Modeling the Digital Map based on RFC8345: Sharing Experience

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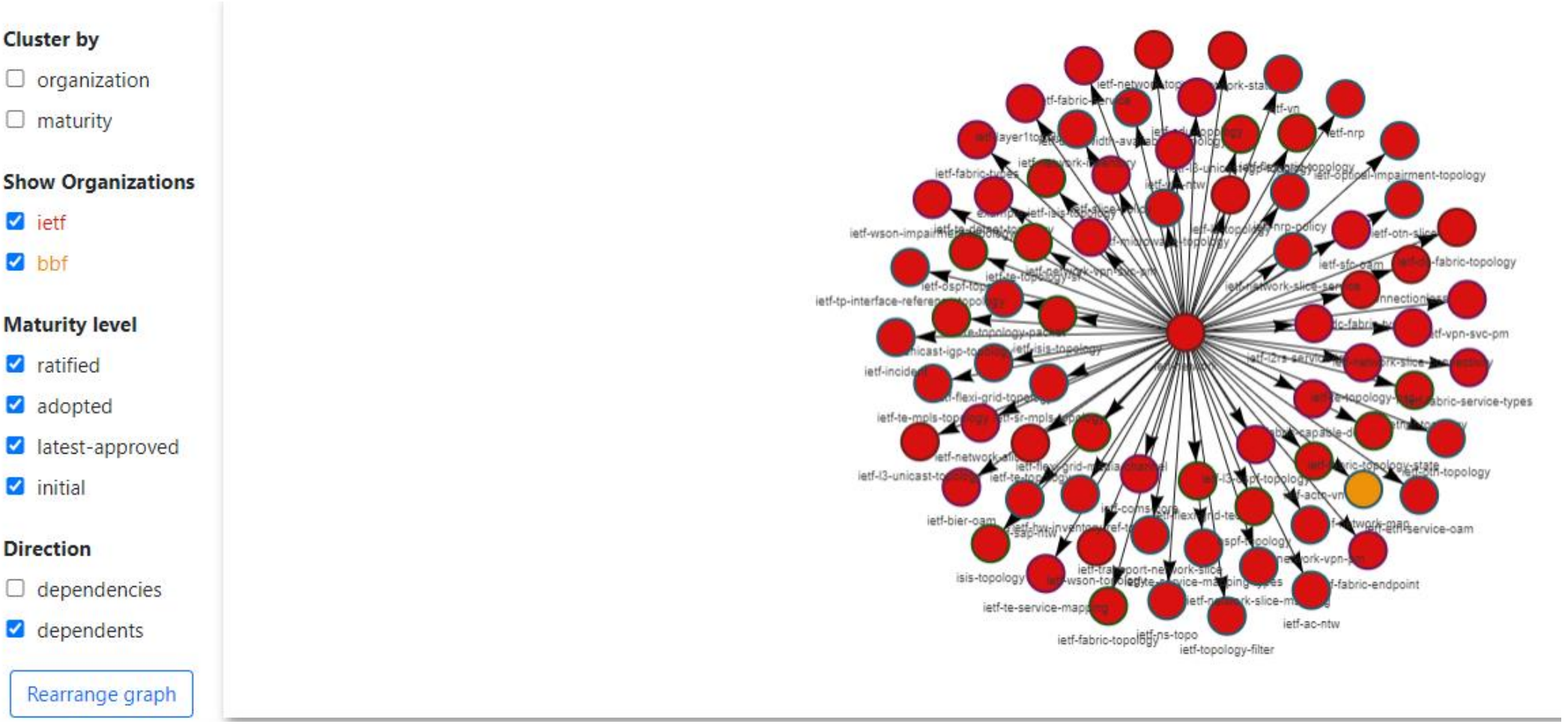
Topology & Digital Map: Everything is done, right?

- RFC 8345: A YANG Data Model for Network Topologies
- RFC 8346: A YANG Data Model for Layer 3 Topologies
- RFC 8944: A YANG Data Model for Layer 2 Network Topologies
- RFC 8795: YANG Data Model for Traffic Engineering (TE) Topologies
- Etc.

