Modeling the Digital Map based on RFC8345: Sharing Experience

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olga.havel@huawei.com

Community (Authors and Contributors)

Generic Digital Map drafts:

draft-havel-opsawg-digital-map

- Oscar Gonzalez de Dios oscar.gonzalezdedios@telefonica.com
- Ahmed Elhassany Ahmed.Elhassany@swisscom.com
- Thomas Graf thomas.graf@swisscom.com
- Mohamed Boucadair mohamed.boucadair@orange.com
- Olga Havel olga.havel@huawei.com
- Benoit Claise benoit.claise@huawei.com
- Nigel Davis ndavis@ciena.com

draft-davis-opsawg-some-refinements-to-rfc8345

- Nigel Davis ndavis@ciena.com
- Olga Havel olga.havel@huawei.com
- Benoit Claise benoit.claise@huawei.com

IGP Digital Map drafts:

draft-ogondio-opsawg-isis-topology

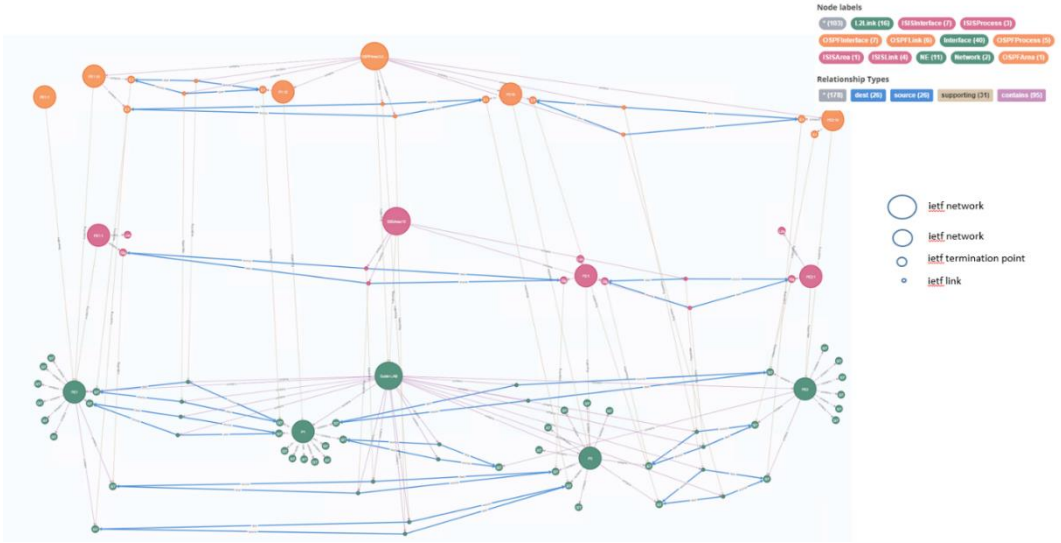
- Oscar Gonzalez de Dios oscar.gonzalezdedios@telefonica.com
- Samier Barguil Giraldo samier.barguil_giraldo@nokia.com
- Victor Lopez victor.lopez@Nokia.com
- Daniele Ceccarelli dceccare@cisco.com
- Benoit Claise benoit.claise@huawei.com
- Olga Havel olga.havel@huawei.com
- Pablo Pavon pablo.pavon@upct.es

draft-ogondio-opsawg-ospf-topology

- Oscar Gonzalez de Dios oscar.gonzalezdedios@telefonica.com
- Samier Barguil Giraldo samier.barguil_giraldo@nokia.com
- Victor Lopez victor.lopez@Nokia.com

Objectives

- *Can the central RFC 8345 YANG module be a good basis to model a Digital Map?*
- *How the different topology related IETF YANG modules fit (or not) together?*
- *Modelling of digital map entities, relationships, and rules, how to build aggregated entities and relationships from device to network views*



- *Does the base model support key requirements that emerge for a specific layer?*
- *Modelling multiple underlay/overlay layers from physical to customer service layer. To what extent it is easy to augment the base model to support new technologies?*
- *Can the base model be augmented for any new layer and technologies?*

Core Digital Map Use Cases and Requirements collected from Operators so far

Use Cases:

