Digital Map
IETF NMOP
Meeting
draft-havel-nmop-digital-map-concept-00

IETF 120 NMOP
26 July 2024
Vancouver, Canada

Presenter: Olga Havel
Authors: Olga Havel, Benoit Claise, Oscar Gonzalez de Dios, Thomas Graf
Agenda

• Updates Since Last Digital Map Interim
• Propose an action plan for Digital Map activities
• Open questions
IETF Digital Map Activities

Generic Digital Map drafts:

Digital Map: Concept, Requirements, and Use Cases (draft-havel-nmop-digital-map-concept-00)
- Olga, Benoit, Oscar, Thomas

Modeling the Digital Map based on RFC 8345: Sharing Experience and Perspectives (draft-havel-nmop-digital-map-01)
- Olga, Benoit, Oscar, Ahmed, Thomas, Nigel

Some Refinements to Network Topologies (RFC8345) (draft-davis-nmop-some-refinements-to-rfc8345-00)
- Nigel, Olga, Benoit

IGP Digital Map drafts:

A YANG Data Model for Intermediate System to intermediate System (IS-IS) Topology (draft-ogondio-nmop-isis-topology)
- Oscar, Samier, Victor, Daniele, Benoit, Olga, Pablo

A YANG Data Model for Open Shortest Path First (OSPF) Topology (draft-ogondio-nmop-ospf-topology)
- Oscar, Samier, Victor

RFC8345 & Augmentation Analysis:

- Olga, Nigel + contributions/feedback from authors

IETF 120 Digital Map Hackathon:

Misc/Hackathons at main · ietf-wg-nmop/Misc (github.com)
- Oscar, Olga, Benoit, Sherif, Pierre, Vivek

RFC8345 bis:

- Side meeting with TEAS: IETF-Meetings/120 at main · ietf-wg-nmop/IETF-Meetings (github.com)
- Started working on RFC8345bis
This document defines the concept of Digital Map, explains its connection to the Digital Twin, and identifies a set of Digital Map requirements and use cases.

Based on recommendation from the NMOP co-chair, this document was extracted from draft-havel-nmop-digital-map-concept

**Rationale (Why?)**
- There is a *lot of interest* and questions about the Digital Map concept and its relationship to the Network Digital Twin.
- Need to *separate* concepts from the experiments and the identified gaps.
- *Ease* collaboration between the various teams and allow for assessment of various approaches to take place in parallel.
- Separate *core design from recommended* approaches going forward and modelling guidelines, more discussion ongoing with different viewpoints.
- *divide-and-conquer* approach to drive *making concrete* progress in this area.

**Expected contribution (What?)**
- Have a *reference document* for the concept of Digital Map, independent of the modelling approach.
- Agree on *key related terms* and their definitions.
- Inventory of a *focused set of target use cases*.
- Identify *requirements* for solution design.
• Terminology for:
  • Digital Twin taken from NMRG definition
  • Topology (it was not defined anywhere in IETF)
  • Topology layer
  • Digital Map
  • Digital Map modelling
  • Digital Map model
  • Digital Map data

• How Digital Map and Digital Twin relate

• What are the use cases and requirements for Digital Map
Next Steps for draft-havel-nmop-digital-map-concept

• We believe it is ready for adoption
  • previous comments addressed
  • important to agree terminology for all other Digital Map activities

• Solicit WG review and feedbacks

• Request WG adoption
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**RFC8345 bis:**

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- Started working on RFC8345bis
draft-havel-nmop-digital-map (status)

• New version submitted
• As per Med’s suggestion, removed the parts that we moved to concept draft
• Added ids for GAPs for ease of referencing, instead numbers
• Added some details to the gaps, added some semantic info
• Added Chapter 4 for summary of the RFC8345 analysis
• Minor updates to conclusions
• Some editorial changes
The RFC 8345 Augmentations Analysis (STATUS)

