5G RAN and Wireless xHaul (formerly WTP) Modeling, Testing, and Implementation in collaboration with O-RAN and Linux Foundation

Contributors (in alpha order; speakers’ names underlined)

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ONF SDN Models

• Development of the ONF Core Model
• Extension to Photonic and Wireless Technologies
• Implementation and Testing
Modelling SDN

The Core model provides a standardized implementation-neutral representation of things and the relationship between those things in the SDN problem space

- Network functions. *Model focus:*
  - Virtualized termination/forwarding in any network
- Physical Equipment supporting the network. *Model focus:*
  - Field Replaceable Units (FRUs), non-FRUs, strands etc.
- Control functions supporting the network. *Model focus:*
  - Representation of functions related to closure of control loops
  - Presentation of views of the resources for the purpose of control
- Processing functionality supporting/using the network. *Model focus:*
  - Any abstract function
- Resource/System/Scheme specifications. *Model focus:*
  - Constraints, rules and specs for the overall systems
- Software supporting the control
  - Files, Installed Software, Containers, VMs,

Most recent focus has been on Analogue Guided Media networks, using photonic networks as the key application.

TR-512.A.4 provides the explanation of the use of the Core Model for photonic networks.

This work has been used extensively by OTCC and Facebook TIP
Model to create a common language

- Goals:
  - A well defined widely applicable representation of the *semantics* of managed network functionality that is *lightweight*, has a *modular* architecture and is technology/technique *agnostic*
  - Reduce the formation of overlapping inconsistent implementations which hinder overall progress

- Approach:
  - Leverage industry best-practices, patterns and tools to close the *model to implementation* round trip loop
  - Use Agile modelling methodology to construct a formal model using Papyrus UML
    - A graphical modeling language highlights underlying patterns
    - The environment provides a framework for:
      - Development of understanding about control of networks
      - Capturing a representation of the understanding
      - Maintaining growing insight
  - Promote Core Model use/extension

- Use:
  - Derivation of Interface/database models using generators to generate consistent artefacts in JSON, Yang etc.
Core Model: TR-512 v1.4

- A suite of description documents and XMI encoded UML constructs and diagrams.
Canonical network model (virtualized/functional): Forwarding, Termination and Topology

Model for any networking, for any network technology, with any degree of virtualization, at any scale, at any abstraction and in any interrelated view.
Photonic network analysis and modeling

Modelling of fundamental functions

Modelling of Aggregated functions

Modelling of Devices

Modelling of Networks

Using the model entities to represent photonics at all scales gives a consistent model regardless of the degree of aggregation etc.
PoCs & plugfests followed by pilots and/or PIZ (Production Innovation Zone)

- PoC AS FUNDAMENTAL STEP OF ‘IMPLEMENTATION DRIVEN STANDARD’

1. DEVELOP THE “MODEL”
2. DEVELOP DEFAULT VALUE MEDIATOR
3. DEVELOP INTERFACE VALIDATOR
4. IMPLEMENT THE STANDARD IN DEVICES AND CONTROLLER

Proof Of Concept (PoC) is the ‘central event’ of a recursive approach for standard improvement and open SW source delivery.

Feedbacks from PoC to improve the standard:
- Frozen spec
- Frozen yang
- Frozen open source SW

STANDARD RELEASED (version x.x)
PoC = ONAP (ODL) WIRELESS CONNECTED DEVICES (AS EXAMPLE)
PILOT = 5G xHaul Network Automation

- Automation requires end2end network representation, which consolidates all device types, all vendors and OSI layers 0-4 in a single network topology
- Ceragon, Deutsche Telekom, Ericsson, Huawei, Infinera, Nokia, SIAE Microelettronica and Telefonica commonly defined a set of complementary information models based on the ONF Core IM:
  - Wire Equipment (SFP handling)
  - Radio Interface (ONF TR-532)
  - Wire Interface (based on IEEE 802.3)
  - Ethernet (incl. Queueing, Scheduling, Shaping)
  - Ethernet MAC
  - VLAN (based on IEEE 802.1Q-2018)
  - Basic IP Interface and Layer3VPN
Joint 5G-xHaul SDN Pilot

