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**A YANG Data Model for Microwave Radio Link  
draft-ietf-ccamp-mw-yang-01**

**Abstract**

This document defines a YANG data model in order to control and manage the radio link interfaces, and the connectivity to packet (typically Ethernet) interfaces in a microwave/millimeter wave node.

**Requirements Language**

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](#)].

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## [1.](#) Terminology and Definitions

The following terms are used in this document:

Carrier Termination (CT) 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 (RLT) is an interface providing packet capacity and/or TDM capacity to the associated Ethernet and/or TDM interfaces in a node and used for setting up a transport service over a microwave/millimeter wave link.

The following acronyms are used in this document:

ACM Adaptive Coding Modulation

ATPC Automatic Transmit Power Control



CM Coding Modulation

CT Carrier Termination

RLT Radio Link Terminal

RTPC Remote Transmit Power Control

XPIC Cross Polarization Interference Cancellation

MIMO Multiple-Input Multiple-Output

## 2. Introduction

This document defines a YANG data model for management and control of the radio link interface(s) and the relationship to packet (typically Ethernet) and/or TDM interfaces in a microwave/millimeter wave node. ETSI EN 302 217 series defines the characteristics and requirements of microwave/millimeter wave equipment and antennas. Especially ETSI EN 302 217-2 [EN 302 217-2] specifies the essential parameters for the systems operating from 1.4GHz to 86GHz. The data model includes configuration and state data.

The design of the data model follows the framework for management and control of microwave and millimeter wave interface parameters defined in [[I-D.ietf-ccamp-microwave-framework](#)]. This framework identifies the need and the scope of the YANG data model, the use cases and requirements that the model needs to support. Moreover, it provides a detailed gap analysis to identify the missing parameters and functionalities of the existing and established models to support the specified use cases and requirements, and based on that recommends how the gaps should be filled with the development of the new model.

According to the conclusion of the gap analysis, the structure of the data model is based on the structure defined in [[I-D.ahlberg-ccamp-microwave-radio-link](#)] and it augments [RFC 7223](#) to align with the same structure for management of the packet interfaces. More specifically, the model will include interface layering to manage the capacity provided by a radio link terminal for the associated Ethernet and TDM interfaces, using the principles for interface layering described in [RFC 7223](#) as a basis.

The designed YANG data model uses established microwave equipment and radio standards, such as ETSI EN 302 217-2, and the IETF: Radio Link Model [[I-D.ahlberg-ccamp-microwave-radio-link](#)] and the ONF: Microwave Modeling [[ONF-model](#)] as the basis for the definition of the detailed leafs/parameters, and proposes new ones to cover identified gaps which are analysed in [[I-D.ietf-ccamp-microwave-framework](#)].



### 3. YANG Data Model (Tree Structure)

#### 3.1. the YANG Tree

```

module: ietf-microwave-radio-link
  +--rw radio-link-protection-groups
  |   +--rw radio-link-protection-group* [name]
  |       +--rw name string
  |       +--rw protection-architecture-type? identityref
  |       +--rw protection-operation-type? enumeration
  |       +--rw working-entity* if:interface-ref
  |       +--rw revertive-wait-to-restore? uint16
  |       +--rw radio-link-protection-members* if:interface-ref
  |       +---x protection-external-commands
  |           +---w input
  |               +---w protection-external-command? identityref
  +--ro radio-link-protection-groups-state
  |   +--ro radio-link-protection-group* [name]
  |       +--ro name string
  |       +--ro protection-status? identityref
  +--rw xpic-pairs {xpic}?
  |   +--rw xpic-pair* [name]
  |       +--rw name string
  |       +--rw enabled? boolean
  |       +--rw xpic-members* if:interface-ref
  +--rw mimo-groups {mimo}?
  |   +--rw mimo-group* [name]
  |       +--rw name string
  |       +--rw enabled? boolean
  |       +--rw mimo-members* if:interface-ref
  augment /if:interfaces/if:interface:
    +--rw id? string
    +--rw mode identityref
    +--rw carrier-terminations* if:interface-ref
    +--rw rlp-groups* leafref
    +--rw xpic-pairs*
    |   -> /xpic-pairs/xpic-pair/name {xpic}?
    +--rw mimo-group?
    |   -> /mimo-groups/mimo-group/name {mimo}?
    +--rw tdm-connections* [tdm-type] {tdm}?
    |   +--rw tdm-type identityref
    |   +--rw tdm-connections uint16
  augment /if:interfaces/if:interface:
    +--rw carrier-id? string
    +--rw tx-enabled? boolean
    +--rw tx-frequency uint32
    +--rw rx-frequency? uint32