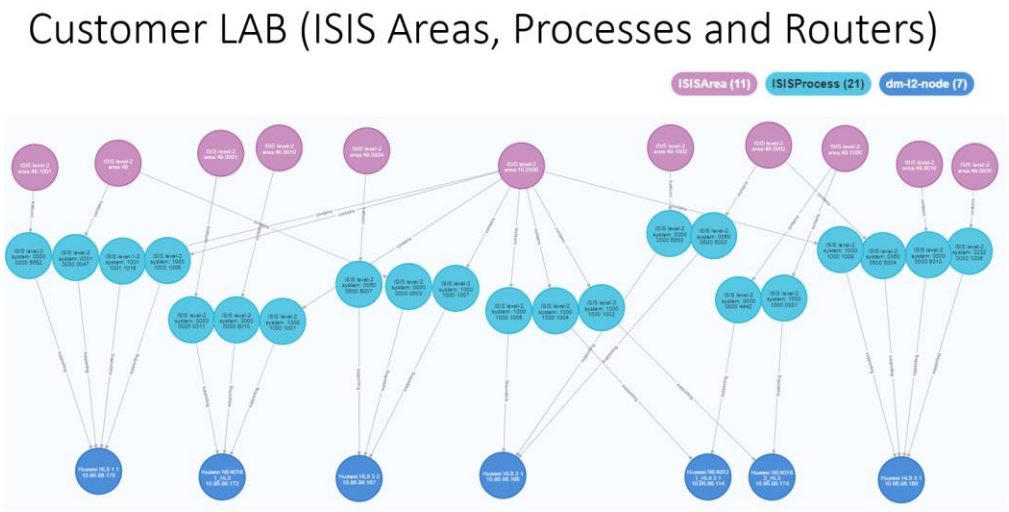
- *Network Inventory Queries*
- *Service Placement Feasibility Checks*
- *Service->Subservice->Resource*
- *Resource->Subservice->Service*
- *Intent / Service Assurance*
- *Service E2E and Per-Link KPIs on the Digital Map (delay, jitter and loss)*
- *Capacity Planning*
- *Network Design*
- *Simulations*
- *Closed Loop*

Requirements:

1. Basic model with Network, Node, Link, Interface, Layers
2. Layered from physical to customer service (intent)
3. Open and programmable (read/write for what-if for DM)
4. Standard based Digital Map model and API
5. Cross-domain
6. Semantics for layered network topologies
7. Relationships
8. Extensible with metadata
9. Pluggable for specific functional modules
   - inventory, KPIs, ..
   - Note: not everything will be in YANG
10. Optimized for graph traversal

Different users may use different layers and have different requirements

What we implemented and evaluated



Technologies implemented in the PoC, 4 LABs, 2 operator LABs:

- Implemented with RFC 8345 (with and without limitations + **feedback)**
  - ✓ Common Network Topology (aligned with RFC8345)
  - ✓ Layer 2 Network Topology (aligned with RFC8944)
  - ✓ Layer 3 Network Topology (aligned with RFC8346)
  - ✓ OSPF routing (aligned with *draft-ogondio-opsawg-ospf-topology-01*)
  - ✓ IS-IS routing (aligned with *draft-ogondio-opsawg-isis-topology-01*)

- Implemented with RFC 8345 (with and without limitations), custom augmentations for new network types and network, node, tp and link properties, to align with any standards in the future PoC versions:
  - ✓ BGP routing
  - ✓ MPLS LDP and MPLS TE Tunnels
  - ✓ SRv6 Tunnels
  - ✓ L3VPN service

RFC 8345 Limitations for Digital Map Modelling?

- Bidirectional links
- Multi-point connectivity (hub and spoke, full mesh, complex)

Proposed solutions in:
draft-davis-opsawg-some-refinements-to-rfc8345

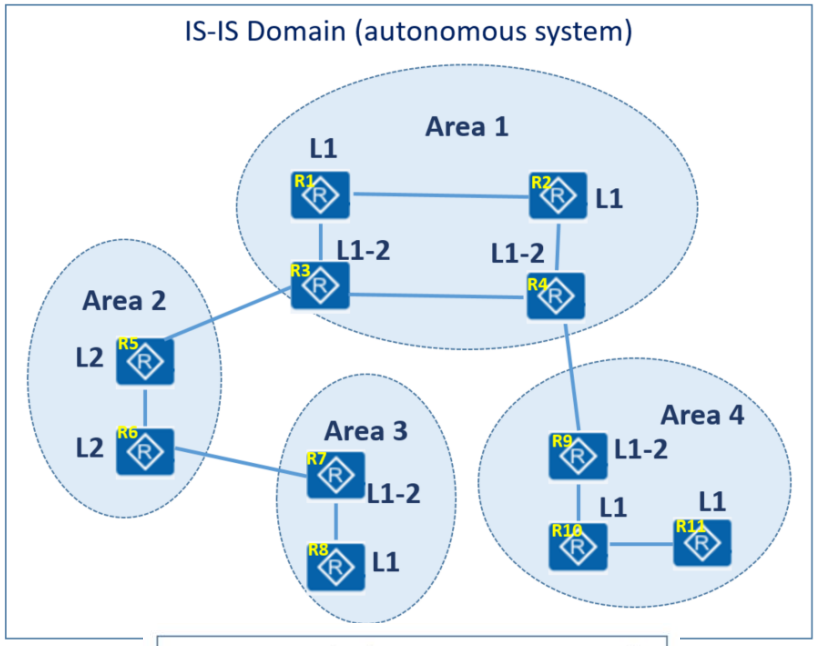
- Links between domains/networks
- Networks part of other networks
- Nodes, TPs and Links in multiple networks

