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Extension to the Link Management Protocol (LMP/DWDM -rfc4209) for Dense Wavelength Division Multiplexing (DWDM) Optical Line Systems to manage the application code of optical interface parameters in DWDM application draft-ggalimbe-ccamp-flex-if-lmp-12

Abstract

This experimental memo defines extensions to LMP(rfc4209) for managing Optical parameters associated with Wavelength Division Multiplexing (WDM) adding a set of parameters related to multicarrier DWDM interfaces to be used in Spectrum Switched Optical Networks (sson).

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1. Introduction

This experimental extension addresses the use cases described by "draft-ietf-ccamp-dwdm-if-lmp" and extend it to the Spectrum Switched Optical Network applications. LMP [RFC4902] provides link property correlation capabilities that can be used between a transceiver device and an Optical Line System (OLS) device. Link property correlation is a procedure by which, intrinsic parameters and capabilities are exchanged between two ends of a link. Link property correlation as defined in RFC4204 allows either end of the link to supervise the received signal and operate within a commonly understood parameter window. Here the term 'link' refers in particular to the attachment link between OXC and OLS (see Figure 1). The relevant novelty is the interface configuration having a multiple carrier where the client signal is spread on. The parameters are not yet fully defined by ITU-, so this document can jast be seen as an experimental proposal not binding operators and vendors to comply and implement them

2. DWDM line system

Figure 1 shows a set of reference points (Rs and Ss), for a single-channel connection between transmitter (Tx) and receiver (Rx) devices. Here the DWDM network elements in between those devices include an Optical Multiplexer (OM) and an Optical Demultiplexer (OD). In addition it may include one or more Optical Amplifiers (OA) and one or more Optical Add-Drop Multiplexers (OADM).

```
       +-------------------------------------------------+
    Ss |              DWDM Network Elements              | Rs
+--+ | |  | \                                       / |  |  | +--+
Tx L1--|->|   \    +------+            +------+   /   |--|-->Rx L1
+---+  |  |    |   |      |  +------+  |      |  |    |  |    +--+
+---+  |  | FX |   |      |  | FLEX |  |      |  | FX |  |    +--+
Tx L2--|->| OM |-->|------|->|ROADM |--|------|->| OD |--|-->Rx L2
+---+  |  |    |   |      |  |      |  |      |  |    |  |    +--+
+---+  |  |    |   |      |  +------+  |      |  |    |  |    +--+
Tx L3--|->|   /    | DWDM |    |  ^    | DWDM |   \   |--|-->Rx L3
+---+  |  | /      | Link +----|--|----+ Link |     \ |  |    +--+
       +-----------+           |  |           +----------+
                            +--+  +--+
                            |        |
                         Rs v        | Ss
                         +-----+  +-----+
                         |RxLx |  |TxLx |
                         +-----+  +-----+
```

Ss = Sender reference point at the DWDM network element tributary output, this can be a set of multiple transceivers carrying the same client payload.
Rs = Receiver reference point at the DWDM network element tributary input this can be a set of multiple transceivers carrying the same client payload.

FX OM = Flex-Spectrum Optical Mux
FX OD = Flex-Spectrum Optical Demux
Flex ROADM = Flex-Spectrum Optical Add Drop Mux (reconfigurable)

extending Fig. 5.1/G.698.2

Figure 1: Linear Single Channel approach

Figure 2 Extended LMP Model (from [RFC4209])

```
        +------+ Ss    +------+       +------+    Rs +------+
        |      | ----- |      |       |      | ----- |      |
        | OXC1 | ----- | OLS1 | ===== | OLS2 | ----- | OXC2 |
        |      | ----- |      |       |      | ----- |      |
        +------+       +------+       +------+       +------+
          ^  ^             ^              ^             ^  ^
          |  |             |              |             |  |
          |  +-----LMP-----+              +-----LMP-----+  |
          |                                                |
          +----------------------LMP-----------------------+
```

OXC : is an entity that contains Multiple carriers transponders
OLS : generic Flex-Spectrum optical system, it can be -
Optical Mux, Optical Demux, Optical Add
Drop Mux, Amplifier etc.
OLS to OLS: represents the Optical Multiplex section
<xref target="ITU.G709"/>
Rs/Ss : reference points in between the OXC and the OLS

Figure 2: Extended LMP Model

3. Use Cases

The set of paramentes exchanged between OXC and OLS is to support the Spectrum Switched Optical Network in therms of Number of Sub-carriers available at the transceiver and their characteristics to provide the SSON control plane all the information suitable to calculate the path and the optical feasibility. This draft extends the "draft-ietf-ccamp-dwdm-if-lmp" to sson applications.