```

+--rw duplex-distance?                    uint32

```

+--rw channel-separation          uint32
+--rw polarization?              enumeration
+--rw power-mode                 enumeration
+--rw selected-output-power      power
+--rw atpc-lower-threshold       power
+--rw atpc-upper-threshold       power
+--rw coding-modulation-mode     enumeration
+--rw selected-cm               identityref
+--rw selected-min-acm          identityref
+--rw selected-max-acm          identityref
+--rw if-loop?                  enumeration
+--rw rf-loop?                  enumeration
+--rw ct-performance-thresholds
  +--rw received-level-alarm-threshold?  power
  +--rw transmitted-level-alarm-threshold? power
  +--rw ber-alarm-threshold?             enumeration
augment /if:interfaces-state/if:interface:
+--ro tx-oper-status?          enumeration
+--ro actual-transmitted-level? power
+--ro actual-received-level?   power
+--ro actual-tx-cm?            identityref
+--ro actual-snr?              decimal64
+--ro actual-xpi?              decimal64 {xpica}?
+--ro capabilities
  +--ro min-tx-frequency?      uint32
  +--ro max-tx-frequency?      uint32
  +--ro min-rx-frequency?      uint32
  +--ro max-rx-frequency?      uint32
  +--ro available-min-output-power? power
  +--ro available-max-output-power? power
  +--ro available-min-acm?      identityref
  +--ro available-max-acm?      identityref
augment /if:interfaces-state/if:interface/if:statistics:
+--ro bbe?          yang:counter32
+--ro es?           yang:counter32
+--ro ses?          yang:counter32
+--ro uas?          yang:counter32
+--ro min-rltm?     power
+--ro max-rltm?     power
+--ro min-tltm?     power
+--ro max-tltm?     power

```

### [3.2.](#) Explanation of the Microwave Data Model

The leaves in the Interface Management Module augmented by Radio Link Terminal (RLT) and Carrier Termination (CT) are not always relevant.



"/interfaces/interface/enabled" is not relevant for RLT. Enable and disable of an interface is done in the constituent CTs.

The packet related measurements "in-octets", "in-unicast-pkts", "in-broadcast-pkts", "in-multicast-pkts", "in-discards", "in-errors", "in-unknown-protos", "out-octets", "out-unicast-pkts", "out-broadcast-pkts", "out-multicast-pkts", "out-discards", "out-errors" are not within the scope of the microwave radio link domain and therefore not relevant for RLT and CT.