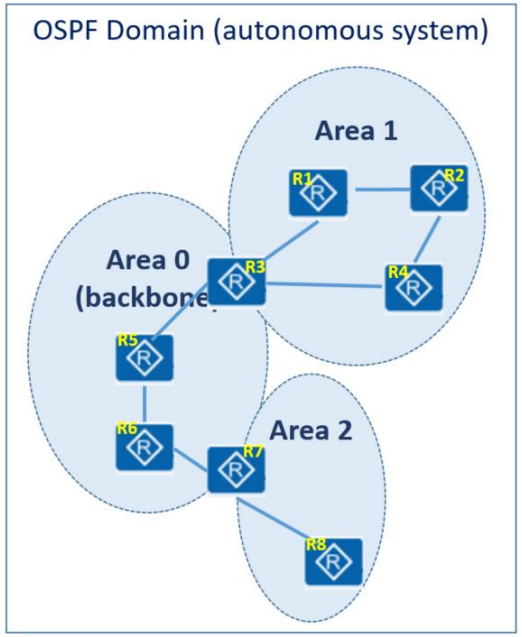
Implemented the IS-IS and OSPF using the drafts:
draft-ogondio-opsawg-isis-topology
draft-ogondio-opsawg-ospf-topology
Identified the limitations

- We need additional supporting relationships (TP->Node, Node->Network)
- Relationship Properties
- Termination Point Roles
- Layers / Sublayers
- Tunnels and Paths. Further analysis for RFC8345 versus RFC8795
- Supporting or underlay. Further analysis for RFC8345 versus RFC8795

How to model IS-IS and OSPF the right way?

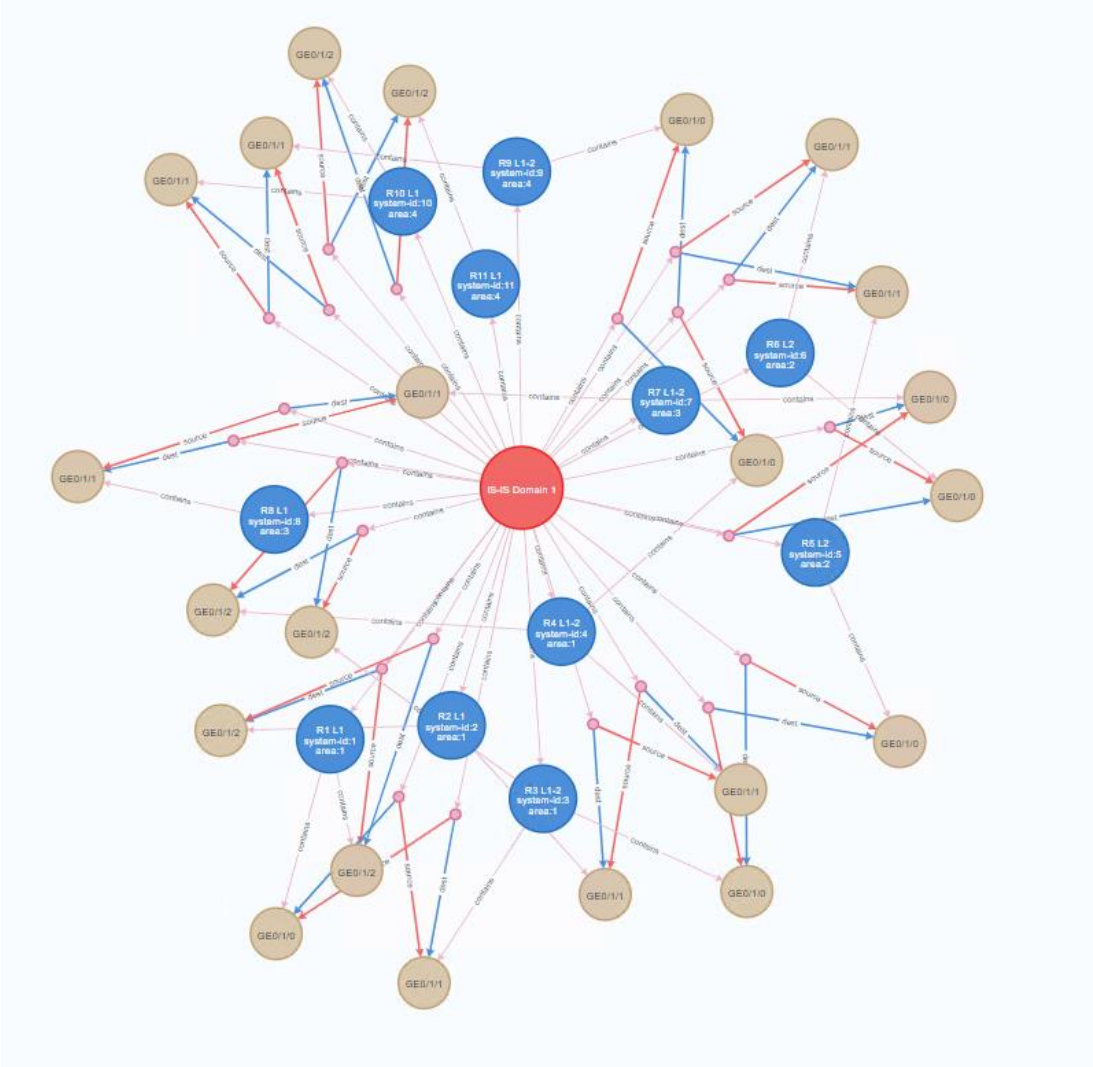
- **RFC 8345 does not model links between different networks**
  - ***Why is it a problem for IS-IS Digital Map?***
    - we cannot model IS-IS areas as topological entities without extending RFC 8345
  - ***What about OSPF?***
    - This is **NOT** the problem for OSPF as the links belong to one area only, nodes can belong to multiple areas
- **RFC 8345 does not allow networks to be part of other networks**
  - ***Why is it a problem for IS-IS Digital Map?***
    - we cannot model AS with multiple IS-IS areas through containment or part-of relationship
  - ***What about OSPF?***
    - This is a problem for OSPF Digital Map as well (AS with multiple OSPF Areas)
- **RFC 8345 does not allow nodes to belong to multiple networks**
  - ***Why is it a problem for IS-IS Digital Map?***
    - if a routing process and interfaces can belong to multiple area, we need to enable the same nodes and interfaces to be parts of multiple networks.
  - ***What about OSPF?***
    - This is a problem for OSPF Digital Map as well, OSPF nodes can belong to multiple areas, although interfaces must belong to 1 area only

