           Use Cases for Virtual Connections on Demand (VCoD) and Virtual Network
                on Demand (VNoD) using Interface to Routing System
                        draft-hares-i2rs-use-case-vn-vc-03

Abstract

   Software Defined Networks (SDN) provide a way to virtualize and
   abstract the network in order to present virtual or abstract
   resources to third-party applications running in software.
   Applications can utilize a programmable interface to receive these
   virtual or abstract resource descriptions in a form that allows
   monitoring or manipulation of resources within the network. The
   Interface to the Routing System (I2RS) provides an interface directly
   to the routing System to monitor best paths to any destination or
   change routes in the routing information base (RIB) or MPLS Label
   Information Base (LIB). The I2RS interfaces may be combined with
   other interfaces to the forwarding plane (ForCES (RFC3746)), device
   configuration (NETCONF), or mid-level/peer-to-peer (ALTO, draft-ietf-
   alto-protocol) system to create these virtual pathways.

   This document outlines how SDN networks can use the I2RS interface to
   implement an automated set of network services for the Virtual
   Connection on Demand (VCoD) and Virtual Network on Demand (VNoD).
   These systems provide service routing a better way to create paths
   within a hub and spoke environment, and provide service routing the
   ability to create pathways based on service.

   This Internet-Draft will expire on January 5, 2015.

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Table of Contents

1. Introduction

   The Interface to the Routing System (I2RS) architecture
   ([I-D.ietf-i2rs-architecture]) describes a mechanism where the
   distributed control plane can be augmented by an outside control
   plane through an open accessible programmatic interface. I2RS
   provides a "halfway point" between completely an architecture that
   replaces the traditional distributed control planes and directly
   configuring devices via off-board processes.

This draft proposes a set of use cases using I2RS mechanisms to
implement a Software Defined Network (SDN) to enact virtual
connections and virtual networks as automated services. This
document focuses on how I2RS would support two automated network
services: Virtual Connection on Demand (VCoD) and Virtual Network on
Demand (VNoD). Virtual Connections on Demand (VCoD) and Virtual
Network on Demand (VNoD) may be used within hub-spoke networks and
improve service routing. In the future, an application enabled SDN
service may provide the Virtual Circuits (VCoD) and Virtual Networks
on Demand (VNoD) for any type of network service.

This document contains a summary of I2RS requirements from VCoD and
VNoD use case, background to I2RS, a VCoD use case, a VNoD use case,
and a discussion of what the RIB Information Model is missing. Those
familiar with I2RS problem statement
([I-D.ietf-i2rs-problem-statement]), I2RS architecture
([I-D.ietf-i2rs-architecture]), and the concepts of Virtual
Connections (VCs) or Virtual Networks (VNs) may wish to skip the
background section.

1.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
document are to be interpreted as described in RFC 2119 [RFC2119].

2. Summary of I2RS requirements

This section contains a summary of what each use case indicates is
needed in the I2RS protocol (features and data). Section 3-5 provide
descriptions of the Virtual Circuit on Demand (VCoD), Virtual Network
on Demand (VNoD), and Automated on Demand Networks. Each of these
sections specifies a use case description followed by a summary of
I2RS requirements.

The use cases in this document have been numbered to allow coherent
compilation of the the I2RS requirements into a single list. In this
draft, each unique requirement for the I2RS protocol(I2RS client-I2RS
agent) for the Virtual Circuit on Demand (VCoD) use caes has the
label VCoD-REQnn where nn is an number. Each unique requirement for
the VNoD use case has the label VNoD-REQnn where nn is a number.
This use case also indicates things which are lacking in the Each
unique requirement for for VCoD additions to the I2RS RIB
Informational Model VCOD-IM-REQnn (where nn is a unique number).
Similarly, each unique requirement for VNoD additions to the RIB
informational Model is identified with VNoD-IM-REQnn where nn is a
unique number. Section 6 contains a list of what is missing in the
RIB Informational Model.

