



Wireless Backhaul Network and Services Automation:

SDN SBI YANG models (standards.iteh.ai)

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) millimetre Wave Transmission (mWT).

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Modal verbs terminology

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Introduction

Software-Defined Networking (SDN) is an emerging architecture that is dynamic, manageable and cost-effective, making it ideal for the high-bandwidth, dynamic nature of today's applications. Initially, this architecture aimed to decouple the control plane from the data plane allowing the network control to become directly programmable and the underlying infrastructure to be abstracted for applications and network services. The network devices are in that case limited to the data forwarding. On top of the network devices, an intelligent entity, called "controller" sees the network as a whole and directly injects the data processing rules on each device.

This concept did not get wide scale adoption into operator's networks. Therefore, the market quickly evolved and adopted SDN as the set of solutions removing the existing boundaries between the application and network worlds while conserving the integrity of the equipment data and control planes. As a matter of fact, the network is sometimes seen as a brake. Each modification still often requires manual intervention without orchestration in most organizations. Setting up a simple VLAN can sometimes take several days, with the need to configure many devices one by one: switches, routers, firewalls, etc. Thus, the target became naturally on real network issues: allowing applications to program the network in order to accelerate and improve its deployment and operation.

The wireless backhaul network, as with other network segments, is inherently effected by this transformation. As a matter of fact, having open and standardized MW equipment interfaces was identified as the prerequisite for operating a flexible network across different vendors' equipment and multiple technologies. Most MW vendors are currently developing NETCONF/YANG features enabling equipment openness. However, there is with no consensus today on the used data models. Two main MW SDN standards are working on different implementation approaches leading to the lack of a single clear path forward.

The goal of this work is to accelerate the standardization and implementation of necessary (physical and logical) interfaces as well as YANG data models by adopting a use cases-driven automation architecture for the wireless backhaul/X-Haul networks. By this, service providers can select the standards that fit best into their network architecture, while system vendors can develop solutions to address real customer needs.

To this end, a list of relevant attributes to be considered for each use case is proposed. Moreover, an analysis of existing standard YANG models (e.g. ONF, IETF, IEEE) is carried out providing gaps identification with respect to the defined use cases.

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1 Scope

The present document provides information about the standardized YANG data models as they have been developed within IETF, IEEE and ONF to be used in a use cases-driven automation architecture for the wireless backhaul/X-Haul networks. Moreover, it provides gap analysis of existing standard YANG models (e.g. ONF, IETF, IEEE) and it discusses potential implementation issues.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] ETSI GR mWT 016: "Applications and use cases of Software Defined Networking (SDN) as related to microwave and millimetre wave transmission".
- [i.2] IETF RFC 6020 (October 2010): "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)".
- [i.3] IETF RFC 7950 (August 2016): "The YANG 1.1 Data Modeling Language".
- [i.4] IEEE 802.3.2™: "IEEE Standard for Ethernet - YANG Data Model Definitions".
- [i.5] IEEE 802.1™: "IEEE Standard for Local and Metropolitan Area Networks".
- [i.6] IEEE 802.1Qcp™: "IEEE Standard for Local and metropolitan area networks -- Bridges and Bridged Networks -- Amendment 30: YANG Data Model".
- [i.7] IETF RFC 8343: "A YANG Data Model for Interface Management".
- [i.8] IETF RFC 8348: "A YANG Data Model for Hardware Management".
- [i.9] IETF RFC 8561: "A YANG Data Model for Microwave Radio Link".
- [i.10] IETF RFC 8575: "YANG Data Model for the Precision Time Protocol (PTP)".
- [i.11] IETF RFC 8632: "A YANG Data Model for Alarm Management".
- [i.12] draft-liu-dhc-dhcp-yang-model: "Yang Data Model for DHCP Protocol".
- [i.13] draft-ietf-netmod-intf-ext-yang: "Common Interface Extension YANG Data Models".
- [i.14] ONF TR-512 v1.4: "Core Information Model (CoreModel)".

NOTE: Available at https://opennetworking.org/wp-content/uploads/2018/12/TR-512_v1.4_OnfCoreIm-info.zip.

- [i.15] ONF TR-532 v2.0: "Microwave Information Model".
- [i.16] ONF TR-532 v1.1: "Microwave Information Model".

