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APPLICATION-AWARE TRAFFIC ENGINEERING WITH SEGMENT ROUTING

Shakeil Chandler

Rushikesh Jagdale

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AUTHORS:
Shakeil Chandler
Rushikesh Jagdale

ABSTRACT

Techniques are presented herein that enhance segment routing (SR) traffic engineering (TE) through, among other things, the incorporation of a network protocol facility. Such a facility collects active Internet Protocol (IP) network traffic, as it flows in to or out of an interface, and then analyzes the collected data to develop an understanding of network traffic particulars such as, for example, flow, volume, etc. Aspects of the presented techniques leverage a Path Computation Element (PCE) for path calculations and support the ability to create multiple unique service-level agreement (SLA) tunnels, based on application flows or Layer 7 information within a network, for the same set of source and destination addresses. Further aspects of the presented techniques employ a category database (which may comprise a worldwide list of applications and a service category which describes the type of each application) that is updated by a network protocol facility and a tunnel requirements database (that associates an SLA class to specific tunnel requirements) to yield an on-demand tunnel classification capability that allows a PCE entity to leverage the above-described databases to match a required SLA class to an SR TE tunnel within a network. An arrangement as described above, according to the techniques presented herein, offers a new, redefined, way of scaling and providing better SLAs to specific services at an application level.

DETAILED DESCRIPTION

Within the universe of network traffic engineering (TE), there exists a lack of application-aware matching for segment routing (SR) tunnels using a Path Computation Element (PCE) for path calculations. Existing attempts at addressing such a lack encompass, for example, the use of an access control list (ACL) or a policy group to match on Internet Protocol (IP) version 4 (IPv4) or IP version 6 (IPv6) addressing.

Techniques are presented herein that automate and enhance existing TE policies for SR while using a PCE entity for tunnel paths. The presented techniques employ the same concepts and principals for path selection with a PCE entity but add a network protocol facility (that collects active IP network traffic, as it flows in to or out of an interface, and then analyzes the collected data to develop an understanding of network traffic particulars such as, for example, flow, volume, etc.) to incorporate application matching for on-demand tunnels for SR TE.

The network protocol facility that was noted above is enabled on the different infrastructure devices to provide the ability to inspect Layer 7 traffic flows on the ingress interfaces into the SR domain. This then allows the path computation client (PCC) devices to describe the received traffic and request from a PCE entity, based on pre-defined categories, an appropriate tunnel that is based on a defined SLA class.

The approach that was described above, according to aspects of the techniques presented herein, provides for a more granular matching of traffic coming into a multiprotocol label switching (MPLS) virtual private network (VPN) domain that requires a TE tunnel to meet service-level agreement (SLA) requirements. In contrast, existing approaches can only classify traffic up to Layer 3 IP information.

Among other things, aspects of the presented techniques are able to inspect at the application level and make a more detailed decision based on a service category. Figure 1, below, illustrates the elements of an exemplary architecture according to aspects of the techniques presented herein and reflective of the above discussion.

