J. Ahlberg
Ericsson AB
LM. Contreras
TID
A. Ye Min
Huawei
M. Vaupotic
Aviat Networks
J. Tantsura
Individual
K. Kawada
NEC Corporation
X. Li
NEC Laboratories Europe
I. Akiyoshi
NEC
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A framework for Management and Control of microwave and millimeter wave
interface parameters - problem statement
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Abstract

   To ensure an efficient data transport, meeting the requirements
   requested by today's transport services, the unification of control
   and management of microwave and millimeter wave radio link interfaces
   is a precondition for seamless multilayer networking and automated
   network wide provisioning and operation.

   This document describes the required characteristics and use cases
   for control and management of radio link interface parameters using a
   YANG Data Model. It focuses on the benefits of a standardized
   management model that is aligned with how other packet technology
   interfaces in a microwave/millimeter wave node are modeled, the need
   to support core parameters and at the same time allow for optional
   product/feature specific parameters supporting new, unique innovative
   features until they have become mature enough to be included in the
   standardized model.

   The purpose is to create a framework for identification of the
   necessary information elements and definition of a YANG Data Model
   for control and management of the radio link interfaces in a
   microwave/millimeter wave node.

Status of This Memo

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1. Introduction

   Network requirements vary between operators globally as well as
   within individual countries. The overall goal is however the same -
   to deliver the best possible network performance and quality of
   experience in a cost-efficient way.

   Microwave/millimeter wave (hereafter referred to as microwave, but
   including the frequency bands represented by millimeter wave) are
   important technologies to fulfill this goal today, but also in the
   future when demands on capacity and packet features increases.
   Microwave is already today able to fully support the capacity needs
   of a backhaul in a radio access network and will evolve to support
   multiple gigabits in traditional frequency bands and beyond 10
   gigabit in the millimeter wave. L2 packet features are normally an
   integrated part of microwave nodes and more advanced L2 and L3
   features will over time be introduced to support the evolution of the
   transport services to be provided by a backhaul/transport network.

   The main application for microwave is backhaul for mobile broadband.
   Those networks will continue to be modernized using a combination of
   microwave and fiber technologies. The choice of technology is a
   question about fiber presence and cost of ownership, not about
   capacity limitations in microwave. In 2020, more than 65% of all
   cell sites are expected to be connected with microwave solutions.

Open and standardized interfaces are a pre-requisite for efficient management of equipment from multiple vendors. This framework addresses management and control of the radio link interface(s) and the relationship to other packet interfaces, typically to Ethernet interfaces, in a microwave node. A radio link provides the transport over the air, using one or several carriers in aggregated or protected configurations. Managing and controlling a transport service over a microwave node involves both radio link and packet functionality.

Already today there are numerous IETF data models, RFCs and drafts, with technology specific extensions that cover a large part of the packet domain. Examples are IP Management [RFC7277], Routing Management [I-D.ietf-netmod-routing-cfg] and Provider Bridge [PB-YANG]. They are based on RFC 7223 [RFC7223], which is the IETF YANG model for Interface Management, and is an evolution of the SNMP IF-MIB [RFC 2863].

Since microwave nodes will contain more and more packet functionality and the interfaces for those technologies are expected to be managed using those models, there are advantages if radio link interfaces can be modeled and be managed using the same structure and the same approach, specifically for use cases in which a microwave node are managed as one common entity including both the radio link and the packet functionality, e.g. at installation, initial setup, trouble shooting, upgrade and maintenance. All interfaces in a node, irrespective of technology, would then be accessed from the same core model, i.e. RFC 7223, and could be extended with technology specific parameters in models augmenting that core model. The relationship/connectivity between interfaces would be given by the equipment configuration and slot positions or be configured via management systems or controllers.

```
+---------------------------------------------------------------------+
|  Interface [RFC7223]                                                |
|                 +------------------+                                |
|                 |Ethernet Port     |                                |
|                 +------------------+                                |
|                       \                                             |
|                    +----------------------+                         |
|                    |Radio link terminal   |                         |
|                    +----------------------+                         |
|                           \                                         |
|                        +------------------------+                   |
|                        |Carrier termination     |                   |
|                        +------------------------+                   |
+---------------------------------------------------------------------+
```
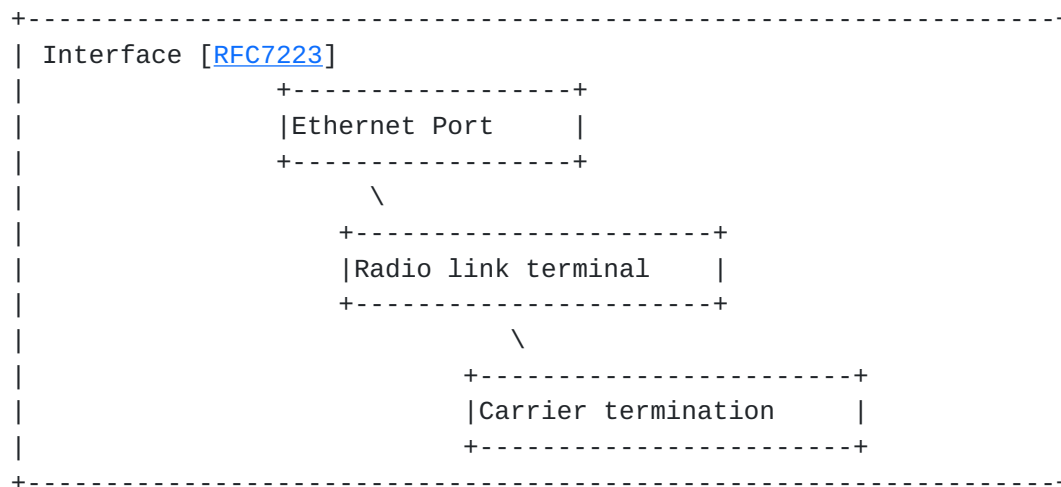
Figure 1: Relationship between interfaces in a node

