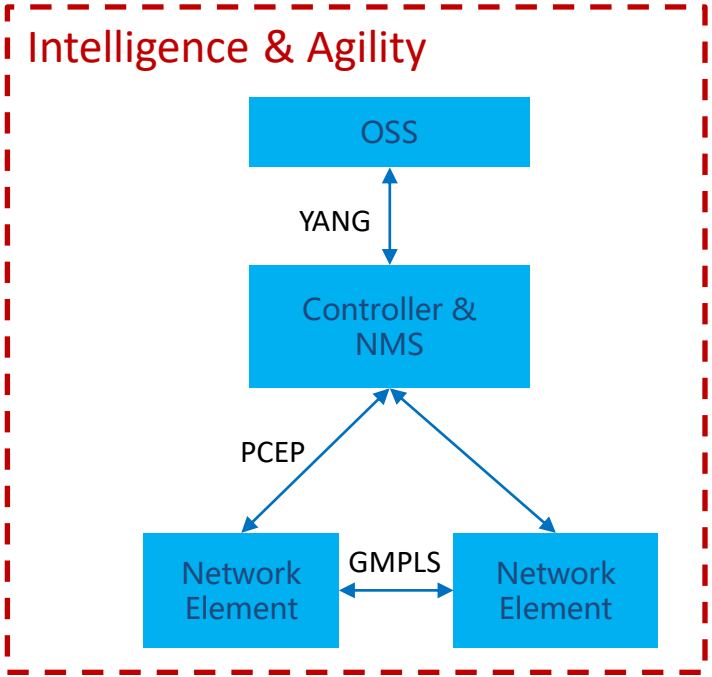
Intelligent and Agile: IETF effort towards the future Optical Networks

Haomian Zheng
IETF Routing Area Directorate Chair

NGON Workshop: June 2023

Outline

- IETF Effort in past decades
  - PCEP/GMPLS from 2005-2015
  - YANG from 2015-Now
- IETF Effort ongoing
  - Intelligence applications
  - Agility protocols
  - Intent-based Networking
  - Digital Twin Architecture



IETF Protocol Work: GMPLS/PCEP

Generalized Multiprotocol Label Switching (GMPLS)

- RFC 3945 — GMPLS Architecture
- RFC 3471 — GMPLS Signaling
- RFC 3473 — RSVP-TE Signaling
- RFC 4202 — GMPLS Routing
- RFC 4203 — OSPF-TE Routing
- RFC 4204 — LMP Discovery

WSON / Flexi-grid Control

- RFC 6163 — WSON RWA Architecture
- RFC 6566 — WSON IA Architecture
- RFC 7698 — Flexi-grid Architecture
- RFC 6205 — WSON Label
- RFC 7446 — WSON RWA info model
- RFC 7699 — Flexi-grid Label
- RFC 7579 — General encoding
- RFC 7689 — WSON RWA RSVP-TE
- RFC 7581 — WSON RWA encoding
- RFC8363 — Flexi-grid OSPF-TE Ext
- RFC 7580 — General constraint OSPF-TE Ext
- RFC 7688 — WSON RWA OSPF-TE Ext
- RFC 7792 — Flexi-grid RSVP-TE Ext