#### **4. YANG Module**

```
<CODE BEGINS> file "ietf-microwave-radio-link.yang"

module ietf-microwave-radio-link {
  yang-version 1.1;

  namespace "urn:ietf:params:xml:ns:yang:ietf-microwave-radio-link";
  prefix "mrl";

  import ietf-yang-types {
    prefix yang;
  }

  import ietf-interfaces {
    prefix if;
  }

  import iana-if-type {
    prefix ianaift;
  }

  organization
    "Internet Engineering Task Force (IETF) CCAMP WG";
  contact
    "
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    ";
```



```
description
  "This is a module for the entities in a generic microwave system.";

revision 2017-06-21 {
  description
    "Updated draft revision with updates of some descriptions to
    increase clarity and some minor adjustments of the model.";
  reference "";
}
revision 2016-12-22 {
  description
    "Draft revision covering a complete scope for configuration
    and state data for radio link interfaces.";
  reference "";
}
revision 2016-10-29 {
  description
    "Draft revision.";
  reference "";
}

/*
 * Features
 */

feature xpic {
  description
    "Indicates that the device supports XPIC.";
}

feature mimo {
  description
    "Indicates that the device supports MIMO.";
}

feature tdm {
  description
    "Indicates that the device supports TDM.";
}

/*
 * Interface identities
 */

identity radio-link-terminal {
  base ianaift:iana-interface-type;
  description
    "Interface identity for a radio link terminal.";
```



```
}

identity carrier-termination {
  base ianaift:iana-interface-type;
  description
    "Interface identity for a carrier termination.";
}

/*
 * Radio-link-terminal mode identities
 */

identity rlt-mode {
  description
    "A description of the mode in which the radio link
    terminal is configured. The format is X plus Y.
    X represent the number of bonded carrier terminations.
    Y represent the number of protecting carrier
    terminations.";
}

identity one-plus-zero {
  base rlt-mode;
  description
    "1 carrier termination only.";
}

identity one-plus-one {
  base rlt-mode;
  description
    "1 carrier termination
    and 1 protecting carrier termination.";
}

identity two-plus-zero {
  base rlt-mode;
  description
    "2 bonded carrier terminations.";
}

/*
 * Coding and modulation identities
 */

identity coding-modulation {
  description
    "The coding and modulation schemes.";
}
```



```
identity half-bpsk-strong {
    base coding-modulation;
    description
        "Half BPSK strong coding and modulation scheme.";
}

identity half-bpsk {
    base coding-modulation;
    description
        "Half BPSK coding and modulation scheme.";
}

identity half-bpsk-light {
    base coding-modulation;
    description
        "Half BPSK light coding and modulation scheme.";
}

identity bpsk-strong {
    base coding-modulation;
    description
        "BPSK strong coding and modulation scheme.";
}

identity bpsk {
    base coding-modulation;
    description
        "BPSK coding and modulation scheme.";
}

identity bpsk-light {
    base coding-modulation;
    description
        "BPSK light coding and modulation scheme.";
}

identity qpsk {
    base coding-modulation;
    description
        "QPSK coding and modulation scheme.";
}

identity qam-4-strong {
    base coding-modulation;
    description
        "4 QAM strong coding and modulation scheme.";
}
```



```
identity qam-4 {
  base coding-modulation;
  description
    "4 QAM coding and modulation scheme.";
}

identity qam-4-light {
  base coding-modulation;
  description
    "4 QAM light coding and modulation scheme.";
}

identity qam-16-strong {
  base coding-modulation;
  description
    "16 QAM strong coding and modulation scheme.";
}

identity qam-16 {
  base coding-modulation;
  description
    "16 QAM coding and modulation scheme.";
}

identity qam-16-light {
  base coding-modulation;
  description
    "16 QAM light coding and modulation scheme.";
}

identity qam-32-strong {
  base coding-modulation;
  description
    "32 QAM strong coding and modulation scheme.";
}

identity qam-32 {
  base coding-modulation;
  description
    "32 QAM coding and modulation scheme.";
}

identity qam-32-light {
  base coding-modulation;
  description
    "32 QAM light coding and modulation scheme.";
}
```



```
identity qam-64-strong {
  base coding-modulation;
  description
    "64 QAM strong coding and modulation scheme.";
}

identity qam-64 {
  base coding-modulation;
  description
    "64 QAM coding and modulation scheme.";
}

identity qam-64-light {
  base coding-modulation;
  description
    "64 QAM light coding and modulation scheme.";
}

identity qam-128-strong {
  base coding-modulation;
  description
    "128 QAM strong coding and modulation scheme.";
}

identity qam-128 {
  base coding-modulation;
  description
    "128 QAM coding and modulation scheme.";
}

identity qam-128-light {
  base coding-modulation;
  description
    "128 QAM light coding and modulation scheme.";