There will always be certain implementations that differ among
products and it is therefore practically impossible to achieve
industry consensus on every design detail. It is therefore important
to focus on the parameters that are required to support the use cases
applicable for centralized, unified, multi-vendor management and to
allow other parameters to be optional or to be covered by extensions
to the standardized model. Furthermore, a standard that allows for a
certain degree of freedom encourages innovation and competition which
is something that benefits the entire industry. It is therefore
important that a radio link management model covers all relevant
functions but also leaves room for product/feature-specific
parameters.

For microwave radio link functionality work has been initiated (ONF:
Microwave Modeling [ONF-model], IETF: Radio Link Model [I-D.ahlberg-
ccamp-microwave-radio-link]). This effort is expected to take these
initiatives into consideration and complement them on the gaps
identified with the ambition to reach consensus within the industry
around one common approach.

2. Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
document are to be interpreted as described in RFC2119 [RFC2119].

3. Terminology and Definitions

Software Defined Networking (SDN) is an emerging architecture that
decouples the network control and forwarding functions enabling the
network control to become directly programmable and the underlying

infrastructure to be abstracted for applications and network
services. This results in an extremely dynamic, manageable, cost-
effective, and adaptable architecture that gives administrators
unprecedented programmability, automation, and control. The SDN
concept is widely applied for network management, the adoption of SDN
framework to manage and control the microwave and millimeter wave
interface is one of the key applications of this work.

Microwave is a band of spectrum with wavelengths ranging from 1 meter
to 1 millimeter and with frequencies ranging between 300 MHz and 300
GHz. Microwave radio technology is widely used for point-to-point
telecommunications because of their small wavelength that allows
conveniently-sized antennas to direct them in narrow beams, and their
comparatively higher frequencies that allows broad bandwidth and high
data transmission rates.

Millimeter wave is also known as extremely high frequency (EHF) or
very high frequency (VHF) by the International Telecommunications
Union (ITU), which can be used for high-speed wireless broadband
communications. Millimeter wave is an undeveloped band of spectrum
that can be used for a broad range of services on mobile and wireless
networks including high-speed, point-to-point wireless local area
networks (WLANs) and broadband access. This band has short
wavelengths that range from 10 millimeters to 1 millimeter, namely
millimeter band or millimeter wave. The 71 - 76 GHz, 81 - 86 GHz and
92-95 GHz bands are used for point-to-point high-bandwidth
communication links, which allows for higher data rates up to 10
Gbit/s but requires a license. Unlicensed short-range data links can
be used on 60 GHz millimeter wave. For instance, the upcoming IEEE
Wi-Fi standard 802.11ad will run on the 60 GHz spectrum with data
transfer rates of up to 7 Gbit/s.

Carrier Termination is an interface for the capacity provided over
the air by a single carrier. It is typically defined by its
transmitting and receiving frequencies.

Radio Link Terminal is an interface providing packet capacity and/or
TDM capacity to the associated Ethernet and/or TDM interfaces in a
node and used for the capacity required for setting up a transport
service over a microwave/millimeter wave link.

4. Application

This framework addresses the definition of an open and standardized
interface for the radio link functionality in a microwave/millimeter
wave node. The application of such an interface used for management
and control of nodes and networks typically vary from one operator to

another, in terms of the systems used, what they are called and how
they interact.