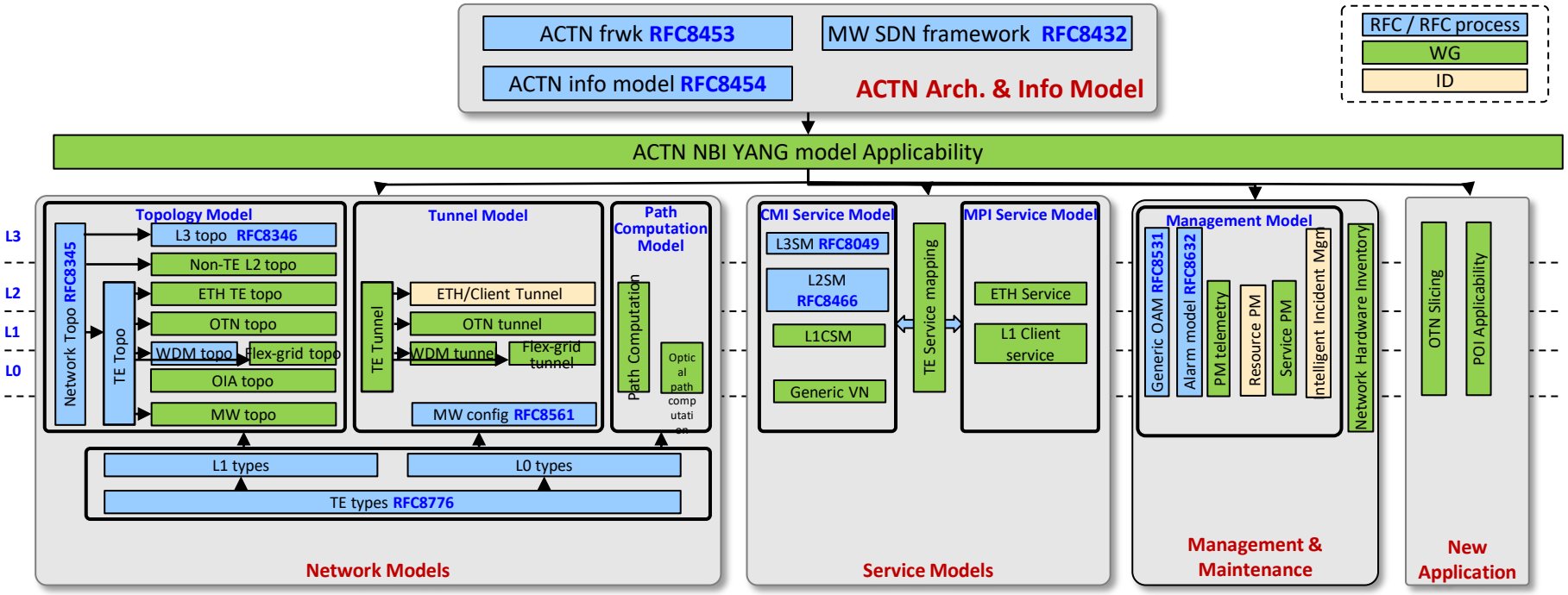
OTN Control

- RFC 4328 — G.709 V1 (ODU1/2/3)
- RFC 7062 — G.709 V3 (ODU0/4/flex)
- RFC 7096 — G.709 info model
- RFC 7138 — G.709 V3 OSPF-TE Ext
- RFC 7139 — G.709 V3 RSVP-TE Ext
- RFC 7892 — ODU signal type IANA registry
- RFC 7963 — New ODU3e1 ODU3e2
- RFC 9376 — B100G ODUCn

Path Computation Element (PCE) Protocol

- RFC 4655 — PCE Architecture
- RFC 5440 — PCE Protocol
- RFC 8231 — Stateful PCEP
- RFC 8281 — PCE Initiation
- RFC 9050 — PCE as Central Controller

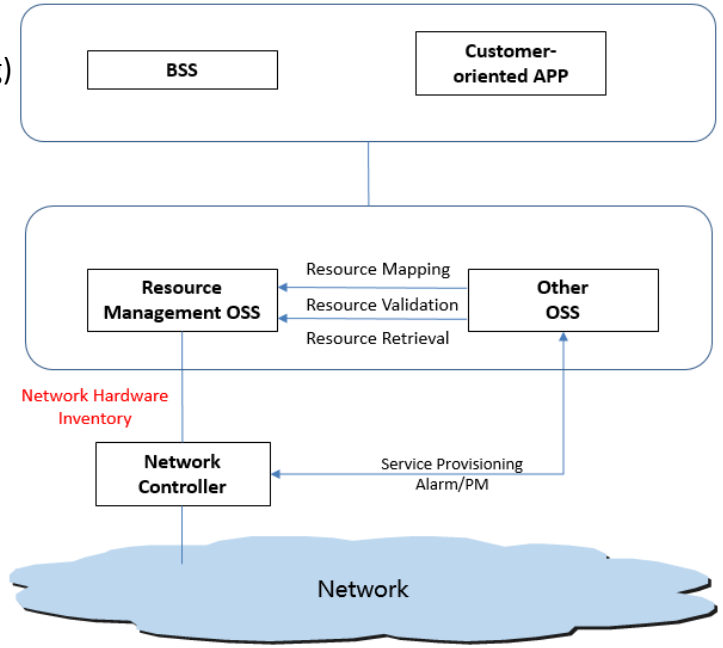
IETF Data Models: T-NBI YANG



- Covers all **L0 ~ L3 network models**, including, e.g., IP/MPLS, OTN, WDM and Microwave
- Covers the **lifecycle management** includes the topology collection, service delivery, management & maintenance
- Models for **new applications** (e.g., POI, slicing) is starting