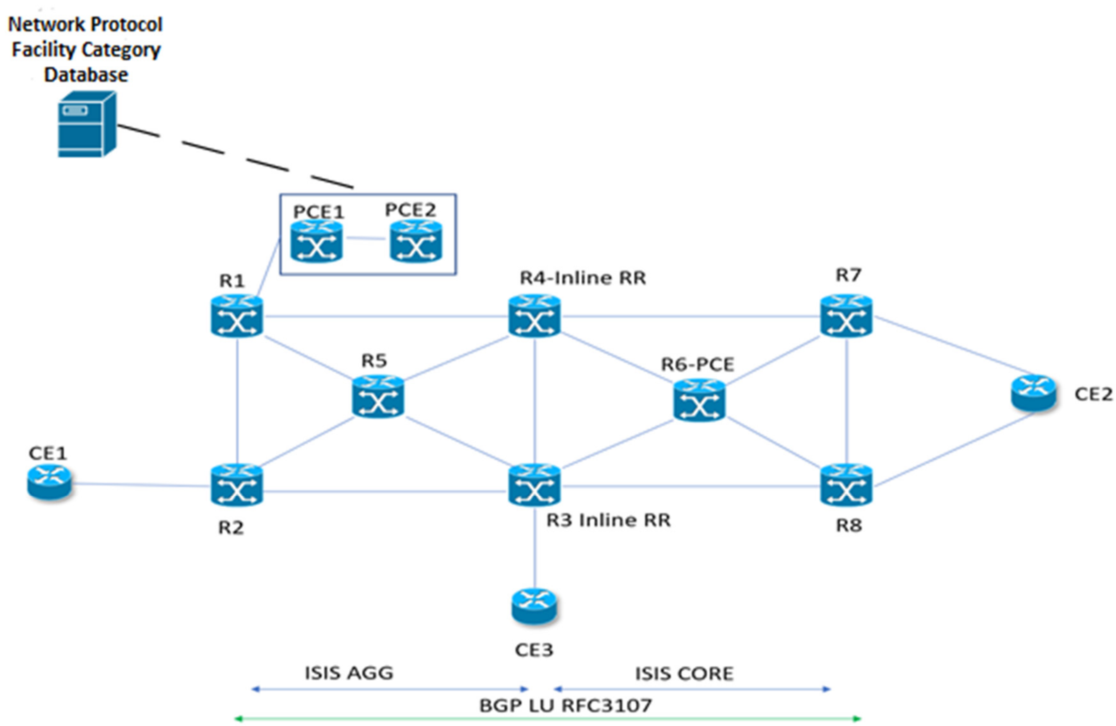

Figure 1: Exemplary Architecture

Figure 1, above, depicts a number of exemplary network elements including, for example, PCE entities (which are identified in the figure as PCE1 and PCE2) and routing entities (which are identified in the figure as R1 through R8).

Importantly in connection with the techniques presented herein, Figure 1, above, illustrates a PCE entity maintaining an external connection to an updated network protocol facility category database (which is identified in the figure as Network Protocol Facility Category Database). Such a database may comprise a worldwide list of applications and a service category which describes the type of each application. Figure 2, below, illustrates elements of one possible arrangement for such a database.

Application	**Category**
IPTV Vendor	Video
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Figure 2: Exemplary Network Protocol Facility Category Database

In addition to a network protocol facility category database, as described and illustrated above, aspects of the techniques presented herein also employ a tunnel requirements database. Such a database may comprise a list of SLA classes and the tunnel requirements for each class. Figure 3, below, illustrates elements of one possible arrangement for such a database.

SLA Class	Tunnel Requirements
Video	40ms 20Mbps
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Figure 3: Exemplary Tunnel Requirements Database

The approach that was described and illustrated in the narrative that was presented above supports an on-demand tunnel classification capability that allows a PCE entity to use the classifications that are provided from an external network protocol facility database to match a required SLA class SR TE tunnel within a network. As just one example, IP television (IPTV) -based traffic that is received from PCC devices may match on a Video Priority SLA class that is defined on the PCE using IPTV as an application and which is classified by the database as video on demand. Figure 4, below, which employs the same exemplary architecture that was presented in Figure 1, above, illustrates elements of such an example.