• Olga and Nigel collaborated on Copy of RFC8345 Augmentations - Google Sheets

• Given the required analysis effort, Med suggested to have a public space to ease collaboration https://github.com/ietf-wg-nmop/Misc/tree/main/Digital-Map-Analysis

• The latest Google Sheet is added to nmop github, updates based on the discussions in Vancouver will be added after IETF120

• Please volunteer to help, add your comments via issues and pull requests or send me an email, it is highly appreciated!!
  • Bo, Med, Qin, Victor, Benoit contributed / reviewed their modules and agree with classification
  • Further reviews in progress
The RFC 8345 Augmentations Analysis (CONCLUSIONS)

• YANG Catalog was initially used to get all augmentations, but we need to do manual evaluation for
• deprecated
• expired
• is it augmentation or import for other purpose
• Current numbers (changing all the time):
• 102 modules relevant for topology (includes 4 RFC8345 modules)
• 27 deprecated (module name changed)
• 23 expired drafts
• 52 active
• Initial results for 52 active:
• 7 are just importing ietf-network and not ietf-network-topology
• 13 are importing ietf-te-topology
• 11 are adding new topological entities, 15 are adding new topological relations, 11 are adding new topology semantics

The RFC8345 augmentations are not consistent, which makes it very hard to deploy the multi-layer digital map. We can expose / understand full layered topology based on RFC8345 for many augmentations, what to do with those 11/15 that are adding topology concepts
IETF120 Digital Map Hackathon

- We demonstrated that IETF RFC8345 is the suitable standard for representing the multi-layered topology for Digital Map.
- The operator may have one ISIS Area in the ISIS Domain or multiple ISIS Areas in the ISIS Domain, there is need for flexibility to model both ways.
- In the case of multiple areas in ISIS Domain, the RFC8345 does not provide the capability for inter-area links.
- We implemented 2 options for comparison.
- We need a new RFC8345 augmentation for the purpose of:
  - Connecting ietf-l3-isis-topology to ietf-isis module.

Option 1

Option 2

L2 Topology

ISIS Topology
Summary of Next Steps for Digital Map Activities

- Adoption of the [draft-havel-nmop-digital-map-concept](#)
- Submit the initial version of RFC8345bis
- More feedback for RFC8345 augmentation analysis from the authors
- New version of other drafts (comments, pull requests, new features)
- IETF121 Hackathon: More layers (SRv6 priority, simple BGP), more operator LABs, more vendors, other use cases, connect to IETF-ISIS better way

We have different opinions if ietf-network-topology (NMOP) or ietf-te-topology (TEAS) is the best basis for modelling the digital map. What about:

- 2 Hackathons at IETF 121, agree the use case
- Pros / cons of both approaches after hackathons, where we can compare API definitions and API request / response examples
- Collect opinions from operators and others
Help Slides
Digital Map Problem Space (I)

- **What do we want to achieve?**
  - How can operators use the IETF topology Yang models to represent a real carrier network.
- **Why? What are the use cases?**
  - Network Inventory Queries
  - Service Placement Feasibility Checks
  - Service->Subservice->Resource
  - Resource->Subservice->Service
  - Intent / Service Assurance
  - Service E2R and Per-Link KPIs on the Digital Map (delay, jitter and loss)
  - Capacity Planning
  - Network Design
  - Ultimately: Digital Twin (What-if, Simulation, Emulation), Closed Loop
- **Goal of current work:**
  - Not boiling the ocean... we start with one particular problem space
  - How to use IETF topology model to represent a real carrier network based on IS-IS domains and OSPF domains for planning/simulation purposes
Digital Map Problem Space (II)

- **Topology Yang models**
  - Topology information is widespread 10s of Yang modules
  - Augmentations cover technology specific details
  - But also cover generic traffic engineering, service attachment points…..