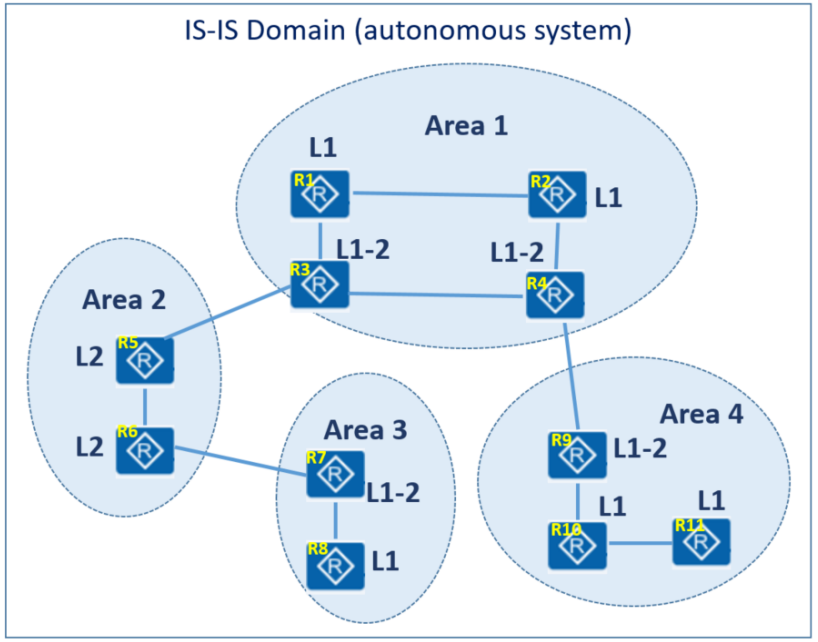




Modelling IS-IS Areas (with RFC 8345 limitations)