3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AR	Availability Ratio
BBE	Background Block Error
BCA	Bands and Carrier Aggregation
BER	Bit Error Ratio
BSS	Business Support System
CBS	Committed Burst Size
CIR	Committed Information Rate
CM	Current Modulation
C-VLAN	Customer – Virtual Local Area Network
DHCP	Dynamic Host Configuration Protocol
DM	Data Model
EB	Errored Block
EBS	Excess Burst Size
EIR	Excess Information Rate
EMS	Element Management System
ES	Errored Second
FER	Frame Error Ratio
FLR	Frame Loss Ratio
HW	Hardware
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IM	Information Model
IP	Internet Protocol
LLDP	Link Layer Discovery Protocol
LOS	Line Of Sight
MAC	Media Access Control
MSE	Mean Square Error
MTBF	Mean Time Between Failures
MTU	Maximum Transmission Unit
MW	MicroWave
N.A	Not Available
NE	Network Element
NMS	Network Management System
OI	Outage Intensity
ONF	Open Networking Foundation
OPEX	Operational Expenditure
OSS	Operations Support System
PCP	Priority Code Point
PEA	Percent Ethernet service Availability
PEU	Percent Ethernet service Unavailability
QoS	Quality of Service
RF	Radio Frequency
RFC	Request For Comment
RSL	Received Signal Level

SBI	SouthBound Interface
SDN	Software Defined Networking
SES	Severely Errored Second
SNR	Signal to Noise Ratio
S-VLAN	Service - Virtual Local Area Network
TTL	Time To Live
UML	Unified Modeling Language
UR	Unavailability Ratio
VLAN	Virtual Local Area Network
XPIC	Cross-Polarization Interference Cancelling
YANG	Yet Another Next Generation

4 Centralized Wireless Backhaul/X-Haul Automation Controller Value

4.1 Benefits

One of the main challenges that service providers face today is to improve end-users' satisfaction - e.g. delivering or upgrading to a new service, whilst having to control multiple isolated-managed and often complicated network systems. This urgently results to the need to increase operational efficiency and enable network agility and programmability. The introduction of the concept of smart network and services automation can be a catalyst towards such business and operational objectives and figure 1 illustrates the foreseen benefits when deploying a centralized wireless backhaul/X-Haul domain controller to address automation.

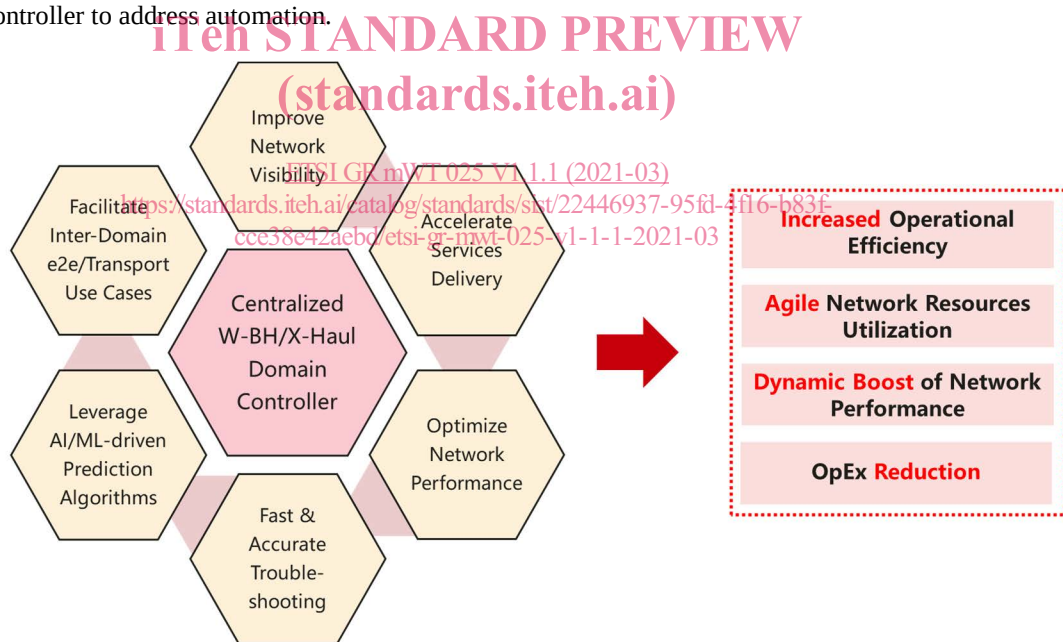


Figure 1: Smart Network and Services Automation Benefits

4.2 Key Success Factors

In order to benefit from automation, open and standardized network interfaces and data models should be used. In addition, the required set of data models have to be technically effective and mature, allowing ease of implementation and future upgrades whilst also taking care of backwards compatibility. Last, but not least, any use case driven automation initiative needs industry-wide collaboration, among service providers and technology makers, to achieve commonly accepted standardized and open interfaces at scale. Figure 2 captures the aforementioned key factors for successful deployments when establishing a network automation framework, which of course applies in the context of centralized wireless backhaul/X-Haul domain controller, as well.



