Knowledge Graphs for YANG-based Network Management

draft-marcas-nmop-knowledge-graph-yang

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Why NMOP?

The Network Management Operations working group is scoped, in rough order from highest to lowest priority, to:

- Present and discuss ***operational issues*** faced by the deployment of existing network management technologies.
- Discuss ***ideas for future short-term experiments*** (i.e., those focused on incremental improvements to network management operations that can be achieved in 1-2 years) and report on the progress of the relevant experimentation being done in the community.
- Discuss network operator use cases and requirements for ***solving anticipated problems*** related to the deployment of network management technologies.

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Excerpt from NMOP Charter

Problem Statement & Motivation

- AI/ML applications need to easily find, understand, access, and combine **heterogenous silos of data**

- Network Telemetry Framework (RFC9232) outlines such variety
  - Protocols, formats, levels

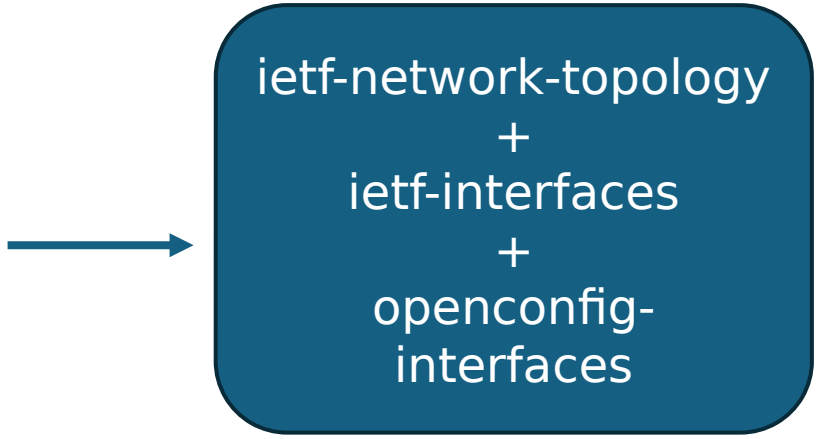
- YANG ecosystem already becomes a challenge:
  - **Tsunami of data models**: Standard, proprietary, open-source (OC, ODL)
  - **Levels of abstraction:** Device, network, service
  - **Protocols:** NETCONF, RESTCONF, YANG Push, gNMI
  - **Formats:** XML, JSON, Protobuf, CBOR

Proposal: Knowledge Graphs

- Enable integration of heterogenous data silos
  - Based on semantic layer built on **formal knowledge representation** (e.g., ontologies)

- Provides **guidelines** for building knowledge graphs from **YANG data**
  1. Graph standards
     - W3C Semantic Web (RDF, OWL) & LPG (Neo4j, ETSI NGSI-LD)
  2. Ontology development
     - Methodologies (Linked Open Terms)
     - Automated knowledge extraction
  3. Knowledge graph construction

- Work result from ongoing research called **CANDIL**
  - CANDIL: A federated data fabric for network analytics, https://doi.org/10.1016/j.future.2024.04.013



Knowledge Graph Applications

- **Service Assurance**
  - SAIN (RFC 9417) is a graph of dependencies between services and symptoms
  - Connection of SAIN graph with other data

```
module: ietf-service-assurance-device

  augment /sain:subservices/sain:subservice/sain:parameter:
    +--rw parameters
      +--rw device    string
```

Figure 1: YANG tree diagram of a subservice augmentation.

- **Network Digital Twins**
  - Paradigm aligned with draft-irtf-nmrg-network-digital-twin-arch
  - Build upon core concepts and mappings defined in draft-havel-nmop-digital-map-concept

- **Data Manifest**
  - draft-ietf-opsawg-collected-data-manifest
  - Explicit representation of contextualized telemetry data

Some Challenges

- Addressing the following challenges will **improve the adoption** of knowledge graphs for network management:
  - **Ontology development**
    - Skills on semantics
    - Mostly manual
  - **Scalability**
    - Distributed and federated architectures
    - Volume of data
    - Real-time use cases
  - **Network configuration**
    - Not only network monitoring

Pending Issues & Next Steps

- Pending Questions
  - #1: Keep focus on YANG?
    - Or broaden the scope with other **data sources like IPFIX or SNMP**?
  - #2: Confirm/infirm whether this is within the NMOP scope

- Next Steps
  - Prototype implementation
    - Creation of knowledge graph from **augmented YANG Library** (draft-lincla-netconf-yang-library-augmentedby)
    - Goal Hackathon in **IETF 121 Dublin**
  - Explore integration with other works within IETF
    - **YANG-Kafka architecture** (draft-ietf-nmop-yang-message-broker-integration)

- Keep collecting feedback from the WG and looking for interested contributors