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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-ietf-ccamp-dwdm-if-lmp-09

Abstract

This memo defines extensions to LMP RFC4209 for managing Optical parameters associated with Wavelength Division Multiplexing (WDM) systems in accordance with the Interface Application Identifier approach defined in ITU-T Recommendation G.694.1 and its extensions.

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Status of This Memo

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1. Introduction

LMP [RFC4209] 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 RFC3591 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 interface parameters are in line with "draft-ietf-ccamp-dwdm-if-param-yang". Use cases are 1- Optical

interface parameter collection, 2- DWDM client - ROADM interconection discovery, 3- Service Setup, 4- Link Monitoring

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
   +---+  |  |    |   |      |  +------+  |      |  |    |  |    +--+
   +---+  |  |    |   |      |  |      |  |      |  |    |  |    +--+
   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
Rs = Receiver reference point at the DWDM network element
     tributary input
Lx = Lambda x
OM = Optical Mux
OD = Optical Demux
ROADM = Reconfigurable Optical Add Drop Mux

Figure 1: Linear Single Channel approach

from Fig. 5.1/G.698.2

Figure 2 Extended LMP Model (from [RFC4209])

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

   OXC        : is an entity that contains transponders
   OLS        : generic 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-T.G709"/>
   Rs/Ss      : reference points in between the OXC and the OLS
```

Figure 2: Extended LMP Model

3. Use Cases

A comparison with the traditional operation scenarios provides an insight of similarities and distinctions in operation and management of DWDM interfaces. The following use cases provide an overview about operation and maintenance processes.

3.1. Optical interface parameter collection

It is necessary to identify the Optical interface characteristics and setting in order to properly calculate the ent to end path and match the Head End interface against the Tail End interface compatibility. The optical parameters may have multiple possible values that the Controller (SDN or GMPLS) can use and select for the best network optimisation. In case of GMPLS, the LMP is suitable to support the parameters exchange between the ROADM and the Transponder (or DWDM interface located into the client box).

3.2. DWDM client - ROADM interconection discovery

Being the DWDM port (Rs and Ss) and ROADM port belonging to different domains and Network Elements, the interconnection between them is not embedded in the Optical Nodes (OLS layer) and can not be shared to the EMS and the Controller. The Controller needs then to retrieve the connectivity using data coming from the two domains correlating them to discover the relationship. The methods to discover the interconnection can be LMP, LLDP, installation provisioning or any

other mechanism using the light (or power) transmitted by the DWDM transmitter and detecter by the ROADM port photodiode. This use case is fundamental to build the interconnections between the DWDM and Client layer (e.g. Routers) and re-build the multilayer network topology.

3.3. Service Setup

It is necessary to differentiate between different operational issues for setting up a light path (a DWDM connection is specific in having defined maximum impairments) within an operational network.

The first step is to determine if transceivers located at different end-points are interoperable, i.e. support a common set of operational parameters. In this step it is required to determine transceiver capabilities in a way to be able to correlate them for interoperability purposes. Such parameters include modulation scheme, modulation parameters, FEC to name a few. If both transceivers are controlled by the same NMS or Control Plane, such data is readily available. However in cases where the transceivers are controlled by different Control Pplanes, a protocol needs to be used to inform the controlling instance (NMS or CP) about transceiver parameters. It is suggested to extend LMP for that purpose.

The second step is to determine the feasibility of a lightpath between two transceivers without applying an optical signal. Understanding the limitations of the transceiver pair, a path through the optical network has to be found, whereby each path has an individual set of impairments deteriorating a wavelength traveling along that path. Since a single transceiver can support multiple parameter sets, the selection of a path may limit the permissible parameter sets determined in previous steps.

The third step is then to setup the connection itself and to determine the Wavelength. This is done using the NMS of the optical transport network or by means of a control plane interaction such as signaling and includes the path information as well as the parameter set information necessary to enable communication.

In the fourth step, optical monitoring is activated in the WDM network in order to monitor the status of the connection. The monitor functions of the optical interfaces at the terminals are also activated in order to monitor the end to end connection.

Furthermore it should be possible to automate this step. After connecting the client device to the neighbor control plane-enabled transport node, a control adjacency may be automatically established, e.g. using LMP.

3.4. Link Monitoring Use Cases

The use cases described below are assuming that power monitoring functions are available in the ingress and egress network element of the DWDM network, respectively. By performing link property correlation it would be beneficial to include the current transmit power value at reference point Ss and the current received power value at reference point Rs. For example if the Client transmitter power has a value of 0dBm and the ROADM interface measured power is -6dBm the fiber patch cord connecting the two nodes may be pinched or the connectors are dirty. As discussed before, the actual path or selection of a specific wavelength within the allowed set is outside the scope of LMP. The computing entities (e.g. the first optical node originating the circuit) can rely on GMPLS IGP (OSPF) to retrieve all the information related to the network, calculate the path to reach the endpoint and signal the path implementation through the network via RSVP-TE.

[ITU-T.G.698.2] defines a single channel optical interface for DWDM systems that allows interconnecting network-external optical transponders across a DWDM network. The optical transponders are external to the DWDM network. This so-called 'Black Link' approach illustrated in Fig. 5-1 of [ITU-T.G.698.2]. The single channel fiber link between the Ss/Rs reference points and the ingress/egress port of the network element on the domain boundary of the DWDM network (DWDM border NE) is called access link. Based on the definition in [ITU-T.G.698.2] it is part of the DWDM network. The access link is typically realized as a passive fiber link that has a specific optical attenuation (insertion loss). As the access link is an integral part of the DWDM network, it is desirable to monitor its attenuation. Therefore, it is useful to detect an increase of the access link attenuation, for example, when the access link fiber has been disconnected and reconnected (maintenance) and a bad patch panel connection (connector) resulted in a significantly higher access link attenuation (loss of signal in the extreme case of an open connector or a fiber cut). In the following section, two use cases are presented and discussed:

1) pure access link monitoring
2) access link monitoring with a power control loop

These use cases require a power monitor as described in G.697 (see section 6.1.2), that is capable to measure the optical power of the incoming or outgoing single channel signal. The use case where a power control loop is in place could even be used to compensate an increased attenuation if the optical transmitter can still be operated within its output power range defined by its application code.

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 (e.g. OTN cross connect) 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 WDM extension for ITU-T G.698.2 [ITU-T.G698.2]/ITU-T G.698.1 [ITU-T.G698.1]/ ITU-T G.959.1 [ITU-T.G959.1]

