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PER PREFIX FLEXIBLE METRIC FOR INTENT BASED ROUTING AND TRAFFIC ENGINEERING USING EIGRP

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ABSTRACT

Routing protocols are typically designed to use a single-cost formula for all of a protocol's routes. In some instances, a network administrator can adjust the cost formula of the Enhanced Interior Gateway Routing Protocol (EIGRP), but the protocol applies the formula uniformly to all prefixes, which can cause all applications to suffer from lower performance. In order to address such issues, techniques are presented herein through which a flexible metric can be applied that is isolated to prefixes. for example, the techniques presented herein provide for the reduced use of Virtual Private Network (VPN) routing & forwarding (VRF) instances on routers and ease network configuration as configurations provided in accordance with the techniques presented herein are only needed at prefix originators.

DETAILED DESCRIPTION

When the intent of prefixes varies in a network, identical paths can result in lower performance of data packet delivery. A wide array of applications typically use a common network over the internet, however, the requirement from the network for each application is different. For example, a video conferencing application needs the network to have low latency, whereas a network storage application needs the network to have high bandwidth. While such applications use a common network, they use different prefixes for operation.

However, due to protocol design to use a single-cost formula for all prefixes, all applications suffer from lower performance. Although the cost formula of EIGRP can be adjusted for either low latency or high bandwidth routes, the protocol applies the formula uniformly to all prefixes.

As an example, consider an example network, as shown below in Figure 1, that involves two different types of links and two different applications. For the sake of example, assume Application 1 needs its prefixes to be routed from low latency paths and Application 2 needs its prefixes to be routed from high bandwidth paths. However, the routing protocol deployed between routers R1 and R2 can only cater to one of the requirements for Application 1 or Application 2.

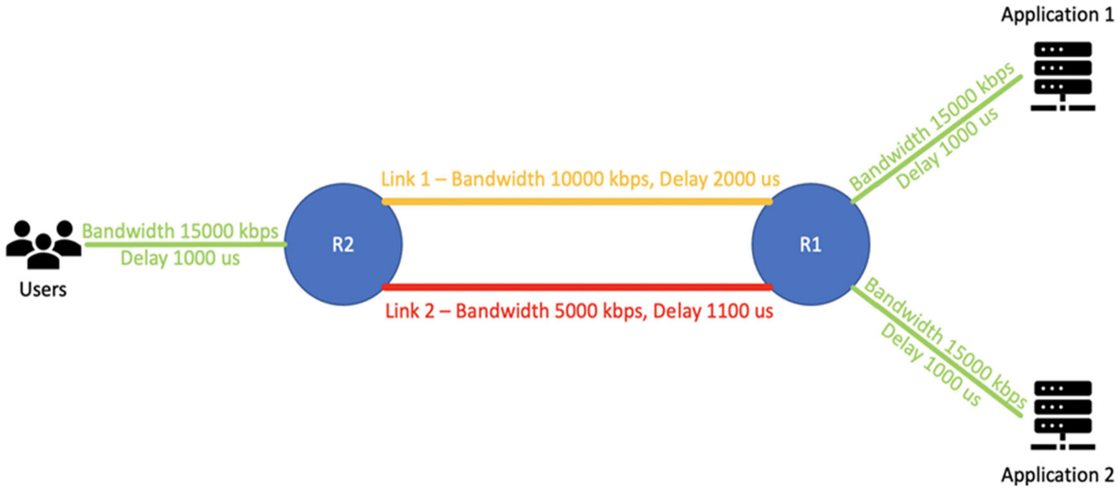

Figure 1: Example Network

The EIGRP cost computation is based on k-values and uses calculations discussed in section 5.6 of Internet Engineering Task Force (IETF) Request For Comments (RFC) rfc7868(Informational RFC) to determine the best path for a given network, as follows:

Max-Throughput = (10 * 65536) / (Interface Bandwidth (kbps))

Net-Throughput = K1 * Max-Throughput + [(K2 * Max-Throughput) / (256 - Load)]

Latency = K3 * [(Delay(ps) * 65536) / 10]

metric = [Net-Throughput + Latency + (K6*ExtAttr)] * [K5 / (K4+Rel)]

For the calculations noted above, the calculation [K1 * Max-Throughput] provides weightage to the minimum reported bandwidth. Further, the calculation [K2 * Max-Throughput) / (256-Load)] provides weightage to a Load factor. The Load can be expressed as a number 1 to 255 in which '1' represents a no-load interface and '255' represents a fully loaded interface. Further, the calculation [K3 * Latency] provides weightage to the total delay of the path. A Reliability Quotient is provided by the calculation [K5/(K4 + Reliability)] if K5 > 0, otherwise, the Reliability Quotient = 1 if K5 = 0, which provides weightage for a path selection based on link quality and packet loss. Finally, the calculation [K6 * ExtAttr] provides weightage to extended attributes, such as jitter and energy. The k-values are shared between devices at the time of establishing neighborship for a network and the k-values remain constant across all prefixes.

In accordance with techniques of this proposal, EIGRP can be enhanced to carry k-values along with other data for prefixes. This can be achieved by implementing new Type-Length-Value objects (TLVs). With k-values being transported along with prefixes, the entire network can determine how to adjust the cost calculation for a given prefix without needing a user to configure the calculation implicitly.