Topology & Digital Map: All Technologies are covered, Right?



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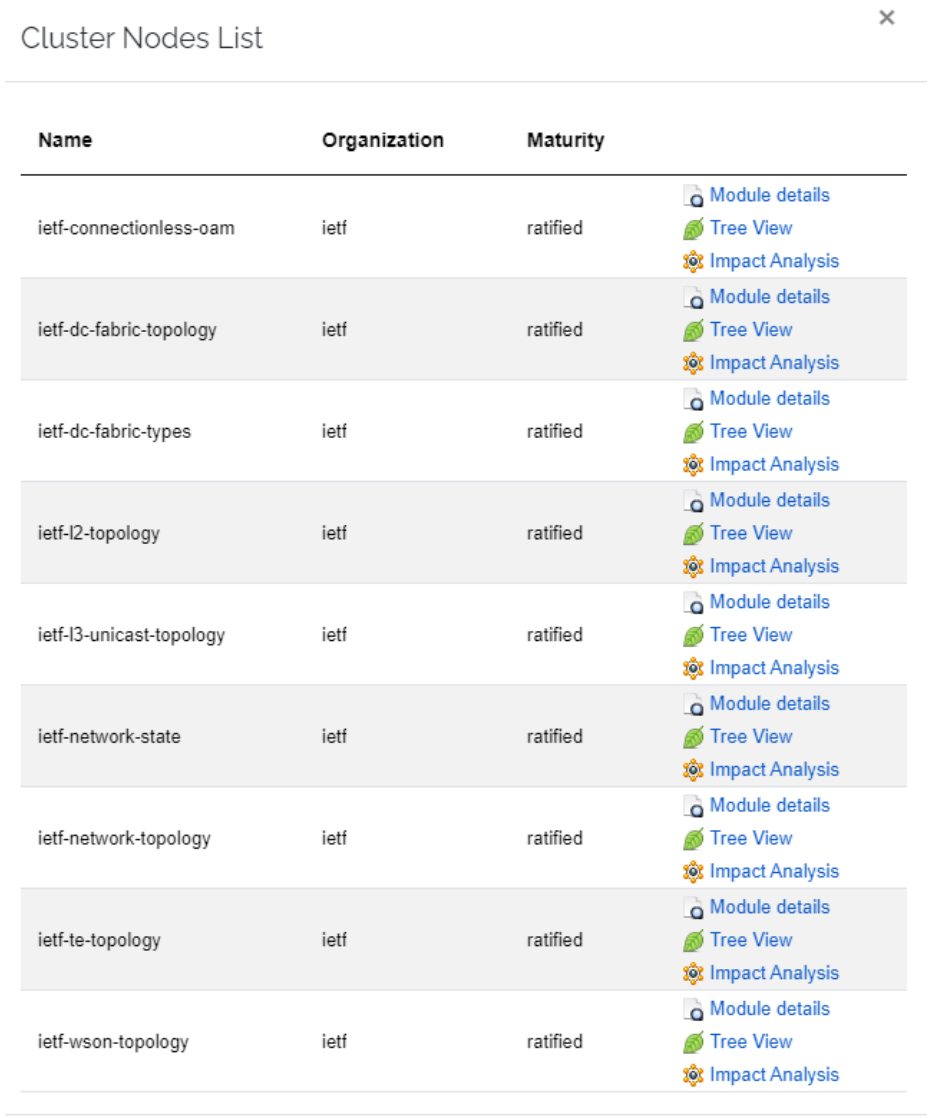
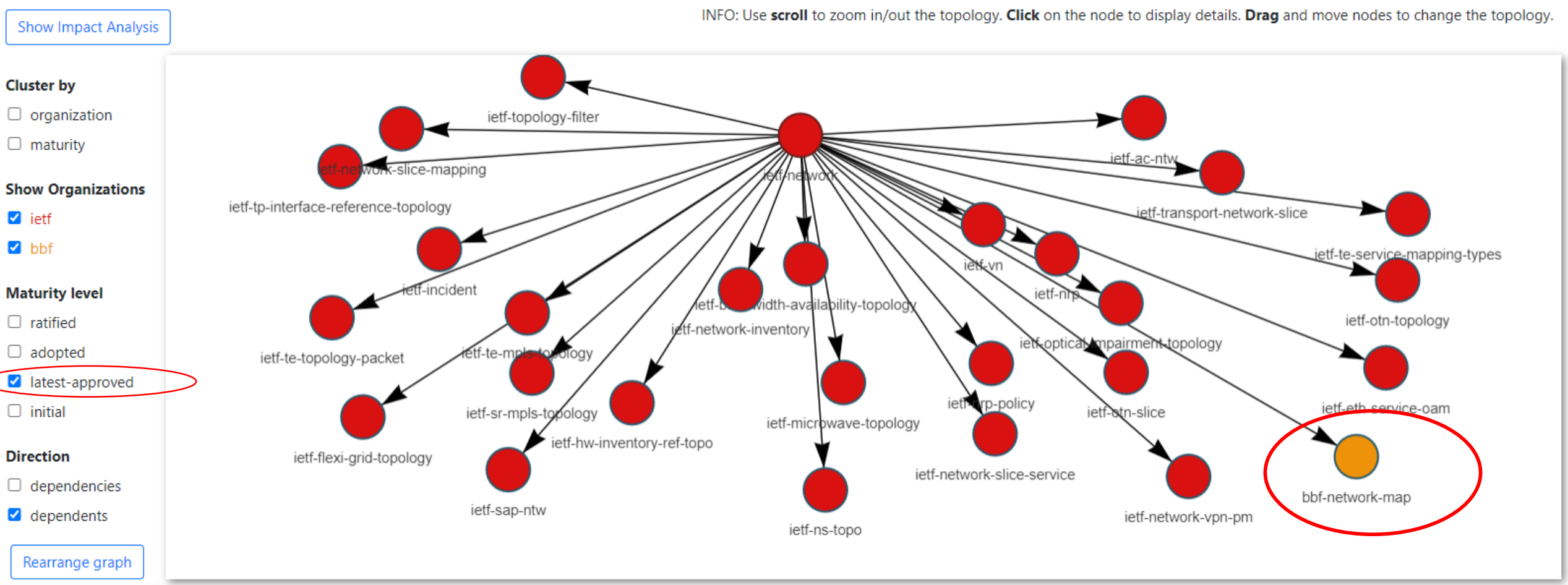
Digital Map: Everything is done, right? We have RFCs