```
  - OCh_General                  (sub-object Type = TBA)
  - OCh_ApplicationIdentier      (sub-object Type = TBA)
  - OCh_Ss                       (sub-object Type = TBA)
  - OCh_Rs                       (sub-object Type = TBA)
```

5. General Parameters - OCh_General

These are a set of general parameters as described in [G698.2] and [G.694.1]. Please refer to the "draft-ietf-ccamp-dwdm-if-param-yang" for more details about these parameters and the [RFC6205] for the wavelength definition.

The general parameters are

1. Central Frequency - (Tera Hz) 4 bytes (see RFC6205 sec.3.2)
2. Number of Application Identifiers (A.I.) Supported
3. Single-channel Application Identifier in use
4. Application Identifier Type in use
5. Application Identifier in use

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)            |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                     Central Frequency                         |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |   Number of Application                 |                     |
 |   Identifiers Supported                 |     (Reserved)      |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 | Single-channel|  A.I. Type    |         A.I. length           |
```

```
    | Application   |   in use      |                               |
    | Identifier    |               |                               |
    | Number in use |               |                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |           Single-channel Application Identifier in use        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |           Single-channel Application Identifier in use        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |           Single-channel Application Identifier in use        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

A.I. Type in use: STANDARD, PROPRIETARY

A.I. Type in use: STANDARD

Refers to G.698.2 recommendation (e.g.) : B-DScW-ytz(v)