}

identity qam-256-strong {
  base coding-modulation;
  description
    "256 QAM strong coding and modulation scheme.";
}

identity qam-256 {
  base coding-modulation;
  description
    "256 QAM coding and modulation scheme.";
}
```



```
identity qam-256-light {
  base coding-modulation;
  description
    "256 QAM light coding and modulation scheme.";
}

identity qam-512-strong {
  base coding-modulation;
  description
    "512 QAM strong coding and modulation scheme.";
}

identity qam-512 {
  base coding-modulation;
  description
    "512 QAM coding and modulation scheme.";
}

identity qam-512-light {
  base coding-modulation;
  description
    "512 QAM light coding and modulation scheme.";
}

identity qam-1024-strong {
  base coding-modulation;
  description
    "1024 QAM strong coding and modulation scheme.";
}

identity qam-1024 {
  base coding-modulation;
  description
    "1024 QAM coding and modulation scheme.";
}

identity qam-1024-light {
  base coding-modulation;
  description
    "1024 QAM light coding and modulation scheme.";
}

identity qam-2048-strong {
  base coding-modulation;
  description
    "2048 QAM strong coding and modulation scheme.";
}
```



```
identity qam-2048 {
  base coding-modulation;
  description
    "2048 QAM coding and modulation scheme.";
}

identity qam-2048-light {
  base coding-modulation;
  description
    "2048 QAM light coding and modulation scheme.";
}

identity qam-4096-strong {
  base coding-modulation;
  description
    "4096 QAM strong coding and modulation scheme.";
}

identity qam-4096 {
  base coding-modulation;
  description
    "4096 QAM coding and modulation scheme.";
}

identity qam-4096-light {
  base coding-modulation;
  description
    "4096 QAM light coding and modulation scheme.";
}

/*
 * Protection architecture type identities
 */
identity protection-architecture-type {
  description
    "protection architecture type";
}

identity one-plus-one-type {
  base protection-architecture-type;
  description
    "One carrier termination and
     one protecting carrier termination.";
}

identity one-to-n-type {
  base protection-architecture-type;
  description
```



```
        "One carrier termination protecting
        n other carrier terminations.";
    }

    /*
    * Protection states identities
    */

    identity protection-states {
        description
            "Identities describing the status of the protection,
            in a group of carrier terminations configured in
            a radio link protection mode.";
    }

    identity unprotected {
        base protection-states;
        description "Not protected";
    }

    identity protected {
        base protection-states;
        description "Protected";
    }

    identity unable-to-protect {
        base protection-states;
        description "Unable to protect";
    }

    /*
    * protection-external-commands identities
    */

    identity protection-external-commands{
        description
            "Protection external commands for trouble shooting purpose.";
    }

    identity manual-switch{
        base protection-external-commands;
        description
            "A switch action initiated by an operator command. It switches
            normal traffic signal to the protection transport entity.";
    }

    identity forced-switch{
        base protection-external-commands;
```



```
    description
      "A switch action initiated by an operator command. It switches
      normal traffic signal to the protection transport entity and
      forces it to remain on that entity even when criteria for
      switching back to the original entity are fulfilled.";
  }

/*
 * TDM-type identities
 */

identity tdm-type {
  description
    "A description of the type of TDM connection,
    also indicating the supported capacity of the
    connection.";
}

identity E1 {
  base tdm-type;
  description
    "E1 connection, 2,048 Mbit/s.";
}

identity STM-1 {
  base tdm-type;
  description
    "STM-1 connection, 155,52 Mbit/s.";
}

/*
 * Typedefs
 */

typedef power {
  type decimal64 {
    fraction-digits 1;
  }
  description
    "Type used for power values, selected and measured.";
}

/*
 * Radio Link Terminal (RLT) - Configuration data nodes
 */

augment "/if:interfaces/if:interface" {
  when "if:type = 'mrl:radio-link-terminal'";
```



```
description
  "Addition of data nodes for radio link terminal to
  the standard Interface data model, for interfaces of
  the type 'radio-link-terminal'.";

leaf id {
  type string;
  default "";
  description
    "ID of the radio link terminal. Used by far-end when
    checking that it's connected to the correct RLT.";
}

leaf mode {
  type identityref {
    base rlt-mode;
  }
  mandatory true;
  description
    "A description of the mode in which the radio link
    terminal is configured. The format is X plus Y.
    X represent the number of bonded carrier terminations.
    Y represent the number of protecting carrier