4.1. Network Management Solutions

The classic network management solutions, with vendor specific domain
management combined with cross domain functionality for service
management and analytics, still dominates the market.

These solutions are expected to evolve and benefit from an increased
focus on standardization by simplifying multi-vendor management,
remove the need for vendor/domain specific management, and enabling
use of open source systems.

4.2. Software Defined Networking

SDN is another application emerging on the market. The main drivers
for SDN introduction from an operator perspective is simplification
and automation of network provisioning as well as E2E network
services. The vision is to have a global view of the network
conditions spanning across different vendors' equipment and multiple
technologies. A variety of different SDN architectures and functions
are being discussed and proposed within the industry, but they all
have in common a very clear relationship to network management. In
some proposals the SDN controller completely replaces the role of a
network management system while in some cases the SDN controller is
seen as an entity managed by the NMS. In any case the SDN functions
shall be seen as part of an overall NMS strategy, no matter how the
functionality is partitioned across units and no matter what
terminology is used.

If nodes from different vendors shall be managed by the same SDN
functions, without the extra effort of introducing mediation layers,
all nodes must align their interfaces. Hence, open and standardized
node interfaces are closely associated with the introduction of SDN.

4.2.1. SDN example of radio link configuration

Radio link terminals comprising a group of carriers are widely used
in microwave technology. There are several kinds of groups:
aggregation/bonding, 1+1 protection/redundancy, etc. To avoid
configuration on each carrier termination, a logical control provides
flexible management without configuring parameters on each carrier
termination directly. An operator using SDN manages radio links by
selecting an allowed operation mode. Alternatively, an operator can
prefer the complete configuration of all the parameters of interest.
Such case is not described in the document for simplicity). The
operation mode is a set of logical metrics or parameters describing a

complete radio link configuration, such as capacity, availability,
priority and power consumption.

```
+------+        +-----+                  +-----+        +-------+
|      |-------| CT1 |   ~~~~~~~~~~    | CT1 |-------|       |
|      |        +-----+                  +-----+        |       |
| RLT1 |                                               | RLT2  |
|      |        +-----+                  +-----+        |       |
|      |-------| CT2 |   ~~~~~~~~~~    | CT2 |-------|       |
+------+        +-----+                  +-----+        +-------+
```

Figure 2: Radio link example

Example of an operation mode table is shown Table 1. One mode (ID =
1) provides high capacity but requires high power consumption;
another mode (ID = 2) provides low power consumption but low
capacity. SDN controller selects one of the operation modes
dynamically, according to the actual capacity need.

ID	Description	Capacity	Availability	Priority	Power
1	High capacity	400	99.9%	Low	High
2	High avail-	100	99.999%	High	Low
	ability				

Figure 3: Example of an operation mode table

The procedure of logical control is as following:

1/ SDN controller gets the supported operation modes by reporting
from the node NE or by other means, e.g., NMS.

2/ According to its operation policy, SDN controller selects one
operation mode from the table and translates that into the required
configuration of the individual parameters for the radio link
terminals and the associated carrier terminations.

The operation mode could be selected based on power consumption.

Nowadays, more and more operators have strong requirement to decrease
the node power consumption. The SDN controller can monitor the real
time traffic distribution, and generated corresponding policy: to set
the operation mode to high capacity on the radio links with heavy

traffic load; to set the operation mode to low power consumption on
the radio links with light traffic load

Radio link aggregation/bonding is widely used in microwave: multiple
carriers are used to carry the traffic in cases where the needed
capacity is beyond the capability of single carriers. During night
time, the actual traffic load may be 1/3 of the peak day time. The
operation mode of low power consumption could be set to turn off some
of the radios within the group to save power consumption.

The operation mode could also be configured based on traffic
priority.

For high priority traffic, it is necessary to assure high
availability. On the other hand, low priority traffic is often high
volume and requires high capacity. The SDN controller can generate
corresponding policy based on the priority of traffic: to set the
operation mode to high availability on the radio links with high
priority traffic; to set the operation mode to high capacity on the
radio links with low priority traffic.

Radio protection/redundancy like a 1+1 Hot Standby is used to
increase overall availability of links between nodes while radio link
aggregation is used to achieve higher capacity. If traffic is
predominately TDM traffic, high availability is required on radio
links. In this case, SDN controller set operation mode as high
availability. On the other hand, if traffic is packet traffic, e.g.,
LTE traffic, capacity is more of a concern. In this case, SDN
controller set the operation mode as high capacity.

5. Use cases

The use cases described should be the basis for identification and
definition of the parameters to be supported by a YANG Data model for
management of radio links, applicable for centralized, unified,
multi-vendor management.