4. Extensions to LMP-WDM Protocol

This document defines extensions to [RFC4209] to allow a set of characteristic parameters, to be exchanged between a router or optical switch and the optical line system to which it is attached. In particular, this document defines additional Data Link sub-objects to be carried in the LinkSummary message defined in [RFC4204] and [RFC6205]. The OXC and OLS systems may be managed by different Network management systems and hence may not know the capability and status of their peer. These messages and their usage are defined in subsequent sections of this document.

The following new messages are defined for the SSON extension
- Multi carrier Transceiver (sub-object Type = TBA)

5. Multi carrier Transceiver

These are a set of general parameters extending the description in [G698.2] and [G.694.1]. ITU-T working groups are working to detail most of parameters and an update of the TLV may be required.

Other than the Application Identifier described in [G698.2] and draft-dharinigert-ccamp-dwdm-if-lmp the parameters to describe a multicarrier transceiver are describes as follows:

1. Modulation format: indicates the Transceiver capabilities to support a single or multiple modulation format like: BPSK, DC-DP-BSPSK, QPSK, DP-QPSK, QAM16, DP-QAM16, DC-DP-QAM16, 64QAM. Hybrid modulation format are supported as well and the parameter is given in bit per symbol.
2. FEC: indicates the FEC types the transceiver can support
3. baud rate: symbols rate, basically this identify the channel symbols number per second
4. Num Carriers: number of (sub)carriers the trasceiver can support and can be "mapped" in a Mediachannel
5. Bits/symbol: number of bit per simbol - fractional in case of hybrid modulation format. (aka spectral efficiency)
6. Subcarrier band (minimum distance between subcarriers) in GHz
7. Guard band (required guard band at the side of media channel)
8. Sub-carrier TX Power: output optical power the transceiver can provide
9. Sub-carrier RX Power: Input optical power Range the transceiver can support, this is known also as Sensitivity
10. Max-pol-power-difference: max power difference between the polarised components
11. Max-pol-skew-difference: maw Skew between polarised signal and subcarriers supported by the transceiver
12. Sub-carrier OSNR robustness

Figure 3: The format of the this sub-object (Type = TBA, Length = TBA) is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Type       |    Length     |         (Reserved)            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|S|I|         Modulation ID     |               FEC             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          baud rate  (Symbol Rate)              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Number of subcarriers    |            Bit/Symbol         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
|          subcarrier band      |           guard band          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       sub-carrier TX power                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     sub-carrier RX power HIGH                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     sub-carrier RX power LOW                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Max-pol-power-difference                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Max-pol-skew-difference                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        sub-carrier OSNR                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

- S: standardized format;
- I: input / output (1 / 0)
- Modulation ID (Format) : is the modulation type:
  BPSK, DC DP BSPSK, QPSK, DP QPSK, 8QAM, 16QAM,
  32QAM, 64QAM, etc.
  - <TBD> (ITU-T reference)
  - value > 32768 (first bit is 1): custom defined values
  Value 0 is reserved to be used if no value is defined
- FEC: the signal Forward Error Corrections type (16-bit
  unsigned integer), the defined values are:
  - <TBD> (ITU-T reference)
  - 32768 (first bit is 1): custom defined values
  Value 0 is reserved to be used if no value is defined
- Baud Rate: the signal symbol rate (IEEE 32-bit float,
  in bauds/s)
  Value 0 is reserved to be used if no value is defined
- Num Carriers
- Bits/symbol(BPS) this indicates the bit per symbol in case of
  hybrid modulation format. It is an off-set with values from 0
  to 127 to be applied to the specified Modulation Format and
  indicates the mix between the selected Modulation Format and its
  upper adjacent.
  (e.g. QPSK + 63 BPS indicates that there is a 50% MIX between
  QPSK and 8-QAM = 2.5 bits per symbol) If value = 0 the
  standard Modulation Format is applied
- Subcarrier band (minimum distance between subcarriers)
- Guard band (required guard band at the side of media channel)
- Sub-carrier Transmit Power
- Sub-carrier Receive HIGH Power range (Sensitivity)
- Sub-carrier Receive LOW Power range (Sensitivity)
- Sub-carrier OSNR robustness
- Max-pol-power-difference
- Max-pol-skew-difference

- Sub-carrier OSNR

Figure 3: Multi carrier Transceiver

6. Security Considerations

LMP message security uses IPsec, as described in [RFC4204]. This document only defines new LMP objects that are carried in existing LMP messages, similar to the LMP objects in [RFC:4209]. This document does not introduce new security considerations.

7. IANA Considerations

LMP <xref target="RFC4204"/> defines the following name spaces and the ways in which IANA can make assignments to these namespaces:

- LMP Message Type
- LMP Object Class
- LMP Object Class type (C-Type) unique within the Object Class
- LMP Sub-object Class type (Type) unique within the Object Class

This memo introduces the following new assignments:

LMP Sub-Object Class names:

under DATA_LINK Class name (as defined in <xref target="RFC4204"/>)
- Multi carrier Transceiver (sub-object Type = TBA)

8. Contributors

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