Topology & Digital Map: Drafts being worked on



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This Talk Covers

- Do those YANG modules work together?
  - Note: notion of package-id in NETMOD
- Do those YANG modules work to create a Digital Map?
  - Relationship between Topology & Digital Map & Digital Twin
- Share our experience in modelling a PoC with a real network
  - Open issues
  - Requirements
  - Etc.

Digital Map, Digital Map Model, and Digital Twin Relationships

- Digital Twin is the full replica of the network for what-if scenarios
- Digital Map is a basic model and a virtual instance of the topological information in the network
- We want to focus on Digital Map Modelling

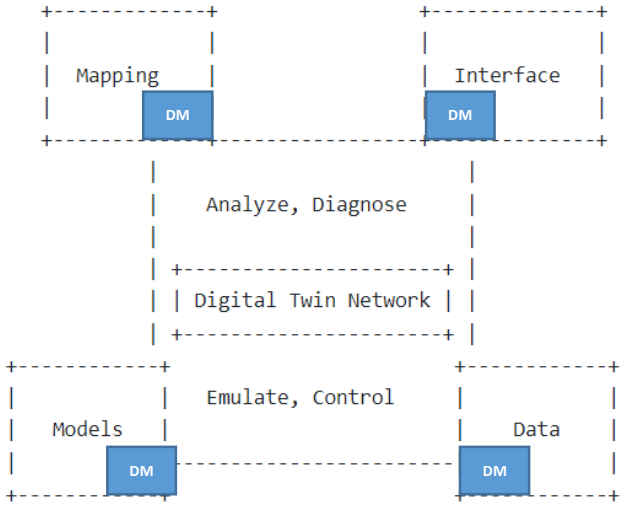


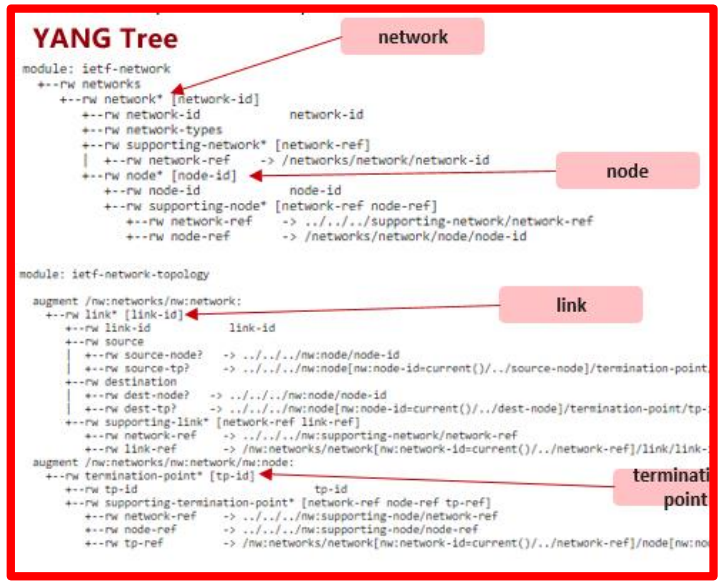
Figure 1: Key Elements of Digital Twin Network

Digital Twin [draft-irtf-nmrg-network-digital-twin-arch]

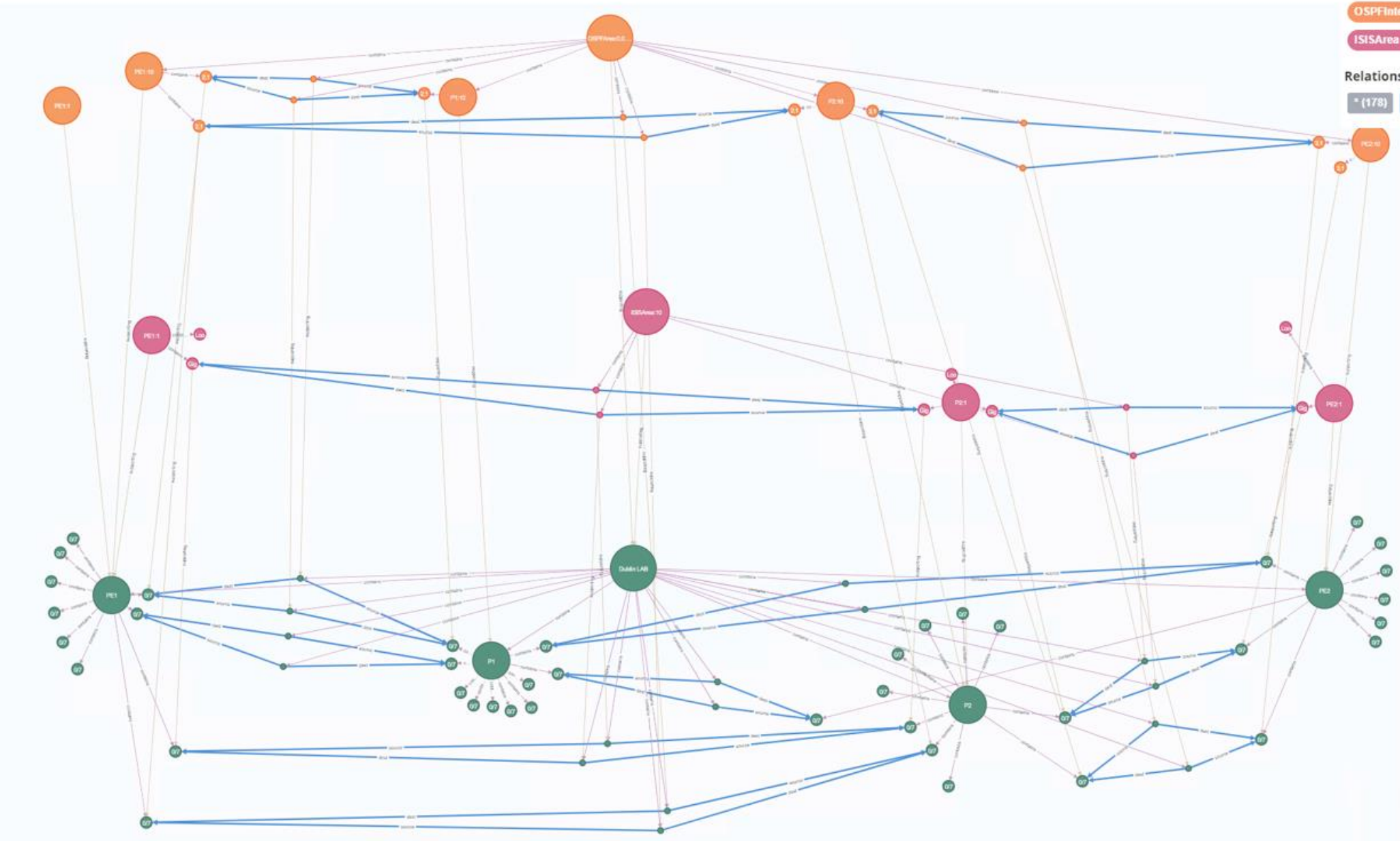
What is Digital Map?