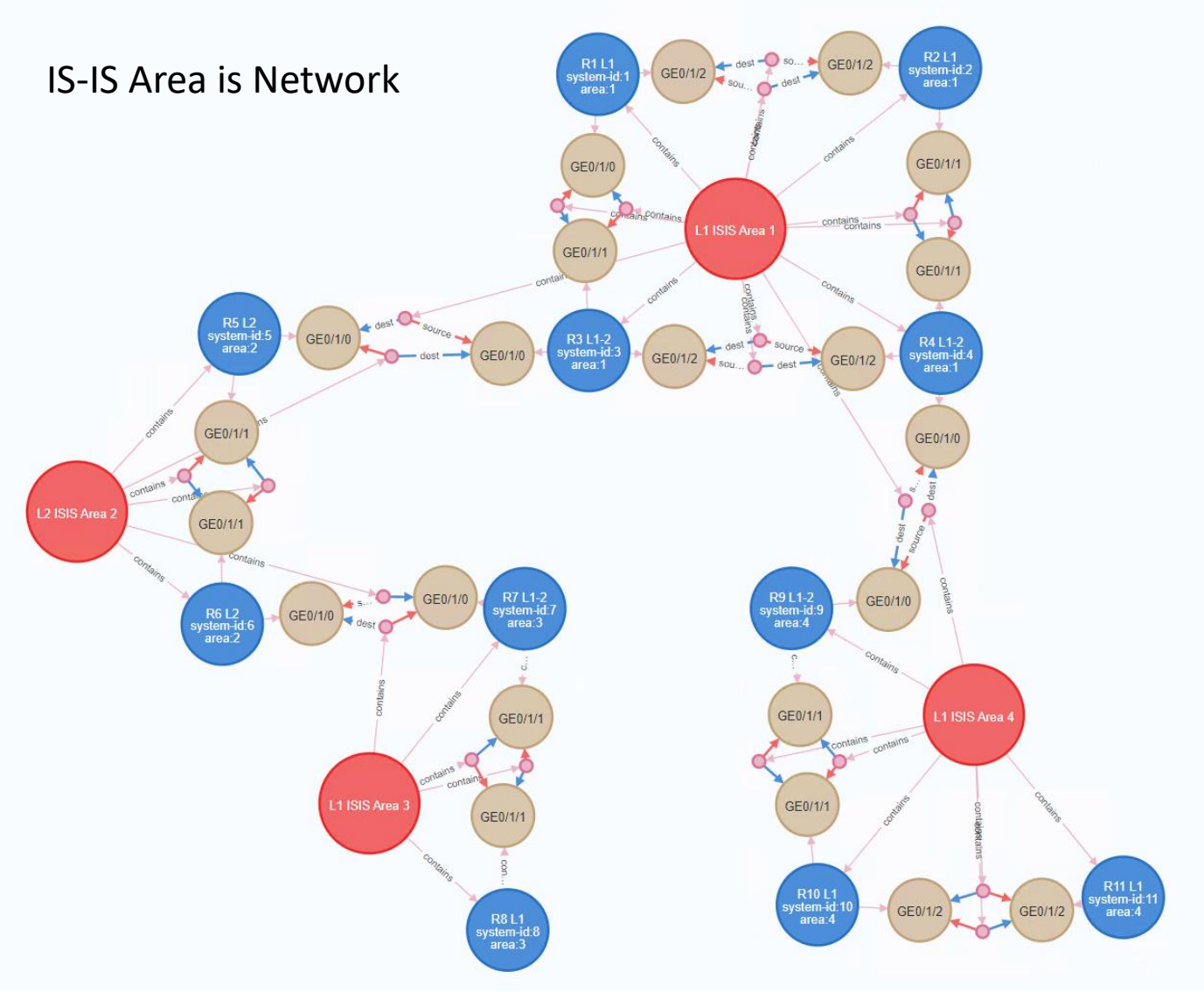
IS-IS Domain is network. IS-IS Areas info in attributes

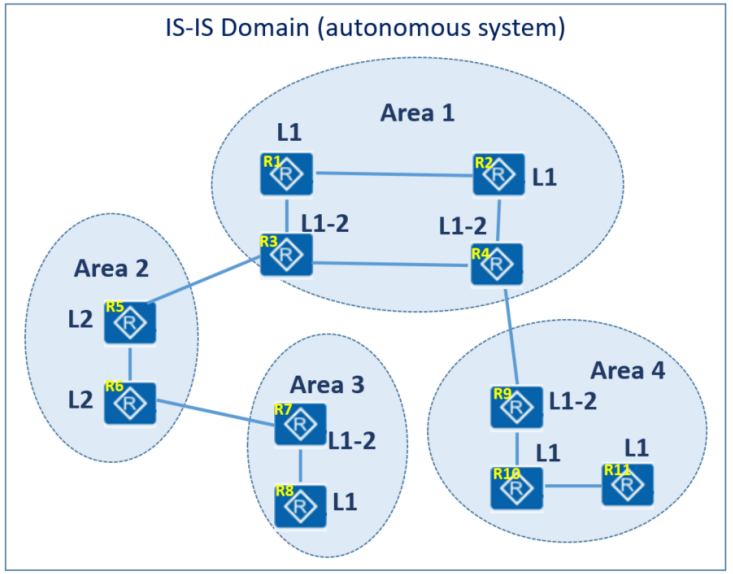




- IS-IS processes grouped in the IS-IS area via the specific IS-IS attribute
- applications would need to understand the meaning of the specific IS-IS attributes in order to understand IS-IS topology
- does not represent the topology of the IS-IS Domain via entities - relationships

Modelling IS-IS Areas (without RFC8345 limitations)





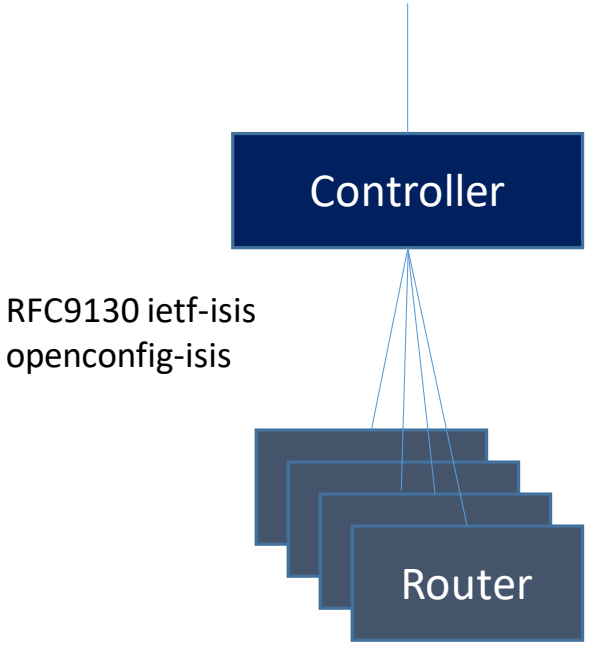
- aligned with the real topology
- allows drill down from the AS->Areas->Processes
- scale
- aligned with the IS-IS topology model and the IS-IS network view in the manuals and training material, IS-IS area entity exists in the model