Data Model for Inventory Management

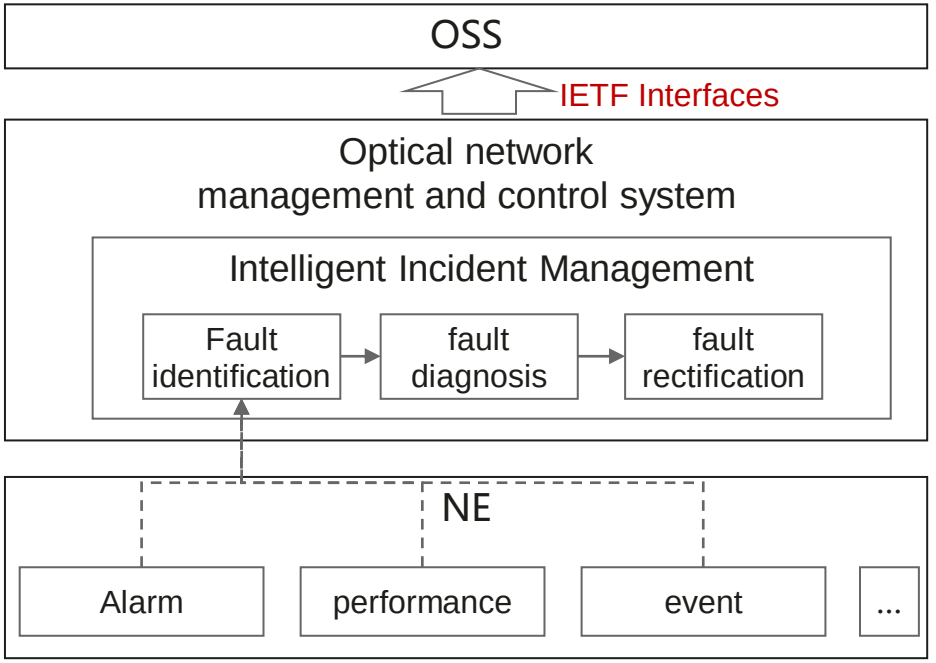
- Challenge：
  - Planning state ≠ Deployment state ≠ Engineering State
  - Manual planning, configuration and commissioning (time-consuming)
- Objective：
  - Make every components visible for retrieval
  - Fast convergence via streaming interfaces
- Enable-technology:
  - Resource Visualization: all data available in data set
  - Accurate Synchronization: real time update for changes
  - Forecast and Warning when risky
  - Automatically configuration for new boards/cards
- Standard effort:
  - Consensus on all the components
  - Clarify the relationship with Topology
  - Standard data model for multi-technologies



https://datatracker.ietf.org/doc/draft-ietf-ccamp-network-inventory-yang/

Intelligent Incident Management

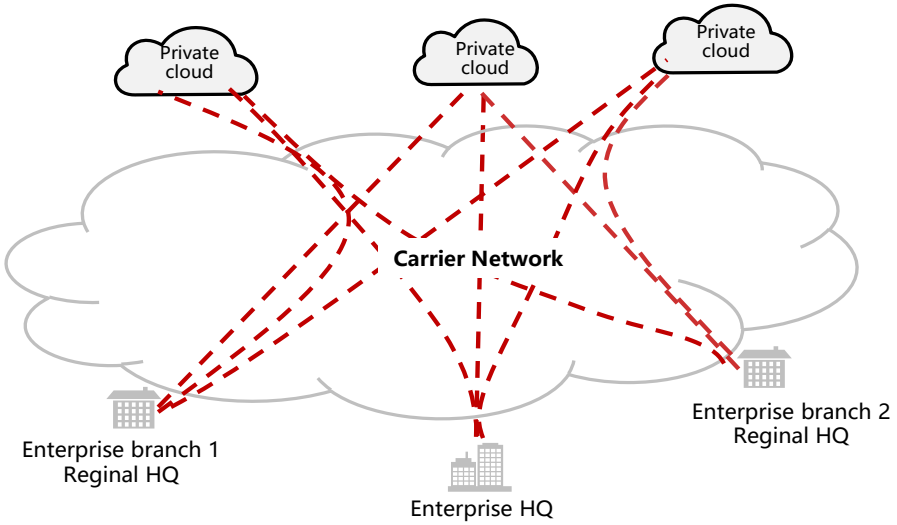
- Challenge
  - Duplicate visiting, inaccurate ticket distribution
  - Massive Alarms caused by one fibre cut
- Objective
  - Accurate Alarm
- Enable-technology
  - Alarm Database via automated collection
  - Root Cause Analysis (RCA) via AI algorithm
  - Procedure improvement on ticket dispatch
  - Integrated with GIS for accurate diagnosis
- Standard effort:
  - Consensus work flow
  - Aligned functional interfaces
  - Standard data model
  - Integrated with existing systems with software update