- What happens when doing the exercise to model a real carrier network?
  - Most parameters required appear in several modules
  - Some gaps are found
  - And the limitations of RFC 8345 forces to model in a particular way, requiring some “hacks”
Digital Map Objectives

- Can RFC 8345 YANG model 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, how to build aggregated entities and relationships from the device view to the network-wide and service views

- Does the base RFC 8345 model support the 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?
### Use Cases:
- Network Inventory Queries
- Service Placement Feasibility Checks
- Service->Subservice->Resource
- Resource->Subservice->Service
- Intent / Service Assurance
- Service E2R and Per-Link KPIs on the Digital Map (delay, jitter and loss)
- Capacity Planning
- Network Design
- What-if / Simulation / Emulation
- Closed Loop

### Requirements:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>RFC8345-based</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Basic model with Network, Node, Link, Interface, Layers</td>
<td>Ok</td>
</tr>
<tr>
<td>2. Layered from physical to customer service (intent)</td>
<td>Ok</td>
</tr>
<tr>
<td>3. Open and programmable (read/write for what-if for DM)</td>
<td>Ok</td>
</tr>
<tr>
<td>4. Standard based Digital Map model and API</td>
<td>Ok</td>
</tr>
<tr>
<td>5. Cross-domain</td>
<td>Ok</td>
</tr>
<tr>
<td>6. Semantics for layered network topologies</td>
<td>Partial</td>
</tr>
<tr>
<td>7. Relationships</td>
<td>Partial</td>
</tr>
<tr>
<td>8. Extensible with metadata</td>
<td></td>
</tr>
<tr>
<td>9. Pluggable for specific functional modules</td>
<td></td>
</tr>
<tr>
<td>- inventory, KPIs, ..</td>
<td></td>
</tr>
<tr>
<td>- Note: not everything will be in YANG</td>
<td></td>
</tr>
<tr>
<td>10. Optimized for graph traversal</td>
<td></td>
</tr>
</tbody>
</table>

Different users may use different layers and have different requirements.
The RFC 8345 Augmentations

- We started working on the analysis and categorization of all RFC8345 augmentations and usage

- Categorization:
  - functional (Topology, TE, PM, Inventory, ..)
  - technology (generic, L3, L2, OSPF, IS-IS, ..)
  - extension
    ✓ New attributes
    ✓ New events
    ✓ New relations
    ? New topological entities
    ? New topological relations
    ? New topological semantics
    ✓ New sublayer
    ✓ Usage (e.g. types reuse)

Some challenges for multi-layer digital map (examples):
- topological entities defined outside of RFC8345 for TE tunnel and ttps but pm augments link for VPN tunnels
- topological entities defined outside for RFC8345 for fabric
- subset of underlay defined outside of RFC8345 for TE underlay
- some generic extensions (e.g. cross-domain links) defined in augmentations (e.g. te-topology) but needed for non te augmentations as well
- some roles for topological entities defined in augmentations in custom ways

The RFC8345 augmentations are not consistent, which makes it very hard to deploy the multi-layer digital map
Goal: topological entities and topological relations for all layers of Digital Map could be modelled using RFC8345
## Identified gap

### Bidirectional Links
- Implement via multiple unidirectional links or via virtual nodes (current RFC8345 approach)
- Leave to different augmentations to solve the problem their own way
- Augment RFC8345 via basic approach from draft-davis-opsawg-some-refinements-to-rfc8345
- Augment RFC8345 via sophisticated approach from draft-davis-opsawg-some-refinements-to-rfc8345
- Consider RFC8345bis

### Multipoint Connectivity
- Implement domains via properties in augmentations
- Leave to different augmentations to solve the problem their own way (see how it is done in RFC8795)
- Augment RFC8345 by adding some simple solution (e.g. move RFC8795 approach for multi-domain links to RFC8345)
- Consider RFC8345bis

### Links between networks
- Implement via supporting relationship or via modelling domains in the IP network
- Leave to different augmentations to solve the problem their own way
- Augment Rfc8345 by adding some simple solution
- Consider RFC8345bis