- 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
  - correlates all Digital Twin data to topological entities at different layers in the layered twin network

- 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

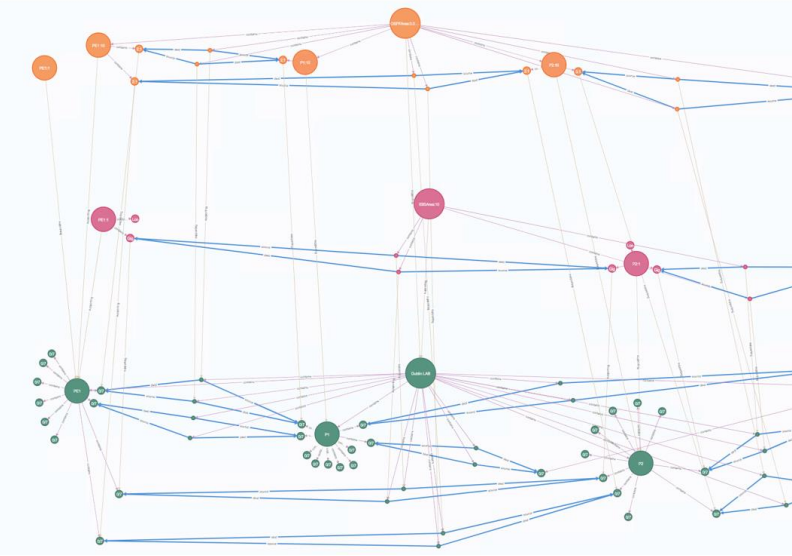


RFC8345 Network Topology Model


Node labels
* (103)
L2Link (16)
ISISInterface (7)
ISISProcess (3)
OSPFInterface (7)
OSPFLink (6)
Interface (40)
OSPFProcess (5)
ISISArea (1)
ISISLink (4)
NE (11)
Network (2)
OSPFArea (1)
Relationship Types
* (178)
dest (26)
source (26)
supporting (31)
contains (95)
ietf network
ietf node
ietf termination point
ietf link