https://datatracker.ietf.org/doc/draft-feng-opsawg-incident-management/

Agility: OTN connection to Cloud

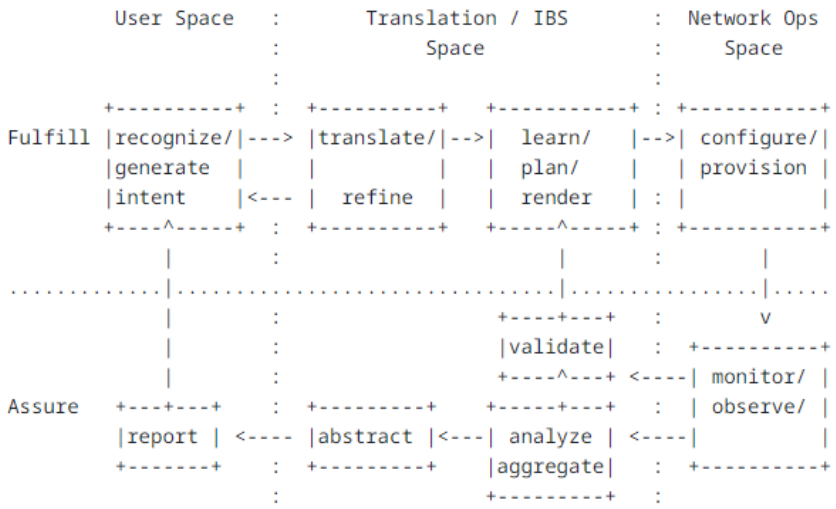
- Challenges
  - Cloud leased line: fast provisioning
  - Agility: dynamic bandwidth adjustment
- Objective
  - Construct connection to cloud for various users
  - With guaranteed qualities and reliabilities
- Enable Technology
  - One-hop Cloud Access for users
  - OTN technologies with ‘finer grid’
  - Fast bandwidth adjustment of data plane
  - Reliability: 1+1+restoration, dynamic rerouting
- Standard effort
  - Scenario Descriptions and functional requirement
  - Gap analysis in architecture and protocol stacks
  - Protocol Extensions on routing, signaling etc.,



https://datatracker.ietf.org/doc/draft-liu-ccamp-optical2cloud-problem-statement/

Intent-based Networking

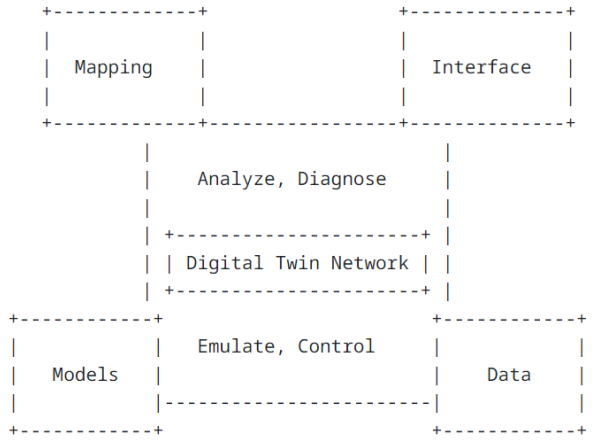
- Challenges
  - Large-scale network with multi-vendor, multi-tech
  - Users only own a few connections in the network
  - Complicated ‘constraints’ in practical operations
- Objective
  - Make user focusing on the output instead of procedure
  - Simplify the representation of complicated network
- Enable Technology
  - Fulfillment: interaction + translation + orchestration
  - Assurance: monitoring + validate + analysis
  - Abstract and Report for close-loop intent
  - APIs allow intent request and query
- IRTF effort
  - Investigate the intent demand for lifecycle management
  - Intent Representation: focus on ‘what’, not ‘how’
  - Collaboration with Service model and Policy
  - Intent Classification



https://datatracker.ietf.org/doc/rfc9315/
https://datatracker.ietf.org/doc/rfc9316/

Digital Twin enables Intelligence & Agility

- Challenges
  - Lack of insights of real-time network status
  - Difficulties in management of analogy signals for optical
- Objective：
  - A real-time representation of an entire network
  - Enhance network efficiency & predict behavior
  - Guide engineers on decision making via simulations
- Enable Technology
  - Real-time data streaming interfaces
  - Intent-driven network management inputs
  - Versatile AI algorithms
- IRTF effort
  - Investigating on Network DT UC and Applications
  - Converging on Network DT Architecture
  - Gap Analysis on APIs



https://datatracker.ietf.org/doc/draft-irtf-nmrg-network-digital-twin-arch/
https://datatracker.ietf.org/doc/draft-francois-nmrg-ai-challenges/
https://datatracker.ietf.org/doc/draft-janz-nmrg-performance-digital-twin/

Summary

- Fundamental Protocol and data model work is maturing
  - GMPLS/PCEP Protocol Stack
  - YANG Data Model for Optical Management & Control

- IETF is driving the vision of Intelligence and Agility, includes
  - Intelligent solutions on specific management problem
  - Extend OTN coverage with higher reliability and agility solutions
  - Evolving from data model to intent-based networking for simplification
  - Architecturally integrated AI/ML in Digital Twin to enhance capabilities

Thank you