    terminations.";
}

leaf-list carrier-terminations {
  type if:interface-ref;
  must "/if:interfaces/if:interface[if:name = current()]"
    + "/if:type = 'mrl:carrier-termination'" {
    description
      "The type of interface must be
      'carrier-termination'.";
  }
  min-elements 1;
  description
    "A list of references to carrier terminations
    included in the radio link terminal.";
}

leaf-list rlp-groups {
  type leafref {
    path "/mrl:radio-link-protection-groups/"
      + "mrl:radio-link-protection-group/mrl:name";
  }
  description
    "A list of references to the carrier termination
    groups configured for radio link protection in this
```



```
        radio link terminal.";
    }

    leaf-list xpic-pairs {
        if-feature xpic;
        type leafref {
            path "/mrl:xpic-pairs/mrl:xpic-pair/mrl:name";
        }
        description
            "A list of references to the XPIC pairs used in this
            radio link terminal. One pair can be used by two
            terminals.";
    }

    leaf mimo-group {
        if-feature mimo;
        type leafref {
            path "/mrl:mimo-groups/mrl:mimo-group/mrl:name";
        }
        description
            "A reference to the MIMO group used in this
            radio link terminal. One group can be used by more
            than one terminal.";
    }

    list tdm-connections {
        if-feature tdm;
        key "tdm-type";
        description
            "A list stating the number of active TDM connections of
            a specified tdm-type that is configured to be supported
            by the RLT.";
        leaf tdm-type {
            type identityref {
                base tdm-type;
            }
            description
                "The type of TDM connection, which also indicates
                the supported capacity.";
        }
        leaf tdm-connections {
            type uint16;
            mandatory true;
            description "Number of connections of the specified type.";
        }
    }
}
```



```
/*
 * Carrier Termination - Configuration data nodes
 */

augment "/if:interfaces/if:interface" {
  when "if:type = 'mrl:carrier-termination'";
  description
    "Addition of data nodes for carrier termination to the
    standard Interface data model, for interfaces of the type
    'carrier-termination'.";

  leaf carrier-id {
    type string;
    default "A";
    description
      "ID of the carrier. (e.g. A, B, C or D)
      Used in XPIC & MIMO configurations to check that the
      carrier termination is connected to the correct far-end
      carrier termination. Should be the same carrier ID on
      both sides of the hop.
      Defaulted when not MIMO or XPIC.";
  }

  leaf tx-enabled {
    type boolean;
    default "false";
    description
      "Disables (false) or enables (true) the transmitter.
      Only applicable when the interface is enabled
      (interface:enabled = true) otherwise it's always
      disabled.";
  }

  leaf tx-frequency {
    type uint32;
    units "kHz";
    mandatory true;
    description
      "Selected transmitter frequency.";
  }

  leaf rx-frequency {
    type uint32;
    units "kHz";
    description
      "Selected receiver frequency.
      Overrides existing value in duplex-distance.
      Calculated from tx-frequency and duplex-distance if
```



```
        only duplex-distance is configured.
        Must match duplex-distance if both leaves are
        configured in a single operation.";
    }

    leaf duplex-distance {
        type uint32;
        units "kHz";
        description
            "Distance between Tx & Rx frequencies.
            Used to calculate rx-frequency when
            rx-frequency is not specifically configured.
            Overrides existing value in rx-frequency.
            Calculated from tx-frequency and rx-frequency if only
            rx-frequency is configured.
            Must match rx-frequency if both leaves are configured
            in a single operation.";
    }

    leaf channel-separation {
        type uint32;
        units "kHz";
        mandatory true;
        description
            "The amount of bandwidth allocated to a carrier.";
    }

    leaf polarization {
        type enumeration {
            enum "horizontal" {
                description "Horizontal polarization.";
            }
            enum "vertical" {
                description "Vertical polarization.";
            }
            enum "not-specified" {
                description "Polarization not specified.";
            }
        }
        default "not-specified";
        description
            "Polarization - A textual description for info only.";
    }

    leaf power-mode {
        type enumeration {
            enum rtpc {
                description "Remote Transmit Power Control (RTPC).";
            }
        }
    }
```



```
    }
    enum atpc {
        description "Automatic Transmit Power Control (ATPC).";
