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KNOWLEDGE GRAPHS FOR NETWORK MANAGEMENT

IETF 118, NMRG 72nd meeting
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Knowledge graphs and semantic interoperability

- **Semantic interoperability** for data heterogeneity [1] [2]:
  - Distributed data management at scale ▸ Data mesh [3]
  - Holistic access to integrated data ▸ Data fabric [4]

- The levels of data modelling [5] [6]:
  - Conceptual (information) level ▸ Business concepts
  - Physical level ▸ Technology-specific (e.g., YANG)

- Knowledge graphs to link the two levels:
  - Machine-readable representation of conceptual data models ▸ Ontologies
  - Self-defining ▸ Data travels with its meaning (semantic metadata)
  - Distributed in nature ▸ URIs for concepts and things

Use Case: YANG Library (RFC 8525)

The concept (class/entity) is the same.

The difference lies in the relationship with this concept - implement vs import.
Use Case: Interface management modules

OpenConfig

module: openconfig-interfaces
  +--rw interfaces
    +--rw interface* [name]
    |  +--rw name            --> ../config/name
    |  +--rw config
    |     +--rw name?        string
    |     +--rw type?        identityref
    |     +--rw mtu?         uint16
    |     +--rw loopback-mode? oc-opt-types:loopback-mode-type
    |     +--rw description? string
    |     +--rw enabled? boolean
    |     +--rw ...

IETF

module: ietf-interfaces
  +--rw interfaces
    |  +--rw interface* [name]
    |     +--rw name            string
    |     +--rw description?    string
    |     +--rw type?           identityref
    |     +--rw enabled? boolean
    |     +--rw link-up-down-trap-enable? enumeration {if-mib}? 
    |     +--ro admin-status    enumeration {if-mib}?

Vendor Proprietary

module: huawei-imf
  +--rw ifm
    |  +--rw global
    |     +--rw statistic-interval? uint32
    |     +--rw ipv4-ignore-primary-sub? boolean
    |     +--rw sub-interface-link-trap-enable? boolean
    |     +--rw ipv4-conflict-enable!
    |     +--rw preempt-enable? boolean
    |     +--rw ipv6-conflict-enable!
    |     +--rw preempt-enable? boolean
    |     +--rw damp!
    |     +--rw tx-off? boolean
    |     +--rw level? boolean
    |          +-(auto)
    |     |     +--rw auto
    |     |     |     +--rw level? damp-level-type
    |     |     |          +-(manual)
    |     |     |          +--rw manual
    |     |     |          +--rw suppress uint32
    |     |     |          +--rw reuse uint32
    |     |     |          +--rw max-suppress-time uint16
    |     |     |          +--rw half-life-period uint16
    |     |     |          +--rw auto-recovery-times
    |     |     |          +--rw auto-recovery-time? [error-down-type]
    |     |          +--rw error-down-type error-down-type
    |     |          +--rw time-value uint32
    |     +--rw interfaces
    |     |  +--rw interface* [name]
    |     |     +--rw name            pub-type?
    |     |     +--rw class? class-type
    |     |     +--rw type? port-type
    |     |     +--rw parent-name?   --> /ifm/
    |     |     +--rw number? string
Ontology development efforts (focus on YANG)

- Linked Open Terms (LOT) methodology [1]
  - Mature methodology, inspired by agile software development
  - Collaboration between domain experts and ontology developers
  - Used in development of standard ontologies (e.g., ETSI SAREF)

- Semi-automatic extraction of knowledge
  - Extract knowledge by analyzing structure of YANG module
  - Examples: YANG list/container refer to entities, YANG leaf to properties/relationships

- MAYA paper [2]
  - Unsupervised ML. Node similarity between YANG leaf nodes
  - Not only structure, but semantics in YANG identifiers, descriptions, type, and references

1. LOT Methodology - https://lot.linkeddata.es
What’s next?

- Ontology development is a hard task
  - Semantic modelling skills
  - Domain expertise
  - Needed for creation of knowledge graphs [1]
  - ... and we are just talking about YANG, thus far

- Looking for feedback/interest from NRMG
  - Explore methodologies/tooling to derive ontologies from YANG models
  - Semantic annotation of YANG data
    - Separate file containing semantic metadata?
    - Leverage YANG annotations? [3]

2. NETMOD Mailing list – “YANG to be replaced by YANBOG? The future of YANG ...”
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THANK YOU!

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