- AT&T, Deutsche Telekom and Telefonica are inviting Operators for parallel execution of SDN tests, trials and pilots
- Newly defined information models shall be tested
- Components (e.g. mediators, applications) will be re-used and know-how will be shared
- Individual, live network testing (instead of PoC) conforms with increased maturity of the technology and fosters deeper involvement of participating organizations
- Software Providers are invited to present own Applications based on the common information models at participating Operators
O-RAN component diagram for 5G RAN (3GPP++)
ONF + O-RAN + ONAP (as SMO) integration

Service Management and Orchestration Management - Service (MnS)

Message bus (e.g. DMaP)

CDS

Non-RT-RIC (A1 and O1)

HV-VES Collector (FCAPS)

VES Collector (FCAPS)

Near-Real-Time RAN Intelligent Controller (RIC)

O-CU-CP

O-CU-UP

O-DU

O-RU

Open Fronthaul

Standard VES collector for rare events like CM, FM.

High Velocity VES collector (HV-VES) for real-time event streaming needed for PM.

O1*: Interface between Service Management and Orchestration Framework and Infrastructure Management Framework supporting O-RAN virtual network functions.

2019-08 will be available later in document "O-RAN Orchestration".
Proposed use cases for ONF / LFN PoC week of December 2\textsuperscript{nd} 2019*

- Physical Network Function (PNF) Plug and Play (PnP)
  
  https://wiki.onap.org/pages/viewpage.action?pageId=40206485

- PM Bulk request
  
  https://wiki.onap.org/pages/viewpage.action?pageId=40206494

- Basic fault

- Basic configuration
  - Read
  - Write

- OOF-based 5G SON use cases

Open topics:
- Dynamic VES subscription mechanism
  - Under discussion by O-RAN and 3GPP
  - Simplification for Demo: pre-configuration of the O-RAN PNF with necessary VES collector information (IP, credentials)

* Coincides with first release O-RAN-SC “Amber” and ONAP rel 5 El Alto (may include add’l ONF entities)
PNF Plug and Play Message flow

1. O-RAN PNF sends VES pnfRegistration – preferred IPv6/TLS
2. Controller (O1) becomes awareness of the new O-RAN PNF via Message bus
3. Controller (O1) checks NetConf end-point on the O-RAN PNF (hello-message) – preferred: IPv6/TLS
5G SON use case example: PCI Optimization using OOF

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<thead>
<tr>
<th>Step</th>
<th>Functionality</th>
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</thead>
<tbody>
<tr>
<td>1a-1d</td>
<td>All modules loaded to support PCI</td>
</tr>
<tr>
<td>2</td>
<td>PCI-Handler MS fetches configuration policies from Policy</td>
</tr>
<tr>
<td>3</td>
<td>Config change notification from RAN to SDN-C (e.g. Nbr list change)</td>
</tr>
<tr>
<td>4a</td>
<td>SDN-C publishes config data change on DMaaP to PCI-Handler-MS.</td>
</tr>
<tr>
<td>4b</td>
<td>PCI-Handler MS obtains relevant info from SDN-C (REST API call)</td>
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<tr>
<td>5</td>
<td>PCI-Handler MS invokes OOF for pre-defined workflow for PCI Optimization (REST API call)</td>
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<tr>
<td>6</td>
<td>OOF gets PCI optimization policies from Policy</td>
</tr>
<tr>
<td>7</td>
<td>OOF queries SDN-C database to fetch data for cells in the region (REST API call)</td>
</tr>
<tr>
<td>8</td>
<td>OOF provides PCI Optimization result to PCI Handler MS (REST API call)</td>
</tr>
<tr>
<td>9</td>
<td>PCI-Handler-MS provides PCI recommendation to Policy on DMaaP</td>
</tr>
<tr>
<td>10</td>
<td>Policy sends message to SDN-C with instruction for PCI configuration changes on DMaaP</td>
</tr>
<tr>
<td>11</td>
<td>SDN-C applies config changes via Netconf</td>
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(SDN-C work done in SDN-R team)
Issues and next steps (a partial list)

- Ongoing efforts to maintain consistency among IM, UML, and YANG (this is non-trivial!)
- Reconcile open information models across multiple open source projects, e.g. ONF, ONAP, O-RAN (one can have too many models!)
- Prosumer® relationships among open source projects and SDOs, as one is expected to provide/consume the other’s work products (and vice versa)
Thank You

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