- Full potential of automation can be unleashed with **open & standardized network interfaces & data models**.



- Required set of data models have to be **technically effective & mature, allowing ease of implementation & future upgrades** (taking care of backwards compatibility).



- Use cases-driven automation needs **industry-wide collaboration** to achieve standardized & lean interfaces.

Figure 2: Key Success Factors for Smart Network & Services Automation

4.3 Architecture

The architecture considered in this work is depicted in figure 3. The focus is on the YANG data models to be implemented on the Network Element (NE) level to enable automated operations across multi-vendor MW domain through the SouthBound Interface (SBI) (red interface in figure 3). Any other interfaces that can exist in a real network topology (e.g. with the hierarchical controller, other transport domain controllers, etc.) are out of the scope of the present document and they are only shown to indicate that the wireless backhaul/X-haul domain controller can be part of a wider SDN architecture for transport and end-to-end network and services automation framework.

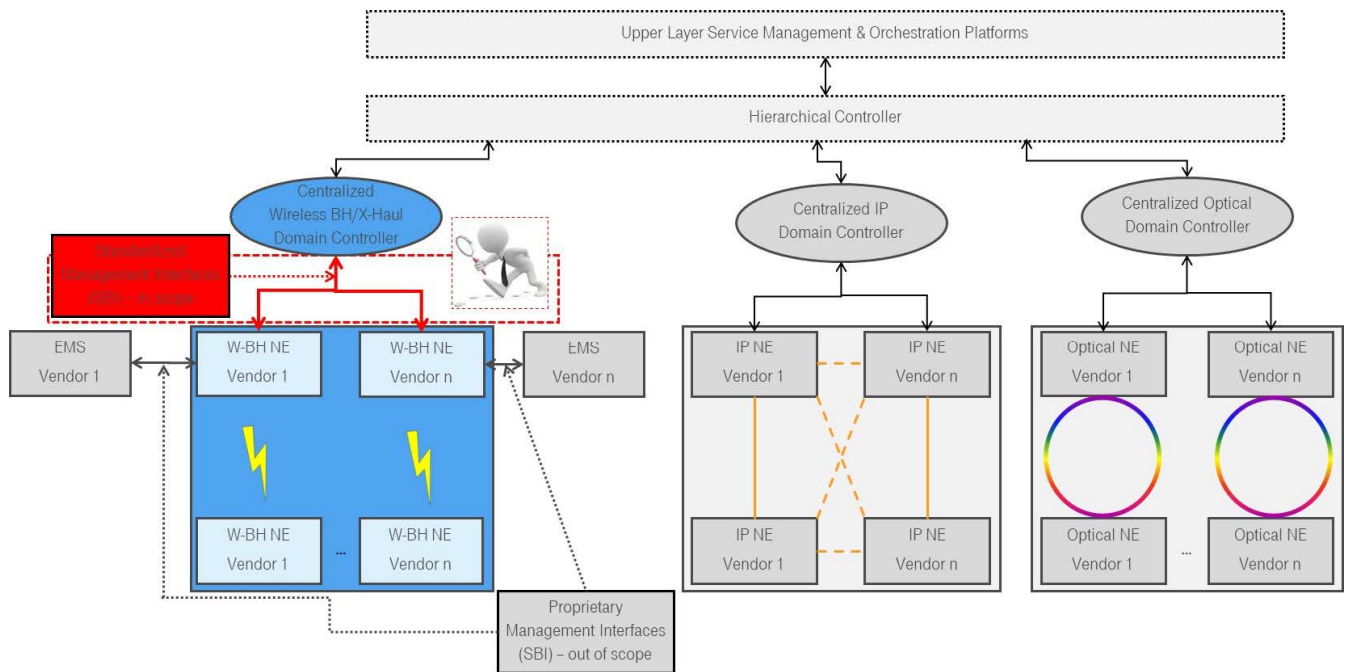


Figure 3: Centralized Wireless Backhaul/X-Haul Domain Controller Architecture

5 Automation Use Cases Analysis

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5.1 Network and Service Auto-discovery

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5.1.1 Motivation

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The use case area of network and service discovery can be broken down into two logical applications.