IS-IS Topology requests – from a Customer LAB

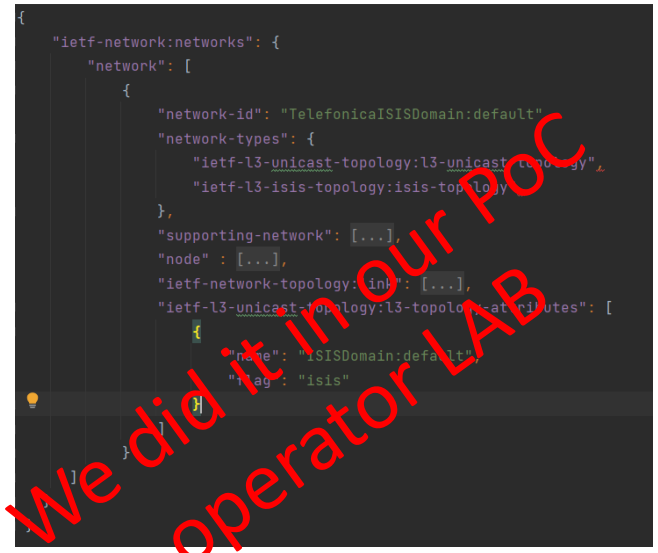
digital map modelling:
draft-ogondio-opsawg-isis-topology

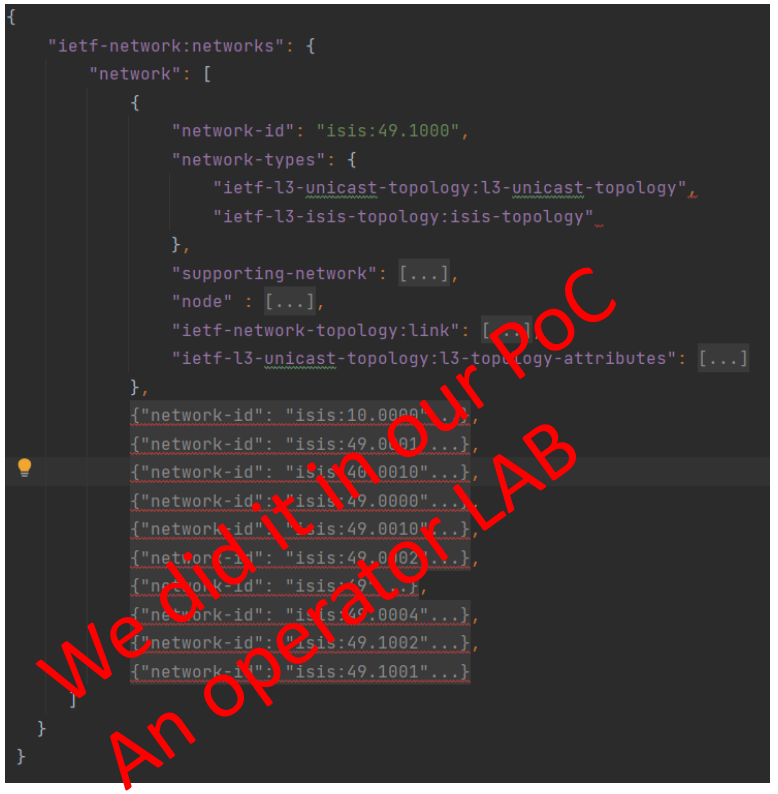
Option 1: No IS-IS Areas
with RFC8345 limitations