    }
}
mandatory true;
description
    "A choice of Remote Transmit Power Control (RTPC)
    or Automatic Transmit Power Control (ATPC).";
}

leaf selected-output-power {
    type power {
        range "-99..40";
    }
    units "dBm";
    mandatory true;
    description
        "Selected output power in RTPC mode and selected maximum
        output power in ATPC mode. Minimum output power in ATPC mode
        is the same as the system capability,
        available-min-output-power.";
}

leaf atpc-lower-threshold {
    when "../power-mode = 'atpc'";
    type power {
        range "-99..-30";
    }
    units "dBm";
    mandatory true;
    description
        "The lower threshold for the input power at far-end used in
        the ATPC mode.";
}

leaf atpc-upper-threshold {
    when "../power-mode = 'atpc'";
    type power {
        range "-99..-30";
    }
    units "dBm";
    mandatory true;
    description
        "The upper threshold for the input power at far-end used in
        the ATPC mode.";
}
```



```
leaf coding-modulation-mode {
  type enumeration {
    enum fixed {
      description "Fixed coding/modulation.";
    }
    enum adaptive {
      description "Adaptive coding/modulation.";
    }
  }
  mandatory true;
  description
    "A selection of fixed or
    adaptive coding/modulation mode.";
}

leaf selected-cm {
  when "../coding-modulation-mode = 'fixed'";
  type identityref {
    base coding-modulation;
  }
  mandatory true;
  description
    "Selected fixed coding/modulation.";
}

leaf selected-min-acm {
  when "../coding-modulation-mode = 'adaptive'";
  type identityref {
    base coding-modulation;
  }
  mandatory true;
  description
    "Selected minimum coding/modulation.
    Adaptive coding/modulation shall not go
    below this value.";
}

leaf selected-max-acm {
  when "../coding-modulation-mode = 'adaptive'";
  type identityref {
    base coding-modulation;
  }
  mandatory true;
  description
    "Selected maximum coding/modulation.
    Adaptive coding/modulation shall not go
    above this value.";
}
```



```
leaf if-loop {
  type enumeration {
    enum disabled {
      description "Disables the IF Loop.";
    }
    enum client {
      description "Loops the signal back to the client side.";
    }
    enum radio {
      description "Loops the signal back to the radio side.";
    }
  }
  default "disabled";
  description
    "Enable (client/radio) or disable (disabled) the IF loop,
    which loops the signal back to the client side or
    the radio side.";
}

leaf rf-loop {
  type enumeration {
    enum disabled {
      description "Disables the RF Loop.";
    }
    enum client {
      description "Loops the signal back to the client side.";
    }
    enum radio {
      description "Loops the signal back to the radio side.";
    }
  }
  default "disabled";
  description
    "Enable (client/radio) or disable (disabled) the RF loop,
    which loops the signal back to the client side or
    the radio side.";
}

container ct-performance-thresholds {
  description
    "Specification of thresholds for when alarms should
    be sent and cleared for various performance counters.";

  leaf received-level-alarm-threshold {
    type power {
      range "-99..-30";
    }
    units "dBm";
  }
}
```



```
    default "-99";
    description
      "An alarm is sent when the received power level is
       below the specified threshold.";
  }

  leaf transmitted-level-alarm-threshold {
    type power {
      range "-99..40";
    }
    units "dBm";
    default "-99";
    description
      "An alarm is sent when the transmitted power level is
       below the specified threshold.";
  }

  leaf ber-alarm-threshold {
    type enumeration {
      enum "10e-9" {
        description "Threshold at 10e-9.";
      }
      enum "10e-8" {
        description "Threshold at 10e-8.";
      }
      enum "10e-7" {
        description "Threshold at 10e-7.";
      }
      enum "10e-6" {
        description "Threshold at 10e-6.";
      }
      enum "10e-5" {
        description "Threshold at 10e-5.";
      }
      enum "10e-4" {
        description "Threshold at 10e-4.";
      }
      enum "10e-3" {
        description "Threshold at 10e-3.";
      }
      enum "10e-2" {
        description "Threshold at 10e-2.";
      }
      enum "10e-1" {
        description "Threshold at 10e-1.";
      }
    }
    default "10e-6";
  }
```



```
        description
            "Specification of at which BER an alarm should
             be raised.";
    }
}

/*
 * Radio Link Terminal - Operational state data nodes
 * Currently nothing in addition to the general
 * interface-state model.
 */

/*
 * Carrier Termination - Operational state data nodes
 */

augment "/if:interfaces-state/if:interface" {
    when "if:type = 'mrl:carrier-termination'";
    description
        "Addition of state data nodes for carrier termination to
         the standard Interface state data model, for interfaces of