### Networks part of another network
- Use the current approach – this is not problem for read but may be an issue for write
- Augment RFC8345 to optionally allow nodes to be defined outside of the network tree and referenced.
- Consider RFC8345bis

### Nodes, tps, links in multiple networks
- 1. Leave to different augmentations to solve the problem their own way (see how it is done in RFC8795)
- 2. Augment RFC8345 by adding some simple solution (e.g. move RFC8795 approach for multi-domain links to RFC8345)
- 3. Consider RFC8345bis

### Missing Supporting Relationships
- 1. Leave to different augmentations to solve the problem their own way (see how it is done in RFC8795)
- 2. Augment RFC8345 by adding some simple solution (e.g. move RFC8795 approach for multi-domain links to RFC8345)
- 3. Consider RFC8345bis

### Missing Topology Semantics

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### Proposal

- Start the work on RFC8345bis to provide the BACKWARD COMPATIBLE MODEL to support all these limitations
- Evaluate any implementations inside the current augmentations for simplicity and if generic
- 3, 6 and 7: consider RFC8795 approach
- 5: The solution needs further analysis as it has bigger impact on the topology tree than other enhancements
Where to add solutions for the RFC8345 Gaps

• The history:
  • Nigel’s slides
  • Email exchange between Olga/Italo/Nigel
  • Olga and Nigel prefer the approach of using RFC8345bis for the Digital Map core topology module
  • Italo prefers the approach of using the RFC8795 for the Digital Map core topology module
  • There was some discussion about how the gaps were addressed in RFC8795 (but that will be important only if we agree the approach
Some pros for having RFC8345 bis as a core Digital Map Topology Model (backward compatible)

- Simplicity
- Layered Topology from Physical to Service / Flow
- RFC8345 supports any use case because it is focused on topology only – does not have any functional information - it can be added via augmentation or some other way
- While RFC8795 has all functional information for traffic engineering, it may be too complex for core topology model and for some other use cases
- RFC8795 YANG tree – 2243 lines
- Italo presented profiles.
  - Simple json/xml instances
  - Can we get info about what profiles are supported via capabilities?
  - What do app developers need to understand. What is the API definition (TE YANG + profile?)
RFC8345bis Status (1)

- Started identifying sections that need updates
  - Unidirectional Links and Multipoint Descriptions
  - Relationships with Inventory
  - Move text from draft-davis-nmop-some-refinements-to-rfc8345-00 (summaries)
  - YANG Module updates

- Work on YANG Module
- I le in progress for Gap 1 and 2
  - Github: yang based on RFC8345 + draft-davis-nmop-some-refinements-to-rfc8345-00
  - To share after IETF120
RFC8345bis Status (2)

• Side meeting with TEAS, 3 candidate approaches discussed for the core Topology Model for Digital Map:
  • Augment RFC8345 YANG
  • RFC8345bis YANG (our preference)
  • Augment RFC8795 YANG (TEAS preference)

• Presented RFC8345 Gaps, Augmentation Analysis, and why we believe using RFC8345 as the core topology model for digital map is the right approach
• There was lots of discussion but no agreement yet

We have different opinions, what to do next? Our proposal:
• 2 Hackathons at IETF 121, agree the use case
• Pros / cons of both approaches after hackathons, where we can compare API definitions and API request / response examples
• Collect opinions from others
IETF APIs (2 Options)

OPTION 1: ISIS Area modelled as network
(can support links between networks)

- processes grouped in the area via the standard IETF RFC 8345 network->node relationship
- applications and algorithms will understand topologies based on the generic entities and relationships, do not need to understand specific IS-IS attributes
- aligned with the IS-IS topology model and the IS-IS network view in the manuals and documentation, cloud entity exists in the model

OPTION 2: ISIS Area modelled as attributes
(current RFC8345 approach for domains with multiple areas)

- processes grouped in the area via the specific IS-IS property
- generic topology applications would need to understand the IS-IS attribute meaning and IS-IS attribute extensions in order to understand IS-IS topology