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IPv6 SPRING Use Cases
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Abstract

The Source Packet Routing in Networking (SPRING) architecture describes how Segment Routing can be used to steer packets through an IPv6 or MPLS network using the source routing paradigm. This document illustrates some use cases for Segment Routing in an IPv6 only environment.

Status of This Memo

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1. Introduction

Source Packet Routing in Networking (SPRING) architecture leverages the source routing paradigm. An ingress node steers a packet by including a controlled set of instructions, called segments, in the SPRING header. The SPRING architecture is described in [I-D.ietf-spring-segment-routing]. This document illustrates some use cases for SPRING/Segment Routing in an IPv6 only environment.

2. IPv6 SPRING use cases

The use cases described in the section do not constitute an exhaustive list of all the possible scenarios: this section only includes some of the most common envisioned deployment models for IPv6 Segment Routing.

In addition to the use cases described in this document, all the SPRING use cases [RFC7855] are also applicable to the SRv6 data plane.

2.1. SPRING in the Small Office

An IPv6-enabled small office (SOHO) provides ample globally routed IP addresses for all devices in the SOHO. An IPv6 small office with multiple egress points and associated provider-assigned prefixes

will, in turn, provide multiple IPv6 addresses to hosts. A small office performing Source and Destination Routing ([I-D.ietf-rtgwg-enterprise-pa-multihoming]) will ensure that packets exit the SOHO at the appropriate egress based on the associated delegated prefix for that link.

A SPRING enabled SOHO provides the ability to steer traffic into a specific path from end-hosts in the SOHO, or from a customer edge router in the SOHO. If the selection of the source routed path is enabled at the customer edge router, that router is responsible for classifying traffic and steering it into the correct path. If hosts in the SOHO have explicit source selection rules, classification can be based on source address or associated network egress point, avoiding the need for DPI-based implicit classification techniques. If the traffic is steered into a specific path by the host itself, it is important to know which networks can interpret the SPRING header. This information can be provided as part of host configuration as a property of the configured IP address.

The ability to steer traffic to an appropriate egress or utilize a specific type of media (e.g., low-power, WIFI, wired, femto-cell, bluetooth, MOCA, HomePlug, etc.) within the home itself are obvious cases which may be of interest to an application running within a SOHO.

Steering to a specific egress point may be useful for a number of reasons, including:

- Regulatory
- Performance of a particular service associated with a particular link
- Cost imposed due to data-caps or per-byte charges
- Home vs. work traffic in homes with one or more teleworkers, etc.

- Specific services provided by one ISP vs. another

Information included in the SPRING header, whether imposed by the end-host itself, a customer edge router, or within the access network of the ISP, may be of use at the far ends of the data communication as well. For example, an application running on an end-host with application-support in a data center can utilize the SPRING header as a channel to include information that affects its treatment within the data center itself, allowing for application-level steering and load-balancing without relying upon implicit application classification techniques at the data-center edge. Further, as more

and more application traffic is encrypted, the ability to extract (and include in the SPRING header) just enough information to enable the network and data center to load-balance and steer traffic appropriately becomes more and more important.

2.2. SPRING in the Access Network

Access networks deliver a variety of types of traffic from the service provider's network to the home environment and from the home towards the service provider's network.

For bandwidth management or related purposes, the service provider may want to associate certain types of traffic to specific physical or logical downstream capacity pipes.

This mapping is not the same thing as classification and scheduling. In the Cable access network, each of these pipes are represented at the DOCSIS [DOCSIS] layer as different service flows, which are better identified as differing data links. As such, creating this separation allows an operator to differentiate between different types of content and perform a variety of differing functions on these pipes, such as byte capping, regulatory compliance functions, and billing.

In a cable operator's environment, these downstream pipes could be a specific QAM (Quadrature Amplitude Modulation) [QAM], a DOCSIS (Data Over Cable Service Interface Specification) [DOCSIS] service flow or a service group.

Similarly, the operator may want to map traffic from the home sent towards the service provider's network to specific upstream capacity pipes. Information carried in a packet's SPRING header could provide the target pipe for this specific packet. The access device would not need to know specific details about the packet to perform this mapping; instead the access device would only need to know the interpretation of the SPRING header and how to map it to the target pipe.