Consider an example, packet format that can be used to carry the k-values, as shown below in Figure 2.

```
+0 1 2 3 4 5 6 7+0 1 2 3 4 5 6 7+0 1 2 3 4 5 6 7+0 1 2 3 4 5 6 7+
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Opcode = 0x08 | Offset = 0x03 |      K1       |      K2       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      K3       |      K4       |      K5       |      K6       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2: Example Packet Format

Regarding the example packet format illustrated in Figure 2, extended metric fields are discussed in section 6.9.3 of RFC 7868, including an opcode (1 byte) that can be used to indicate the type of an extended metric, and an offset (1 byte) that can be used to indicate the number of 16-bit words contained in application-specific data.

A new extended metric option can be provided in accordance with the proposal, which can be referred to as 'Per-Prefix K-values' that can be used for advertising per-prefix k-values. The new 'Per-Prefix K-values' extended metric option can be provided an opcode of 0x08 and an offset of 0x03 as k-values require 6 byes, which equal 3 16-bit words.

Consider an application of the techniques presented herein with reference to an example network as shown below in Figure 3.

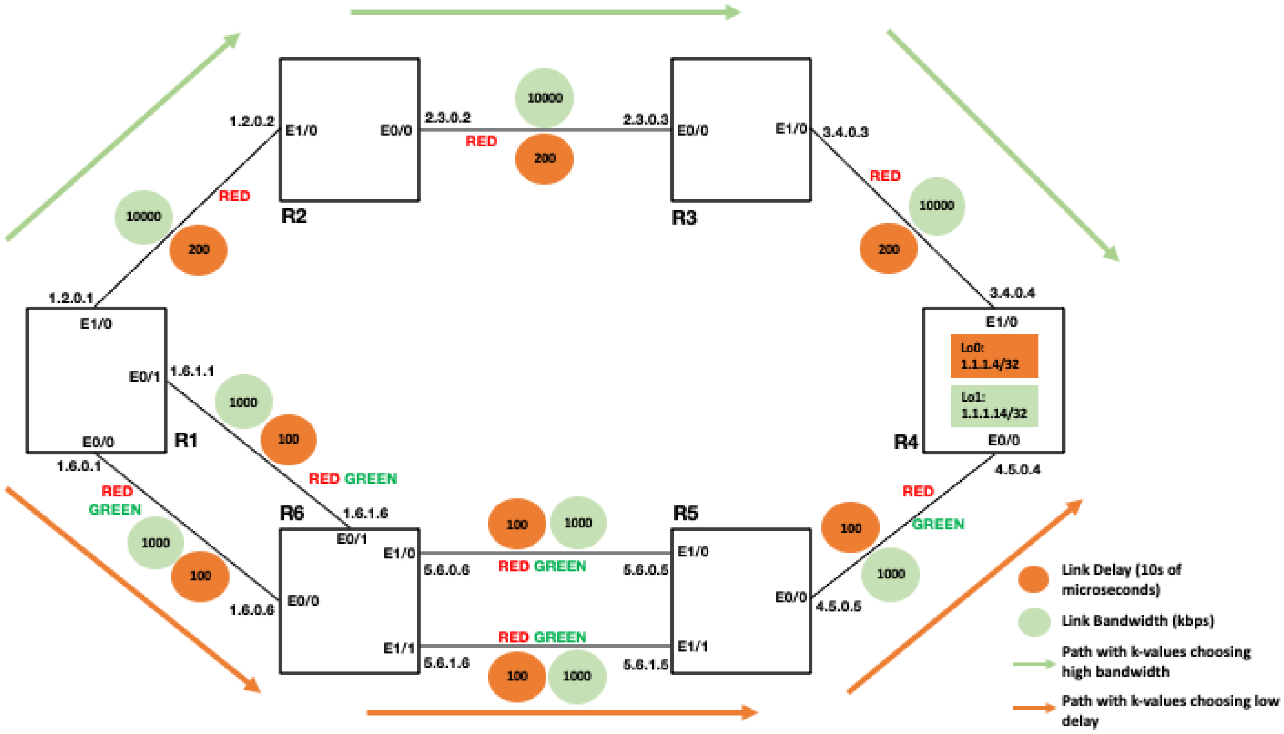

Figure 3: Example Network Implementation

For the example network as illustrated in Figure 3, consider an example in which a prefix '1.1.1.4/32' needs low delay path and a prefix '1.1.1.14/32' needs a high bandwidth path. In accordance with techniques of this proposal, prefix '1.1.1.4/32' can be advertised with K3=1 and all other k-values as 0. This will ensure that only delay is considered in a cost calculation that is minimized in the network for prefix '1.1.1.4/32'. Further, prefix '1.1.1.14/32' can be advertised with K1=1 and all other k-values as 0. This will ensure that only bandwidth is considered in a cost calculation that is maximized in the network for prefix '1.1.1.14/32'. Thus, in accordance with techniques of this proposal, both requirements can be implemented in the network with a single routing protocol handling all prefixes.

In comparison to other potential solutions, the solution presented herein does not require vast design and configuration. The only configuration needed is at the source of prefixes at which a network administrator can assign k-values based on application requirements unlike existing solutions in which multiple VRFs need to be intelligently configured to optimize the links for application requirements. Other potential solutions do not involve advertisement of k-values as are utilized by the techniques of this proposal.

Accordingly, techniques are presented herein through which a flexible metric can be applied that is isolated to prefixes. The techniques may facilitate the reduced use of VRFs on routers and ease network configuration, as configurations provided in accordance with the techniques presented herein are only needed at prefix originators.