The requirements for Virtual Connections on Demand (VCoD) use cases
are:

o VCoD-REQ01: I2RS Agent SHOULD provide the ability to read the
   virtual network topology database for the technology supported to
   determine nodes and connections. For optical, these are the
   optical connections and what node they connect to, and the
   topologies created. For MPLS, this is virtual circuit available,
   what nodes they connect to, and the network topologies created.
   For IP technologies, this could include the GRE tunnels, what
   interface it connects to, and the topologies created. For
   Ethernet circuits this should involve circuit type (e.g, point-to-
   point (P2P) or point-to-multipoint (P2MP)) and what nodes it can
   reach, and the topologies created.

o VCoD-REQ02: I2RS Agent SHOULD provide the ability to influence the
   configuration of a virtual circuit in a node.

o VCod-REQ03: I2RS Agent SHOULD provide monitor and provide
   statistics on the virtual connection to the I2RS client via a Read
   request or status Notification. The I2RS client can then
   determine if the connection falls below a quality level the
   application has requested. If the I2RS client does determine the
   circuit is below the required quality, it could create another
   circuit. The I2RS may choose to create the second virtual
   circuit, transfer flows, and then break the first circuit.

The Virtual Network on Demand (VCoD) contains the same first three
requirements. This means that:

o VNoD-REQ01 = VCoD-REQ01,

o VNoD-REQ02 = VCoD-REQ02, and

o VNoD-REQ03 = VCoD-REQ03.

These requirements will not be repeated, so the VNoD begin with VNoD-
REQ-04.

The requirements for the Virtual Networks on Demand (VNoD) are:

o VT-VN-REQ04: I2RS Agent SHOULD provide the ability to influence
   the configuration of a virtual network in a node.

o VT-VN-REQ05: I2RS Agent SHOULD provide the ability to report
   statistics on the network nodes and end-to-end traffic flows via
   read of status data or via notifications of status.

o VT-VN-REQ06: The I2RS protocol and RIB Informational Model (IM)
   MUST support logical tunnels of type MPLS as well as IP, GRE,
   VxLAN, and GRE. Large carrier networks utilize MPLS in a variety
   of forms (LDP, static MPLS TE, or dynamic TE LSPs created by RSVP-
   TE).

o VT-VN-REQ07: I2RS SHOULD support Informational Models and features
   to allow MPLS technologies to create Hub-spoke topology and
   service routing in networks in Carriers, Enterprise, and Data
   Centers.

o VT-VN-REQ08: I2RS protocols, Information Models, and Data Models
   MUST be able to support Carriers using these MPLS technologies to
   support networks for Mobile BackHaul, on-demand MPLS overlays, and
   on-demand video conferencing networkings.

3. Virtual Circuit on Demand

   Virtual Circuit on Demand (VCoD) application associates to I2RS
   client (or clients) which can communicate with the I2RS agent (or
   agents) which control the VCoD circuit's creation, deletion,
   modification, query for information or status changes. Information
   for this application needs to include for network topology, interface
   statistics, available circuits per node, available bandwidth on
   circuits. Interface statistics might be required on a historical and
   instantaneous time basis. The circuit statistics might also need
   jitter, delay, and exit-point performance.

   The virtual circuits may be obtained via RIB Informational Model (RIB
   IM) ([I-D.ietf-i2rs-rib-info-model]) from the interface list, or from
   the nexthop lists. Write access to set-up new interfaces is not
   clearly spelled out in the current version of the RIB IM, nor are the
   statistics (historical or time). This use case points out additional
   Information Models (IMs) that need to be added to the I2RS
   information models.

   In the example topology below, the VCoD application's I2RS client
   communicates with I2RS agents to set-up virtual circuits from Edge 1
   to Edge 2. The I2RS client communicates with I2RS Agent-1 on node 1,
   I2RS Agent-2 on node 2, I2RS Agent-3 on node 3, and I2RS Agent 4 on
   node 4 for to set-up the virtual circuit. The VCoD application
   contains the necessary logic to determine the pathway from Edge 1 to
   Edge 2.

   A second option for VCoD is to have an application communicate with
   two I2RS clients who cooperate to set-up the virtual connections
   between Edge 1 and Edge 2. Information passed between the two

clients can be done via other IETF protocols (E.g. stateful PCE or ALTO).

3.1. Why I2RS enabled solutions are necessary

Past solutions in this area have included uses of device configuration across multiple nodes (SNMP or NETCONF based) with proprietary services combined with topology queries. The lack of coordinated responses to routing topology queries has created problems in quickly obtaining and configuring changes for Virtual Circuits. New algorithms can create better services in routing and switching. These algorithms include Fast-Reroute of RSVP or IGPs which aid the automatic re-establishment of some circuits, but the complexity of some of these algorithms increases cost within the network elements. It's often difficult to justify the added complexity in the database and algorithms of routing protocols to solve what is considered a point case.