         the type 'carrier-termination'.";

    leaf tx-oper-status {
        type enumeration {
            enum "off" {
                description "Transmitter is off.";
            }
            enum "on" {
                description "Transmitter is on.";
            }
            enum "standby" {
                description "Transmitter is in standby.";
            }
        }
        description
            "Shows the operative status of the transmitter.";
    }

    leaf actual-transmitted-level {
        type power {
            range "-99..40";
        }
        units "dBm";
        description
            "Actual transmitted power level (0.1 dBm resolution).";
    }
}
```



```
leaf actual-received-level {
  type power {
    range "-99..-20";
  }
  units "dBm";
  description
    "Actual received power level (0.1 dBm resolution).";
}

leaf actual-tx-cm {
  type identityref {
    base coding-modulation;
  }
  description
    "Actual coding/modulation in transmitting direction.";
}

leaf actual-snr {
  type decimal64 {
    fraction-digits 1;
    range "0..99";
  }
  units "dB";
  description
    "Actual signal to noise plus interference ratio.
    (0.1 dB resolution).";
}

leaf actual-xpi {
  if-feature xpic;
  type decimal64 {
    fraction-digits 1;
    range "0..99";
  }
  units "dB";
  description
    "The actual carrier to cross-polar interference.
    Only valid if XPIC is enabled. (0.1 dB resolution).";
}

container capabilities {
  description
    "Capabilities of the the installed equipment and
    some selected configurations.";

  leaf min-tx-frequency {
    type uint32;
    units "kHz";
```



```
    description
      "Minimum Tx frequency possible to use.";
  }

  leaf max-tx-frequency {
    type uint32;
    units "kHz";
    description
      "Maximum Tx frequency possible to use.";
  }

  leaf min-rx-frequency {
    type uint32;
    units "kHz";
    description
      "Minimum Rx frequency possible to use.";
  }

  leaf max-rx-frequency {
    type uint32;
    units "kHz";
    description
      "Maximum Tx frequency possible to use.";
  }

  leaf available-min-output-power {
    type power;
    units "dBm";
    description
      "The minimum output power supported.";
  }

  leaf available-max-output-power {
    type power;
    units "dBm";
    description
      "The maximum output power supported.";
  }

  leaf available-min-acm {
    type identityref {
      base coding-modulation;
    }
    description
      "Minimum coding-modulation possible to use.";
  }

  leaf available-max-acm {
```



```
    type identityref {
      base coding-modulation;
    }
    description
      "Maximum coding-modulation possible to use.";
  }
}

augment "/if:interfaces-state/if:interface/if:statistics" {
  when "../if:type = 'mrl:carrier-termination'";
  description
    "Addition of state data nodes in the container statistics
    for carrier terminations to the standard Interface data
    model, for interfaces of the type 'carrier-termination'.";

  leaf bbe {
    type yang:counter32;
    units "number of block errors";
    description
      "Number of Background Block Errors (BBE) during the
      interval. A BBE is an errored block not occurring as
      part of an SES.";
  }

  leaf es {
    type yang:counter32;
    units "seconds";
    description
      "Number of Errored Seconds (ES) since last reset.
      An ES is a one-second period with one or more errored
      blocks or at least one defect.";
  }

  leaf ses {
    type yang:counter32;
    units "seconds";
    description
      "Number of Severely Errored Seconds (SES) during the
      interval. SES is a one-second period which contains
      equal or more than 30% errored blocks or at least
      one defect. SES is a subset of ES.";
  }

  leaf uas {
    type yang:counter32;
    units "seconds";
    description
```



```
        "Number of Unavailable Seconds (UAS), that is, the
        total time that the node has been unavailable during
        a fixed measurement interval.";
    }

    leaf min-rltm {
        type power {
            range "-99..-20";
        }
        units "dBm";
        description
            "Minimum received power level since last reset.";
    }

    leaf max-rltm {
        type power {
            range "-99..-20";
        }
        units "dBm";
        description
            "Maximum received power level since last reset.";
    }

    leaf min-tltm {
        type power {
            range "-99..40";
        }
        units "dBm";
        description
            "Minimum transmitted power level since last reset.";
    }

    leaf max-tltm {
        type power {
            range "-99..40";
        }
        units "dBm";
        description
            "Maximum transmitted power level since last reset.";
    }
}

/*
 * Radio Link Protection Groups - Configuration data nodes
 */

container radio-link-protection-groups {
    description
```