Option 2: With IS-IS Areas
without RFC8345 limitations

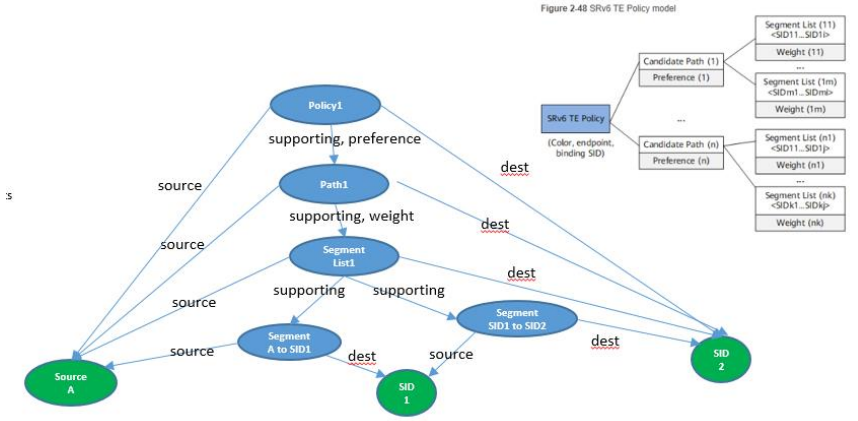


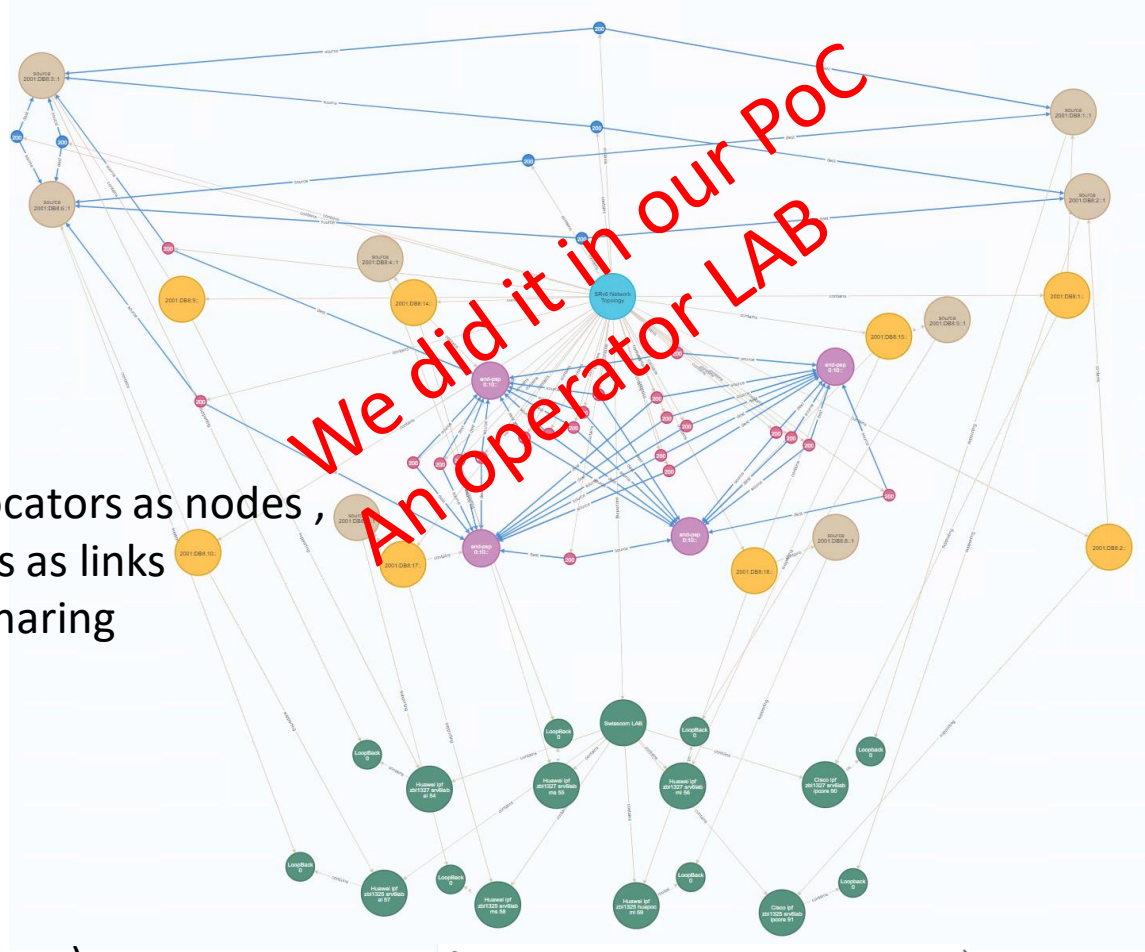
RFC9130 ietf-isis
openconfig-isis





We started working on SRv6 Topology



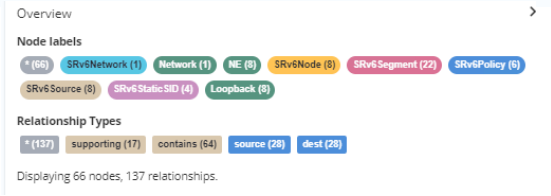


We identified the 2 layers:

1. SRv6 segment / SRv6 network topology: SRv6 Network(s), SRv6 locators as nodes , source, static and dynamic SIDs as tps, segments and segment lists as links
2. SRv6 tunnel topology: policies / tunnels on top of segment lists, sharing

What next?

- review initial modelling in the PoC with customers
- do we need multiple networks? Option 1 versus Option 2
- discuss and finalize relations to services, BGP and IS-IS
- do we want to distinguish between static and dynamic SIDs (2 options)
- do we need to add attributes to the RFC8345 relations (weights)
- Research RFC 8345 versus RFC8795 approach



What's Next?

- *Do SRv6 topology the right way from the beginning!! Dependency with routing – circular dependency?*
- *How the different IGP domains topologies are linked together and with BGP*
- Continue our Evaluation and PoC
  - Evaluate other IETF technology-specific augmentation, one by one
  - More operators and LABs
- How to fulfil all the digital map requirements
  - How to connect to the external world - other YANG modules, not only YANG
  - How to remove the identified limitations
    - Subset of RFC8345 improvements in draft-davis-opsawg-some-refinements-to-rfc8345
    - More drafts for other improvements to come
- Define guidelines for how to augment for new technologies / layers
- Report observations on regular basis to the IETF

Comments ? Questions?