Use cases addressing installation, on-site trouble shooting, fault
resolution and other activities not performed from a centralized
system and which in most cases are product specific are outside the
scope of this framework.

5.1. Configuration Management

Configuration of a radio link terminal, the constituent carrier
terminations and when applicable the relationship to packet/Ethernet
interfaces.

5.1.1. Understand the capabilities and limitations

   Exchange of information between a manager and a device about the
   capabilities supported and specific limitations in the parameter
   values and enumerations that can be used.

   Support for the XPIC feature or not and the maximum modulation
   supported are two examples on information that could be exchanged.

5.1.2. Initial Configuration

   Initial configuration of a radio link terminal, enough to establish
   L1 connectivity over the hop to an associated radio link terminal on
   a device at far end. It MAY also include configuration of the
   relationship to a packet/Ethernet interface, unless that is given by
   the equipment configuration.

   Frequency, modulation, coding and output power are examples of
   parameters typically configured for a carrier termination and type of
   aggregation/bonding or protection configurations expected for a radio
   link terminal.

5.1.3. Radio link re-configuration and optimization

   Re-configuration, update or optimization of an existing radio link
   terminal. Output power and modulation for a carrier termination and
   protection schemas and activation/de-activation of carriers in a
   radio link terminal are examples on parameters that can be re-
   configured and used for optimization of the performance of a network.

5.2. Inventory

5.2.1. Retrieve logical inventory and configuration from device

   Request from manager and response by device with information about
   radio interfaces, their constitution and configuration.

5.2.2. Retrieve logical inventory and configuration from device

   Request from manager about physical and/or equipment inventory
   associated with the radio link terminals and carrier terminations

5.3. Status and statistics

5.3.1. Actual status and performance of a radio link interface

   Manager requests and device responds with information about actual
   status and statistics of configured radio link interfaces and their
   constituent parts.

5.4. Performance management

5.4.1. Configuration of historical measurements to be performed

   Configuration of historical measurements to be performed on a radio
   link interface and/or its constituent parts is a subset of the
   configuration use case to be supported. See 5.1 above.

5.4.2. Collection of historical performance data

   Collection of historical performance data in bulk by the manager is a
   general use case for a device and not specific to a radio link
   interface.

   Collection of an individual counter for a specific interval is in
   same cases required as a complement to the retrieval in bulk as
   described above.

5.5. Fault Management

5.5.1. Configuration of alarm reporting

   Configuration of alarm reporting associated specifically with radio
   interfaces, e.g. configuration of alarm severity, is a subset of the
   configuration use case to be supported. See 5.1 above.

5.5.2. Alarm management

   Alarm synchronization, visualization and handling, and notifications
   and events are generic use cases for a device and not specific to a
   radio link interface an should be supported accordingly.

5.5.3. Troubleshooting and Root Cause Analysis

   Information and actions required by a manager/operator to investigate
   and understand the underlying issue to a problem in the performance
   and/or functionality of a radio link terminal and the associated
   carrier terminations.

6. Requirements

This is a placeholder for a separate chapter about requirements.

7. Security Considerations

TBD.

8. IANA Considerations

N/A.

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Authors' Addresses

   Jonas Ahlberg
   Ericsson AB
   Lindholmspiren 11
   Goeteborg 417 56
   Sweden

   Email: jonas.ahlberg@ericsson.com

   Luis M. Contreras
   Telefonica I+D
   Ronda de la Comunicacion, S/N
   Madrid 28050
   Spain

   Email: luismiguel.contrerasmurillo@telefonica.com

   Ye Min (Amy)
   Huawei Technologies CO., Ltd
   No.1899, Xiyuan Avenue
   Chengdu 611731
   P.R.China

   Email: amy.yemin@huawei.com

   Marko Vaupotic
   Aviat Networks
   Motnica 9
   Trzin-Ljubljana 1236
   Slovenia

   Email: Marko.Vaupotic@aviatnet.com

   Jeff Tantsura
   Individual

   Email: jefftant.ietf@gmail.com

   Koji Kawada
   NEC Corporation
   1753, Shimonumabe Nakahara-ku
   Kawasaki, Kanagawa   211-8666
   Japan

   Email: k-kawada@ah.jp.nec.com

   Xi Li
   NEC Laboratories Europe
   Kurfuersten-Anlage 36
   Heidelberg 69115
   Germany

   Email: Xi.Li@neclab.eu

   Ippei Akiyoshi
   NEC
   1753, Shimonumabe Nakahara-ku
   Kawasaki, Kanagawa 211-8666
   Japan

   Email: i-akiyoshi@ah.jp.nec.com