Abstract Topology and Cost Maps for Software-Defined Inter-Domain Circuits

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I. PROBLEM STATEMENT

Inter-domain routing protocols, such as Border Gateway Protocol (BGP), are critical to the scalability of the Internet, enabling address reachability between routers belonging to different Autonomous Systems (ASes). BGP software and policy configuration are very complex. Service providers pay equipment vendors substantial annual fees for the licensing and maintenance of route-processor software — including BGP and associated management/analytic tools. Under the Software-Defined Network (SDN) paradigm, such per-router annual software costs are expected to be replaced with presumably lower-cost software for centralized SDN controllers.

A research question of interest in whether simplifications are possible to inter-domain routing protocols for best-effort IP service in this new SDN paradigm. Further, for new services, such as dynamic rate-guaranteed Layer-2 (L2) path services and dynamic optical Layer-1 (L1) circuit services, new inter-domain, inter-SDN-controller protocols are called for. Methods for inter-domain routing to support Path Computation Engine (PCE) consider tradeoffs between hierarchical link-state protocols and path-vector protocols [1]. Proposals to share available bandwidth to reduce call blocking probability for inter-domain paths have been proposed [2]. Commercial providers would prefer to share abstracted topologies and available resources without disclosing technology/topology specifics. An open question is whether abstracted available bandwidth information is still useful/feasible in path selection.

II. SOLUTION APPROACH

There is an effort called Application Layer Traffic Optimization (ALTO) underway in the IETF [3] to define a protocol that enables applications to request and receive information about network topology, path costs, link availability, routing policies, and end-host properties. Providers can offer network information in abstracted form since the ALTO protocol offers topology hiding. ALTO cost maps can be used to signal changes in the network state. Dynamic cost maps can reflect information gathered through real-time monitoring.

The ALTO cost abstraction allows for costs to be any metric. The cost variable does not need to be available bandwidth (or its inverse function), or real monetary costs. The costs may be relative, which makes it technology independent. Parameters such as AS-Path, Multi-Exit Discriminator (MED) used in BGP can be encoded as ALTO costs. A method for carrying link-state and traffic engineering information in BGP messages to support ALTO has been proposed in the IETF [4]. The ALTO protocol was proposed for IP-routed best-effort services. We propose to explore whether the ALTO protocol can be extended to support advance-reservation dynamic L2-path and L1-circuit services.

In a recent project, we deployed Open Exchange Software Suite (OESS) [5] and On-Demand Secure Circuits and Advance Reservation System (OSCARs) [6] controllers in 8 university campuses. These campus SDNs were connected via static L2 paths to Internet’s Advanced Layer 2 Service (AL2S) OpenFlow-switch based network. AL2S runs OSCARS and OESS to support dynamic L2 service. This multi-domain setup allowed us to experiment with dynamic advance-reservation L2-path service. The OSCARS server within a domain uses its topology service to push the topology of its domain to the perfSONAR (pS) Topology Service, which then allows OSCARS in other domains to request topology information when needed. While this open topology sharing approach works in the R&E community, it is not suitable for commercial providers. Therefore, as part of this work, we propose to study the feasibility of using the ALTO protocol for sharing inter-domain information required for advance-reservation dynamic L2-path and L1-circuit services.

Our starting point will be an implementation of ALTO in OpenDaylight. Our evaluation approach will combine simulations and experiments on the GENI testbed.

REFERENCES