in the SDI to coordinate SDIs across networks of multiple administrative domains —a new inter-domain SDI paradigm where the broker agents compete freely with each other to provide attractive inter-domain SDI services to ASes while ASes freely choose broker services viable for their inter-networking needs. The proposed method supports the autonomy of the AS and offers a combination of centralized and distributed control planes for better scalability and manageability. The broker services provide centralized control plane between ASes without being a dictating authority of the ASes, while each AS retains autonomy and control plane for its own intra-AS networking. The market-driven brokers will follow the following underlying principles, which are consistent with the principles of the Internet:

- Brokers will offer end-to-end inter-domain solutions for SDIs (e.g. traffic-engineering, higher throughput, lower latency, lower cost, etc.) by using their inter-domain tools,
- Brokers will offer solutions and will broker deals while fully respecting the autonomy of every AS,
- Each AS will choose to (or choose not to) negotiate with a broker based on their needs and interests,
- Brokers will negotiate with vendors to offer bandwidths and other resources at favorable prices, and
- Market-driven competition drives brokers to innovate and to improve services.

The dynamic nature of the market-driven broker-AS interactions will likely to evolve over time. Continuing positive relationships between the broker agents and the ASes can build mutual trust so that they may deepen the level of information exchange for improved services. The market-driven incentives will promote innovative services and healthy competitions towards improved performance of multi-domain networking.

Expected Impact on Future SDI

SDIs with the new market-driven broker plane expects to achieve:
- improved scalability across multiple heterogeneous domains,
- improved end-to-end performance across multiple heterogeneous domains,
- improved robustness and adaptability across multiple heterogeneous domains,
- improved comprehensibility and manageability of multiple heterogeneous domains, and
- improved security, coordination, and stability across multiple heterogeneous domains.

Contribution to the SDI workshop

If selected for presentation, we will provide architecture, simulation, and experimental results, and address monitoring, security, and performance issues related to SDIs with the market-driven broker plane.

References:

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