"Configuration of radio link protected groups (1+1) of carrier terminations in a radio link. More than one protected group per radio-link-terminal is allowed.";

```
list radio-link-protection-group {
  key "name";
  description
    "List of protected groups of carrier terminations
    in a radio link.";

  leaf name {
    type string;
    description
      "Name used for identification of the radio
      link protection group";
  }

  leaf protection-architecture-type {
    type identityref{
      base protection-architecture-type;
    }
    default "one-plus-one-type";
    description
      "The type of protection architecture used,
      e.g. one carrier termination protecting one or
      several other carrier terminations.";
  }

  leaf protection-operation-type {
    type enumeration {
      enum "non-revertive" {
        description
          "In non revertive operation, the traffic
          does not return to the working carrier termination
          if the switch requests are terminated. ";
      }
      enum "revertive" {
        description
          "In revertive operation, the traffic always
          returns to (or remains on) the working
          carrier termination if the switch requests are
          terminated. ";
      }
    }
    default "non-revertive";
    description
      "The type of protection operation, i.e. revertive
      or non-revertive operation.";
```



```
}

leaf-list working-entity {
  when "../protection-operation-type = 'revertive'";
  type if:interface-ref;
  must "/if:interfaces/if:interface[if:name = current()]"
    + "/if:type = 'mrl:carrier-termination'" {
    description
      "The type of a working-entity must be
       'carrier-termination'.";
  }
  min-elements 1;
  description
    "The carrier terminations over which the traffic
     normally should be transported over when there
     is no need to use the protecting carrier termination.";
}

leaf revertive-wait-to-restore {
  when "../protection-operation-type = 'revertive'";
  type uint16;
  units "seconds";
  default "0";
  description
    "The time to wait before switching back to the
     working carrier termination if protection-operation-type
     is revertive.";
}

leaf-list radio-link-protection-members {
  type if:interface-ref;
  must "/if:interfaces/if:interface[if:name = current()]"
    + "/if:type = 'mrl:carrier-termination'" {
    description
      "The type of a protection member must be
       'carrier-termination'.";
  }
  min-elements 2;
  description
    "Association to a group of carrier terminations
     configured for radio link protection and used in
     the radio link terminal.";
}

action protection-external-commands {
  input {
    leaf protection-external-command {
      type identityref {
```



```
        base protection-external-commands;
    }
    description
        "Execution of protection external commands for
        trouble shooting purpose.";
    }
}
}
}
}

/*
 * Radio Link Protection Groups - Operational state data nodes
 */

container radio-link-protection-groups-state {
    config false;
    description
        "State data for radio link protected groups of
        carrier terminations in a radio link.";

    list radio-link-protection-group {
        key "name";
        description
            "List of protected groups of carrier terminations
            in a radio link.";

        leaf name {
            type string;
            description
                "Name used for identification of the radio
                link protection group.";
        }

        leaf protection-status {
            type identityref {
                base protection-states;
            }
            description
                "Status of the protection, in a group of carrier
                terminations configured in a radio link protection
                mode.";
        }
    }
}

/*
 * XPIC & MIMO groups - Configuration data nodes
```



```
*/

container xpic-pairs {
  if-feature xpic;
  description
    "Configuration of carrier termination pairs
    for operation in XPIC mode.";

  list xpic-pair {
    key "name";
    description
      "List of carrier termination pairs in XPIC mode.";

    leaf name {
      type string;
      description
        "Name used for identification of the XPIC pair.";
    }

    leaf enabled {
      type boolean;
      default "false";
      description
        "Enable(true)/disable(false) XPIC";
    }

    leaf-list xpic-members {
      type if:interface-ref;
      must "/if:interfaces/if:interface[if:name = current()]"
        + "/if:type = 'mrl:carrier-termination'" {
        description
          "The type of a xpic-member must be
          'carrier-termination'.";
      }
      min-elements 2;
      max-elements 2;
      description
        "Association to XPIC pairs used in the radio link
        terminal.";
    }
  }
}

container mimo-groups {
  if-feature mimo;
  description
    "Configuration of carrier terminations
    for operation in MIMO mode.";
```



```
list mimo-group {
  key "name";
  description
    "List of carrier terminations in MIMO mode.";

  leaf name {
    type string;
    description
      "Name used for identification of the MIMO group.";
  }

  leaf enabled {
    type boolean;
    default "false";
    description
      "Enable(true)/disable(false) MIMO";
  }

  leaf-list mimo-members {
    type if:interface-ref;
    must "/if:interfaces/if:interface[if:name = current()]"
      + "/if:type = 'mrl:carrier-termination'" {
      description
        "The type of a mimo-member must be
         'carrier-termination'.";
    }
    min-elements 2;
    description
      "Association to a MIMO group if used in the radio
       link terminal.";
  }
}

}

}

<CODE ENDS>
```

## 5. Security Considerations

The YANG module defined in this memo is designed to be accessed via the NETCONF protocol [[RFC6241](#)]. The lowest NETCONF layer is the secure transport layer and the mandatory-to-implement secure transport is SSH [[RFC6242](#)]. The NETCONF access control model [[RFC6536](#)] provides the means to restrict access for particular NETCONF users to a pre-configured subset of all available NETCONF protocol operations and content.



There are a number of data nodes defined in the YANG module which are writable/creatable/deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., <editconfig>) to these data nodes without proper protection can have a negative effect on network operations.

The security considerations of [RFC7223] also apply to this document.

## 6. IANA Considerations

TBD.

## 7. References

### 7.1. Normative References

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