Digital Map PoC

- We modelled digital map entities, relationships, rules for instantiating aggregated entities and relationship instances and mappings to different vendors
- We modelled multiple underlay/overlay layers from L2 to customer service layer
- We based our modelling on [RFC8345] and we successfully modelled the following using this approach:
  - L2 and L3 Network Topology
  - OSPF, IS-IS, BGP Topologies
  - Tunnel Topologies MPLS LDP, MPLS TE, SRv6
  - L3 VPN Network Service
  - Customer L3VPN Service
- The modelling approach based on [RFC8345] provides the out of box standard IETF based API
- Collection of data from multi-vendor network, with using both standard and vendor specific APIs
- During the PoC, we collected the requirements from multiple service providers. We verified the approach by demoing it iteratively to them and improving the PoC based on their feedback.



What are the/your Core Digital Map Requirements?

	RFC8345-based
• basic model with Network, Node, Link, Interface, Layers	Ok
• layered from physical to L2 to L3 … to customer service (intent)	Ok
• open and programmable (read/write for what-if for DM)	Ok
• standard based Digital Map model and API	Ok
• cross-domain	Ok
• semantics for layered network topologies	Partial
• relationships	Partial
• extensible with metadata	
• Pluggable for specific functional modules	
◦ inventory, KPIs	
◦ Note: not everything will be in YANG	
• Any others?	

Modelling Experience: RFC8345 Specific Observations

- Bidirectional links
- Multi-point connectivity (hub and spoke, full mesh, complex)
- We may need additional supporting relationships (TP->Node, Node->Network)
- More Network-related semantic is needed
  - We modelled Tunnels ad Paths via RFC8345 but we lost some semantics that is in RFC8795
  - We modelled all inter-layer relationships via supporting, maybe extend with how underlay is done in RFC8795
  - Relationship Properties
  - Relationship Subtypes
  - Layers / sub-layers
  - Some common roles, balance between simplicity and semantics: primary, backup, aggregation, hub, spoke
- Guideline:
  - use TunnelId versus LinkId for TE

Modelling Experience – High Level Observations

- We successfully modelled entities, properties and relationships layers and technologies in 2 two different labs using RFC8345
- Principles
  - Focus on simple layered topological model
- Open Issues
  - Separation of L2 and L3 Topology
  - Layers versus sublayers
  - Generic IGP routing with paths versus basic OSPF, IS-IS
  - Same technology at different layers (BGP for underlay versus BGP per VPN)
- Guideline:
  - We can extend for new properties but all entities need to augment IETF Network, Node, Link or Termination Point

What's Next?

- Continue our PoC
- Evaluate the technology-specific augmentation, one by one
- How to connect to other YANG modules
  - Progress OSPF and IS-IS drafts
  - SAP & Circuit
- How to fulfil all the digital map requirements
- Side meetings with interesting parties
- Report observations on regular basis to the IETF

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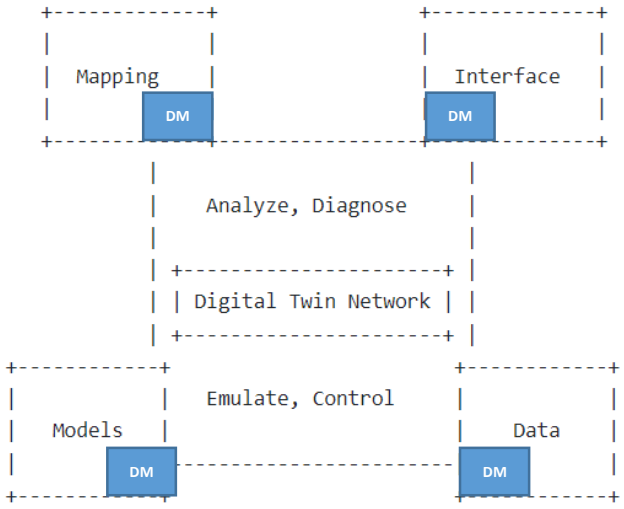
Feedback

- Valid problem?
- What are the/your Core Digital Map Requirements?
- What are your use cases?
- We are here the entire week!

Appendix

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
- 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 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



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