```
     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
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                Single-channel Application Code                |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                Single-channel Application Code                |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                Single-channel Application Code                |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

A.I. Type in use: PROPRIETARY

Note: if the A.I. type = PROPRIETARY, the first 6 Octets of the Application Identifier in use are six characters of the PrintableString must contain the Hexadecimal representation of an OUI (Organizationally Unique Identifier) assigned to the vendor whose implementation generated the Application Identifier; the remaining octets of the PrintableString are unspecified.

```
     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
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                        OUI                                    |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |              OUI cont.        |          Vendor value         |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                           Vendor Value                        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3: OCh_General

6. ApplicationIdentifier - OCh_ApplicationIdentifier

This message is to exchange the application identifiers supported as described in [G698.2]. There can be more than one Application Identifier supported by the transmitter/receiver in the OXC. The number of application identifiers supported is exchanged in the "OCh_General" message. (from [G698.1]/[G698.2]/[G959.1] and G.874.1)

The parameters are:

1. Number of Application Identifiers (A.I.) Supported

2. Single-channel application identifier Number uniquely identifiers this entry - 8 bits

3. Application Indentifier Type (A.I.) (STANDARD/PROPRIETARY)

4. Single-channel application identifier -- 96 bits (from [G698.1]/[G698.2]/[G959.1]

- this parameter can have multiple instances as the transceiver can support multiple application identifiers.

Figure 4: 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)            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Number of Application               |                       |
|   Identifiers Supported               |     (Reserved)        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Single-channel|  A.I. Type    |         A.I. length           |
| Application   |               |                               |
| Identifier    |               |                               |
| Number        |               |                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|               Single-channel Application Identifier           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
   |               Single-channel Application Identifier           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |               Single-channel Application Identifier           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   //              ....                                           //
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Single-channel|               |         A.I. length           |
   | Application   |   A.I. Type   |                               |
   | Identifier    |               |                               |
   | Number        |               |                               |
   |               |               |                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |               Single-channel Application Identifier           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |               Single-channel Application Identifier           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |               Single-channel Application Identifier           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

A.I. Type in use: STANDARD, PROPRIETARY

A.I. Type in use: STANDARD
Refers to G.698.2 recommendation : B-DScW-ytz(v)

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                Single-channel Application Code                |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                Single-channel Application Code                |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                Single-channel Application Code                |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

A.I. Type in use: PROPRIETARY

Note: if the A.I. type = PROPRIETARY, the first 6 Octets of the Application Identifier in use are six characters of the PrintableString must contain the Hexadecimal representation of an OUI (Organizationally Unique Identifier) assigned to the vendor whose implementation generated the Application Identifier; the remaining octets of the PrintableString are unspecified.

```
    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
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        OUI                                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              OUI cont.        |           Vendor value        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Vendor Value                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 4: OCh_ApplicationIdentifier

7. OCh_Ss - OCh transmit parameters

These are the G.698.2 parameters at the Source(Ss reference points). Please refer to "draft-ietf-ccamp-dwdm-if-param-yang" for more details about these parameters.

1. Output power

Figure 5: The format of the OCh 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)           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Output Power                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 5: OCh_Ss transmit parameters

8. OCh_Rs - receive parameters

These are the G.698.2 parameters at the Sink (Rs reference points).

1. Current Input Power   - (0.1dbm) 4bytes

Figure 6: The format of the OCh receive sub-object (Type = TBA, Length = TBA) is as follows:

The format of the OCh receive/OLS Sink 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)  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   Current Input Power                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 6: OCh_Rs receive parameters

9. 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.

10. 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"/>)

- OCh_General (sub-object Type = TBA)
- OCh_ApplicationIdentifier (sub-object Type = TBA)
- OCh_Ss (sub-object Type = TBA)
- OCh_Rs (sub-object Type = TBA)

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