While the set-up of these virtual circuits is possible with current technology, the lack of the I2RS-like framework makes VCoD network complex. With this support, VCoD may be able to reduce complexity on the individual nodes.

3.2. Why is not in scope for I2RS

The means by which the VCoD application determines which I2RS client to associate with is outside the I2RS protocol and architecture. A list of virtual circuits per node may be queried from the RIB Informational Model's (RIB IM) ([I-D.ietf-i2rs-rib-info-model]) interface and nexthop lists. However, other means may be used to determine the possible interfaces on a node. For example, ALTO could inform the application which nodes have an I2RS Agent supporting the VCoD service, and SNMP/NETCONF could be used to determine which interfaces were configured.

3.3. Example Topology for Virtual Circuit on Demand (VCoD)

```
           +----------------------------+
           | Application (VCoD)          |
           +---*------------------------+
               |                     |
               |                     |
       +-------*------------+<NETCONF>+-------------------+< NETCONF
       |I2RS client 1       |< PCE info> |I2RS Commissioner-2 |< PCEP
       |VC controller       |            | VN controller      |
       +--*---------*--*-*-+                 +-------------------+
          |         |  | |                         |            |
          |         |  | |------------------------+  |          |
          |         |  |-----------+       |       |  |          |
          |         |  |           |       |       |  |          |
       +--------+ +--------+   +---------+  +----------+
       | I2RS   | | I2RS   |   | I2RS    |  | I2RS     |
       | Agent-1| |Agent-2 |   | Agent-3 |  | Agent-4  |
       |--------| |--------+   +---------+  +----------+
       | node 1 | | node 2 |   | node 3  |  | node 4   |
       +--------+ +--------+   +---------+  +----------+
          | |       | |           |  |
      edge1 |-------|  |-----------|  |
                                      |----edge2
```
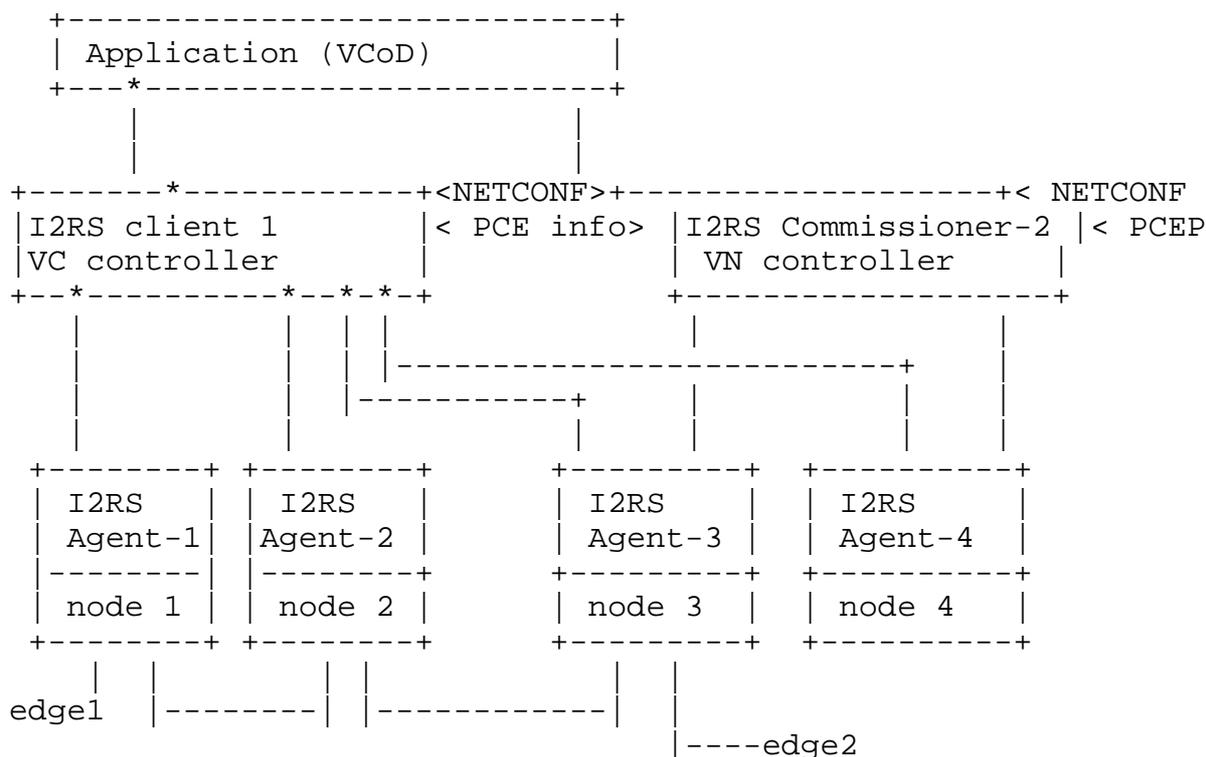
3.4. I2RS Requirements for Virtual Circuit on Demand (VCoD)