2.3. SPRING in Data Center

Some Data Center operators are transitioning their Data Center infrastructure from IPv4 to native IPv6 only, in order to cope with IPv4 address depletion and to achieve larger scale. In such environment, source routing, as enabled by Segment Routing IPv6, can be used to steer traffic across specific paths through the network. The specific path may also include a given function one or more nodes in the path are requested to perform.

In addition one of the fundamental requirements for Data Center architecture is to provide scalable, isolated tenant networks. In such scenarios, Segment Routing can be used to identify specific nodes, tenants, and functions and to build a construct to steer the traffic across that specific path.

2.4. SPRING in Content Delivery Networks

The rise of online video applications and new, video-capable IP devices has led to an explosion of video traffic traversing network operator infrastructures. In the drive to reduce the capital and operational impact of the massive influx of online video traffic, as well as to extend traditional TV services to new devices and screens, network operators are increasingly turning to Content Delivery Networks (CDNs).

Several studies showed the benefits of connecting caches in a hierarchical structure following the hierarchical nature of the Internet. In a cache hierarchy one cache establishes peering relationships with its neighbor caches. There are two types of relationship: parent and sibling. A parent cache is essentially one level up in a cache hierarchy. A sibling cache is on the same level.

Multiple levels of hierarchy are commonly used in order to build efficient caches architecture.

In an environment, where each single cache system can be uniquely identified by its own IPv6 address, a list containing a sequence of the caches in a hierarchy can be built. At each node (cache) in the list, the presence of the requested content is checked. If the requested content is found at the cache (cache hits scenario) the sequence ends, even if there are more nodes in the list; otherwise next element in the list (next node/cache) is examined.

2.5. SPRING in Core networks

While the overall amount of traffic offered to the network continues to grow and considering that multiple types of traffic with different characteristics and requirements are quickly converging over single network architecture, the network operators are starting to face new challenges.

Some operators are currently building, or plan to build in the near future, an IPv6 only native infrastructure for their core network. These operators are also looking at the possibility to setup an explicit path based on the IPv6 source address for specific types of traffic in order to efficiently use their network infrastructure. In case of IPv6 some operators are currently assigning or plan to assign IPv6 prefix(es) to their IPv6 customers based on regions/geography,

thus the subscriber's IPv6 prefix could be used to identify the region where the customer is located. In such environment the IPv6 source address could be used by the Edge nodes of the network to steer traffic and forward it through a specific path other than the optimal path.

The need to setup a source-based path, going through some specific middle/intermediate points in the network may be related to different requirements:

- The operator may want to be able to use some high bandwidth links for specific type of traffic (like video) avoiding the need for over-dimensioning all the links of the network;

- The operator may want to be able to setup a specific path for

delay sensitive applications;

- The operator may have the need to be able to select one (or multiple) specific exit point(s) at peering points when different peering points are available;

- The operator may have the need to be able to setup a source based path for specific services in order to be able to reach some servers hosted in some facilities not always reachable through the optimal path;

- The operator may have the need to be able to provision guaranteed disjoint paths (so-called dual-plane network) for diversity purposes

All these scenarios would require a form of traffic engineering capabilities in an IPv6 only network environment.

3. Contributors

Many people contributed to this document. The authors of this document would like to thank and recognize them and their contributions. These contributors provided invaluable concepts and content for this document's creation.

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5. IANA Considerations

This document does not require any action from IANA.

6. Security Considerations

This document presents use cases to be considered by the SPRING architecture and potential IPv6 extensions. As such, it does not introduce any security considerations. However, there are a number of security concerns with source routing at the IP layer [RFC5095]. It is expected that any solution that addresses these use cases to also address any security concerns.

7. References

7.1. Informative References

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7.2. Normative References

[RFC7855] Previdi, S., Ed., Filsfils, C., Ed., Decraene, B., Litkowski, S., Horneffer, M., and R. Shakir, "Source Packet Routing in Networking (SPRING) Problem Statement and Requirements", RFC 7855, DOI 10.17487/RFC7855, May 2016, <https://www.rfc-editor.org/info/rfc7855>.

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