Auto-Discovery - Traditional microwave NE deployment procedures can often be more complex than other transport technology domains due to the detailed planning, coordination, spectrum license applications and configuration of physical layer radio attributes before commissioning can take place. In addition, the initial installation procedure typically requires significant time and effort from expert resource before higher layer protocols can be established for further configuration and service provisioning. A standardized and interoperable SBI has the potential for near real-time integration of multi-vendor NE with centralized network planning tools to automate or assist commissioning, optimization and validation of new radio links.

NE Capabilities and Domain Characteristics - The ability to track and query configuration capabilities and active topology of the network underpin the management ability of the operator. An SDN ambition for the operator is the ability to provision end to end services regardless of the underlying transport technology. This can only be realized with effective technology domain abstraction where technology specific automation (based on NE capabilities and topology) can be handled by domain controllers. A standardized super-set of technology specific capabilities (e.g. physical links, ports, HW profile and services) would allow network services to be implemented in multi-vendor, multi-technology domain.

5.1.2 Expected value

The most significant benefit for operators of automatic discovery of NE (which in turn facilitates automated or semi-automated commissioning and inventory systems) is through OPEX cost savings. Deployment of microwave transmission equipment is a particularly costly and time consuming procedure where standardized interfaces and data models can enable faster time to market and enable greater flexibility of suppliers and supplier equipment without the (often cost prohibitive) proprietary NMS/OSS/BSS integration.

Auto-discovery of network equipment topology and capabilities also could enable seamless integration of new applications for near real-time visualization of microwave link information relevant to planning and operational teams. New applications could permit accurate and frequent asset and inventory management tasks, track upgrades and their impacts, re-configuration and security patching across all domains. Where such procedures are currently manual or part-manual processes there is significant scope for error and inaccuracy which could be removed through automated configuration audits and automatic correction against the target/desired configuration.

5.1.3 Functionality description

Network and Services auto-discovery is a function that will allow to automatically detect and connect new microwave nodes to a management system and to retrieve inventory information from the node.

5.1.4 Gap analysis in standard models

Table 1: UC1 Gap Analysis

Attribute	ONF		IETF/IEEE	
	Parameter Name	Model/Submodel	Parameter Name	Model/Submodel
Per Hardware Instance (i)				
Model Number	model-identifier	ONF TR-512 v1.4 [i.14]	model-name/ physical-index	ietf-hardware (IETF RFC 8348 [i.8])
Model Version	version	ONF TR-512 v1.4 [i.14]	model-name	ietf-hardware (IETF RFC 8348 [i.8])
Serial Number	serial-number	ONF TR-512 v1.4 [i.14]	serial-num	ietf-hardware (IETF RFC 8348 [i.8])
Hardware Version	part-type-identifier	ONF TR-512 v1.4 [i.14]	hardware-rev	ietf-hardware (IETF RFC 8348 [i.8])
Modem Version	n.a (under development)	-	firmware-rev/ software-rev	ietf-hardware (IETF RFC 8348 [i.8])
NE Name	control-construct/name or control-construct/label	ONF TR-512 v1.4 [i.14]	name	ietf-hardware (IETF RFC 8348 [i.8])
NE Description	control-construct/name or control-construct/label	ONF TR-512 v1.4 [i.14]	description	ietf-hardware (IETF RFC 8348 [i.8])
Firmware Version	n.a (under development)	-	firmware-rev	ietf-hardware (IETF RFC 8348 [i.8])
Software Version	n.a (under development)	-	software-rev	ietf-hardware (IETF RFC 8348 [i.8])
Data Model Version	n.a but communicated during netconf session	-	Revision statement	ietf-hardware (IETF RFC 8348 [i.8])
Interface Id	control-construct/logical- termination-point/layer- protocol/local-id	ONF TR-512 v1.4 [i.14]	Uuid(IETF RFC 8348 [i.8])/ if-index(IETF RFC 8343 [i.7])/ id(IETF RFC 8561 [i.9])	ietf-hardware (IETF RFC 8348 [i.8])/ ietf-interfaces(IETF RFC 8343 [i.7])/ ietf-microwave-radio-link (IETF RFC 8561 [i.9])
Chassis id	control-construct/top-level- equipment/uuid (core- model)	ONF TR-512 v1.4 [i.14]	physical-index	ietf-hardware (IETF RFC 8348 [i.8])
Per Radio Interface (i)				
RF Enabled	transmitter-is-on receiver-is-on	ONF TR-532 v2.0 [i.15]/air- interface-configuration	tx-enabled	ietf-microwave-radio-link (IETF RFC 8561 [i.9])
Channel Spacing/Duplex	duplex-distance-list	ONF TR-532 v2.0 [i.15]/air- interface-capability	channel- separation/ duplex- distance	ietf-microwave-radio-link (IETF RFC 8561 [i.9])