   The following things need to be supported for this application:

   o VCoD-REQ01: I2RS Agents SHOULD provide the ability to read the
      virtual network topology database for the technology supported.
      For optical, these are the optical connections and what node they
      connect to, and the topologies created. For MPLS, this is virtual
      circuit available, what nodes they connect to, and the network
      topologies created. For IP technologies, this could include the
      GRE tunnels, what interface it connects to, and the topologies
      created. For Ethernet circuits this should involve circuit type
      (e.g, point-to-point (p2p) or point-to-multipoint (p2mp)) and what
      nodes it can reach, and the topologies created.

   o VCoD-REQ02: I2RS Agent SHOULD provide the ability to influence the
      configuration of a virtual circuit in a node.

   o VCoD-REQ03: I2RS Agent SHOULD provide monitor and provide
      statistics on the virtual connection to the I2RS client via a Read
      request or status Notification. The I2RS client can then
      determine if the connection falls below a quality level the
      application has requested. If the I2RS client does determine the

circuit is below the required quality, it could create another
circuit. The I2RS may choose to create the second virtual
circuit, transfer flows, and then break the first circuit.

What is needed in the RIB IM Model

o VCoD-RIB_IM-REQ01: The RIB IM model
   ([I-D.ietf-i2rs-rib-info-model] provides with each route an
   associated nexthop-list 0-N members. Each nexthop-list is flagged
   with a protection preference (1 or 2), and a Load balance weight
   (1 to 99). If the host routes for all nodes in the topology exist
   within the RIB IM model's instantiation, then the nexthop member
   on the nexthop-list SHOULD provide the following information:

   * identifier for interface

   * egress interface (logical, virtual, or physical)

   * address of physical interface (IP address or MAC) plus RIB

   * tunnel encapsulation for interface (IP GRE, MPLS tunnel),

   * logical tunnel identifier

   * RIB name (for look-up resolution)

   * flags for specialized look-ups (Discard packets, discard with
      error notification, receive)

o VT-VC-RIB_IM-REQ02: The RIB IM model's primitives SHOULD include
   circuit type (p2p, mp2mp), optical connection information, and
   additional statistics per virtual circuit.

o VT-VC_RIB_IM-REQ03:The RIB IM model's instantiation within the
   protocol must provide an easy way to specify queries for this
   information.

4. Virtual Network on Demand (VNoD)

   Virtual Networks on Demand (VNoD) are simply extensions to the
   Virtual Connections on Demand concept. The I2RS client is tasked to
   create a virtual network instead of a single connection.

   The example sequence would be that the application discovers the
   appropriate I2RS clients (I2RS VNoD client 1 and I2RS VNoD Client 2)
   which support VNoD via a protocol outside the I2RS framework (e.g.
   ALTO). The I2RS Client-2 works with the I2RS Agents 1-4 to set-up a
   virtual network. This involves the following:

o gathering potential topology information (in order to create the
   network,

o set-up the virtual network (via influencing configurations on
   node),

o monitoring changes in topology (in order to potential failovers,

o influencing changes to virtual network via configurations, and

o removing the virtual network after the demand has expired.

```
                 +-------------------------+
                 |  Application            |
                 +-------------------------+
                    |                 |
                    |                 |
     +------------------+< Policy   +------------------+<Policy
     |I2RS VNoD client 1|<PCE info  |I2RS client 2     |< PCEP
     |                  |           |                  |
     +------------------+           +------------------+
         |                              | |   |      |
         |---------------------------+  | |   |      |
         |              +--------------- |      |      |
         |              |                |      |      |
       +--------+ +--------+     +---------+  +----------+
       | I2RS   | | I2RS   |     | I2RS    |  | I2RS     |
       | Agent-1| |Agent-2 |     | Agent-3 |  | Agent-4  |
       |--------| |--------+     +---------+  +----------+
       | node 1 | | node 2 |     | node 3  |  | node 4   |
       +--------+ +--------+     +---------+  +----------+
          |  |       |  |           |  | |       |  |
          |  |-------|  |-----------|  | +------+   |-end-point-3
          |             |              |            |
      end-point-1       |              |
                        |----end-point2
```
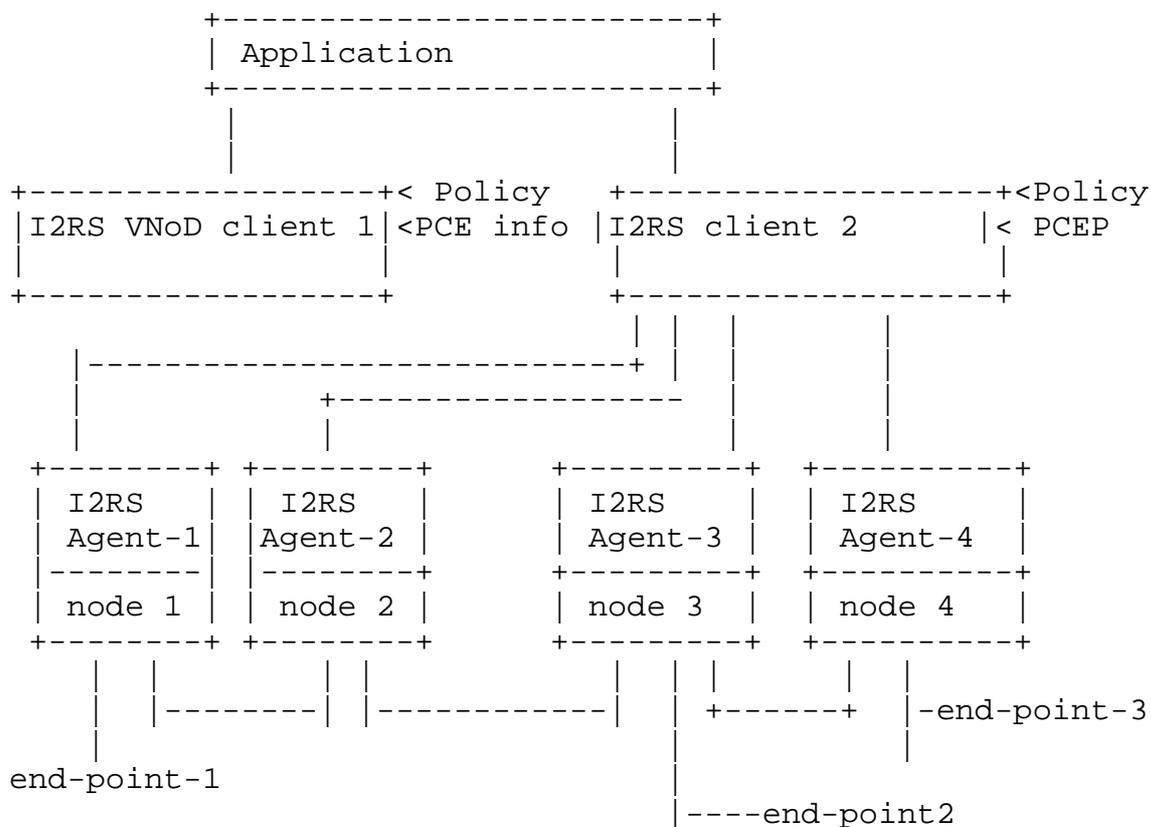
   This topology shares some configuration needs with the central
   membership computation for MPLS VPNs from (draft-white-i2rs-use-
   cases) but the mechanisms are not specific to MPLS VPNs.

   This requires the following from I2RS protocol (client-agent)

o VCoD/VNoD-REQ01: I2RS Agents SHOULD provide the ability to read
   the virtual network topology database for the technology
   supported. For optical, these are the optical connections and

what node they connect to, and the topologies created. For MPLS, this is virtual circuit available, what nodes they connect to, and the network topologies created. For IP technologies, this could include the GRE tunnels, what interface it connects to, and the topologies created. For Ethernet circuits this should involve circuit type (e.g, point-to-point (p2p) or point-to-multipoint (p2mp)) and what nodes it can reach, and the topologies created.

o VCoD/VNoD-REQ02: I2RS Agent SHOULD provide the ability to influence the configuration of a virtual circuit in a node.

o VCoD/VnoD-REQ03: I2RS Agent SHOULD provide the ability to report statistics on the virtual connection to the I2RS client via read of status data or via notifications of status. The I2RS client can then determine if the connection falls below a quality level the application has requested. If the I2RS client does determine the circuit is below the required quality, it could create another circuit. The I2RS may choose to create the second virtual circuit, transfer flows, and then break the first circuit.

o VNOD-REQ04: I2RS Agent SHOULD provide the ability to influence the configuration of a virtual network in a node.

o VNoD-REQ05: I2RS Agent SHOULD provide the ability to report statistics on the network nodes and end-to-end traffic flows via read of status data or via notifications of status.