Help Slides

Why Digital Map?

- Digital Twin [draft-irtf-nmrg-network-digital-twin-arch]
  - collects the topology data, KPI data, alarm data, incident data
  - stores configuration data, traffic engineered data, planned data (what if), simulation and emulation data and behaviours
  - has information about actions and behaviours at different layer that can be device specific, network-wide or per customer services

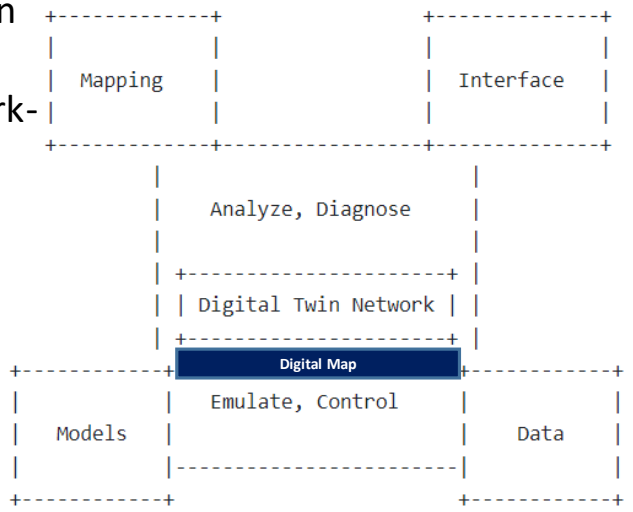


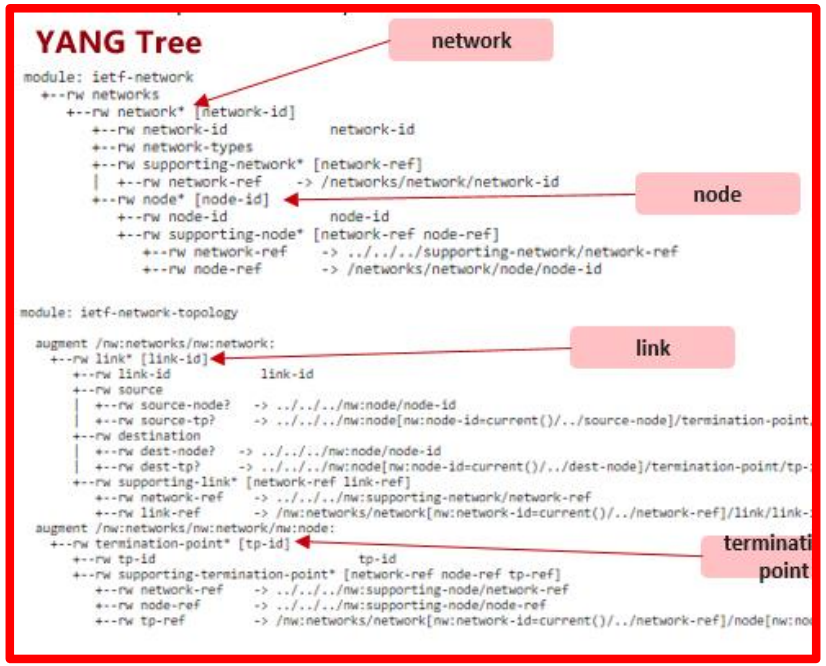
Figure 1: Key Elements of Digital Twin Network

- How to correlate all models and data in the Digital Twin?
  - via topological entities at different layers (from physical to customer service)
- Hence the Digital Map is the basis and prerequisite for the Digital Twin
  - It provides a basic model and a virtual instance of the topological information in the network
  - correlates all Digital Twin data to topological entities at different layers in the layered twin network

What is Digital Map?

- Digital Map provides the core multi-layer topology model of the digital twin that defines:
  - the core topological entities
  - their role in the network
  - core properties that identify entities at different layers
  - relationships between the entities, both inside each layer and between the layers

- Digital Map model is a basic topological model that must link to other functional parts of the digital twin and connects them all:
  - configuration, maintenance, assurance (KPIs, status, health, symptoms), traffic engineering, different behaviours and actions, simulation, emulation, mathematical abstractions, AI algorithms, etc



RFC8345 Network Topology Model

IVY

- The charter of the Network Inventory (IVY) IETF Working Group (WG) can be found at https://datatracker.ietf.org/doc/charter-ietf-ivy/.
- The IVY effort focuses on the network inventory (as the charter says, "including a variety of information such as product name, vendor, product series, embedded software, and hardware/software versions").
- Network Inventory is probably the first Use Case for the Digital Map, but there are many other use cases for Digital Map
- Our Draft is Complementary to Network Inventory (IVY) IETF Working Group
- Our draft has a broader outlook covering all Digital Map use case requirements, and will correlate with the existing IETF models, e.g., topology, service attachment points (SAP), etc.

Relationship with OPSAWG and IVY