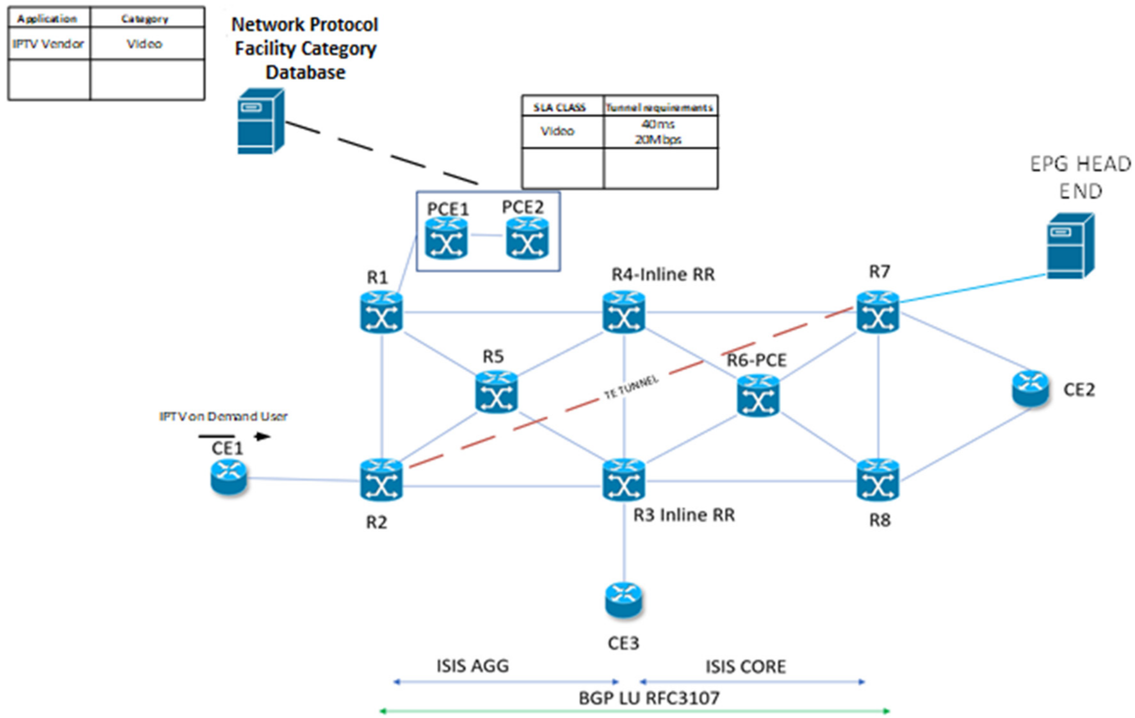

Figure 4: Illustrative IPTV-Based Example

Figure 4, above, depicts, among other things, an illustrative network protocol facility category database (as described previously and as illustrated in Figure 2, above), an illustrative tunnel requirements database (as described previously and as illustrated in Figure 3, above), and an exemplary TE tunnel (which is indicated in the figure as a dashed red line between network elements R2 and R7).

Aspects of the techniques presented herein may be employed in or under a number of different use cases. As just one example, mobile Long-Term Evolution (LTE) providers are unable to offer detailed quality of service (QoS) assurances for products that are offered over LTE mobile subscriptions (since all of the LTE traffic is identified with the same QoS tag at an E-UTRAN Node B (eNodeB)). Employing aspects of the techniques presented herein provides application-aware TE that allows the SR edge nodes to inspect ingress traffic from the VPN and provides the operator of the SR TE network with the ability to categorize different traffic flows from the same source to different TE tunnels.

In summary, techniques have been presented herein that enhance SR TE through, among other things, the incorporation of a network protocol facility. Such a facility collects active IP network traffic, as it flows in to or out of an interface, and then analyzes the collected data to develop an understanding of network traffic particulars such as, for example, flow, volume, etc. Aspects of the presented techniques leverage a PCE for path calculations and support the ability to create multiple unique SLA tunnels, based on application flows or Layer 7 information within a network, for the same set of source and destination addresses. Further aspects of the presented techniques employ a category database (which may comprise a worldwide list of applications and a service category which describes the type of each application) that is updated by a network protocol facility and a tunnel requirements database (that associates an SLA class to specific tunnel requirements) to yield an on-demand tunnel classification capability that allows a PCE to leverage the above-described databases to match a required SLA class to an SR TE tunnel within a network. An arrangement as described above, according to the techniques presented herein, offers a new, redefined, way of scaling and providing better SLAs to specific services at an application level.