5. Automated On Demand Networks

   Automated On-Demand networks becomes a reasonable technology within a network by utilizing the I2RS architecture. While automated on-demand circuit provisioning and de-provisioning is possible now, the effort to configure and reconfigure nodes to provide the Automatic On-Demand circuits can be difficult. With I2RS, the I2RS client can instruct the I2RS Agents within a network to create On-Demand circuits and then remove the circuits returning the network to its configured state. With I2RS enhanced monitoring capability, the monitoring needed for these state changes is incorporated within the I2RS framework.

   The current scope for these Automated On-Demand Circuits in the IETF's I2RS working group's charter is limited to hub-spoke networks and service routing. This section discusses the progress on the I2RS against the use cases, and proposes additional additional Automated On-Demand Circuits.

   Current Status of the Automated On-Demand Functionality

Both the hub-spoke network and service network may include a
centralized control network element such as
[I-D.ji-i2rs-usecases-ccne-service]. These centralized control
network elements may use I2RS access to individual node's RIB
information via the I2RS RIB Information Model (IM)
([I-D.ietf-i2rs-rib-info-model]), or obtain full network topology
information from other protocols (BGP Route Reflector, PCE
([RFC4655]), or ALTO [I-D.bernstein-alto-topo]). With the recent
inclusion of IGP (OSPF and ISIS) link-state information into BGP TLVs
via [I-D.ietf-idr-ls-distribution], all of these sources can provide
centralized services that can provide topology maps at the AS and IGP
level.

I2RS Information Models (IM) are being proposed which can store:

o Network Topologies (IM) [I-D.medved-i2rs-topology-im], and

o Service Topologies IM) [I-D.hares-i2rs-info-model-service-topo].

I2RS features Needed Future On-Demand Networks

o VNoD-REQ06: The I2RS protocol and RIB Informational Model (IM)
   MUST support logical tunnels of type MPLS as well as IP, GRE,
   VxLAN and GRE. L Large Carrier networks utilize MPLS in a variety
   of forms (LDP, static MPLS TE, or dynamic TE LSPS created by RSVP-
   TE or CR-LDP).

o VNoD-REQ07: I2RS SHOULD support Informational Models and features
   to allow MPLS technologies to create Hub-spoke topology and
   service routing in networks in Carriers, Enterprise, and Data
   Centers.

o VNoD-REQ08: I2RS protocols, Information Models, and Data Models
   MUST be able to support Carriers using these MPLS technologies to
   support networks for Mobile BackHaul, on-demand MPLS overlays, and
   on-demand video conferencing networkings.

6. What is Missing in RIB Informational Model (RIB IM)

Based on these requirements, the following is needed in the RIB IM
Model:

o VNoD-RIB_IM-REQ01: The RIB IM model
   ([I-D.ietf-i2rs-rib-info-model] provides with each route an
   associated nexthop-list 0-N members. Each nexthop-list is flagged
   with a protection preference (1 or 2), and a Load balance weight
   (1 to 99). If the host routes for all nodes in the topology exist

within the RIB IM model's instantiation, then the nexthop member
on the nexthop-list SHOULD provide the following information:

* identifier for interface

* egress interface (logical, virtual, or physical)

* address of physical interface (IP address or MAC) plus RIB

* tunnel encapsulation for interface (IP GRE, MPLS tunnel),

* logical tunnel identifier

* RIB name (for look-up resolution)

* flags for specialized look-ups (Discard packets, discard with
  error notification, receive)

o VNoD-RIB_IM-REQ02: The RIB IM model's primitives SHOULD include
  circuit type (p2p, mp2mp), optical connection information, and
  additional statistics per virtual circuit.

o VNoD_RIB_IM-REQ03:The RIB IM model's instantiation within the
  protocol must provide an easy way to specify queries for this
  information.

7. IANA Considerations

This document includes no request to IANA.

8. Security Considerations

This document has no security issues as it just contains use cases.

9. References

9.1. Normative References

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