Channel Control Protocol

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derived and extended from: kramer_3ca_1_1117.pdf

Key Features of Nx25G-EPON Architecture

No dependencies between the numbers of upstream and downstream channels enabled in each ONU $\Longrightarrow$

- Channels can be enabled and disabled independently based on traffic load or specific diagnostic/maintenance needs
- EPON's DC/UC bandwidth asymmetry can be changed dynamically

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No fixed pairing between downstream and upstream channels $\Longrightarrow$

- A GATE arriving on any downstream channel may carry grants for any upstream channels.

No fixed mapping of LLIDs to channels $\Longrightarrow$

- Any LLID provisioned at a given ONU may be served by any of the channels enabled in that ONU

Channel Control Principles

- ❑ For backward compatibility, ONUs may need to operate with some of the channels turned off
  - – 50/50G-EPON ONU configured to operate as 50/25G-EPON ONU
  - – 50/25G-EPON ONU configured to operate as 25/25G-EPON ONU

- ❑ Individual channels may be turned off for other reasons, e.g.,:
  - – To save power
  - – To perform diagnostic/maintenance (i.e., rogue ONU detection)
  - – For optical protection

- ❑ Turning a channel on/off means turning OLT/ONU receiver and transmitter on/off, accordingly

- ❑ **ONU <u>shall preserve</u> channel state across power cycle**
  - – If a channel in an ONU has been disabled by NMS, that channel should not get enabled automatically after the ONU power cycle (or else user actions will undo operator's configurations)

Channel Control Protocol Requirements

❏ To manage channels in Nx25G-EPON, the Channel Control Protocol needs to support two operations:

1. **Querying ONU's channel state**
2. **Configuring ONU channels**

Each ONU channel can be in one of these states:

- **Absent** (e.g., 25Gb/s ONU does not have channel n° 2)
- **Enabled** (channel is operational, i.e., it exists, not failed, and not disabled)
- **Remotely disabled** (i.e., disabled by the NMS)
- **Locally disabled** (i.e., disabled by ONU if PMD failure is imminent)
- **Failed** (i.e., PMD has failed)

To configure a channel, NMS issues one of these commands:

- **Enable Channel**
- **Disable Channel**

Protocol Messages

- ❑ Channel Control Protocol needs 4 messages:
  - **QUERY** – NMS queries ONU for the state of each channel.
  - **QUERY_RESPONSE** – ONU inform NMS of the state of each channel.
  - **CONFIG** – NMS configures one or more channels in the ONU.
  - **CONFIG_RESPONSE** – ONU informs NMS of the result of the last CONFIG command (and optionally, the new state of each channel).

- ❑ It is much more efficient to query/configure all available channels (up to 2 downstream + up to 2 upstream for Nx25G-EPON) using one message than it is to use a separate message for each channel
  - One message exchange vs. multiple message exchanges

- ❑ Such mechanism is easily extensible to a larger number of channels, given the size of a MAC Control message (64 octets)

What's next for CCP

NG-EPON

❑ Motion #8 from November 2017 adopted CCP implemented using MAC Control messages

❑ Two CCPDU shall be defined:

- CC_REQUEST sent by the OLT to query and configure channels in an ONU

- CC_RESPONSE sent by an ONU in response to CC_REQUEST to inform the OLT of the state of

❑ Details have not been provided to date and draft D1.3 features only CCP outline, with no content. This contribution brings in specification details

CCPDU structure

CC_REQUEST / CC_RESPONSE

CCPDU Structure

❑ CCPDU is a MAC Control message (Length/Type = 0x8808). Similar to MPCPDU defined in Clause 144, but not timestamped

❑ Destination Address = unicast of a fully registered ONU or MAC Control Multicast address.

❑ Opcodes values 0x0020 and 0x0021 are used

❑ Control Multiplexer and Control Parser can properly process CCPDUs today. Additional data path from MAC Control Client needed to receive and transmit CCPDUs from MAC Control Client.

Destination Address	6
Source Address	6
Length/Type = 0x8808	2
Opcode = CCPDU	2
Value + Padding	44
FCS	4

CC_REQUEST CCPDU

❑ Extends CCPDU structure with downstream and upstream channel action field set as shown below

Destination Address	6
Source Address	6
Length/Type = 0x8808	2
Opcode = 0x0020	2
ActionDC0	1
ActionDC1	1
Reserved	14
ActionUC0	1
ActionUC1	1
Reserved	26
FCS	4

Bits	Description
0-7	Channel Action 0x00 – **No Action** 0x01 – **Disable Channel** 0x02 – **Enable Channel** 0x03 ÷ values reserved 0xFF

❑ 2 downstream and 2 upstream channel action fields needed in Nx25G-EPON; many more can be supported if needed

❑ Each channel action field has the same channel actions defined

CC_RESPONSE CCPDU

❑ Extends CCPDU structure with downstream and upstream channel status field set as shown below

Destination Address	6
Source Address	6
Length/Type = 0x8808	2
Opcode = 0x0021	2
StatusDC0	1
StatusDC1	1
Reserved	14
StatusUC0	1
StatusUC1	1
Reserved	26
FCS	4

Bits	Description
0-3	Channel Status 0x0 – **Channel Absent** 0x1 – **Enabled** 0x2 – **Remotely disabled** (i.e., disabled by the NMS) 0x3 – **Locally disabled** (i.e., disabled by ONU if PMD failure is imminent) 0x4 – **Channel Failure** (i.e., PMD has failed) 0x5-0xF – values reserved
4-7	Action Result Code 0x0 – **No Action Requested** 0x1 – **Action Succeeded** 0x2 – **Action Failed** 0x3 – **No Change Required** (i.e, the channel is already in the requested state) 0x4 – **Invalid Command** (i.e., an attempt to turn on a non-existent channel) 0x5-0xF – values reserved

Channel State Transition Matrix

Received Command

Initial Channel State	0x00 **No action**	0x01 **Disable channel**	0x02 **Enable channel**
0x0 **Channel absent**	0x00 Channel absent; No action requested.	0x40 Channel absent; Invalid command.	0x40 Channel absent; Invalid command.
0x1 **Channel enabled**	0x01 Channel enabled; No action requested.	0x12 Channel disabled remotely; Action succeeded.	0x31 Channel enabled; No change required.
0x2 **Remotely disabled**	0x02 Channel disabled remotely; No action requested.	0x32 Channel disabled remotely; No change required.	0x11 Channel enabled; Action succeeded.
0x3 **Locally disabled**	0x03 Channel disabled locally; No action requested.	0x12 Channel disabled remotely; Action succeeded.	0x11 Channel enabled; Action succeeded.
0x4 **Channel Failure**	0x04 Channel failure; No action requested.	0x24 Channel failure; Action failed.	0x24 Channel failure; Action failed.

Example Request and Response

❑ Request to and Response from a 50/25G-EPON ONU.

Initial Channel State

Ch	Ch. State	Description
DC0	0x1	Channel enabled
DC1	0x1	Channel enabled
UC0	0x1	Channel enabled
UC1	0x0	Chanel absent

CC_REQUEST Message

Ch. Action	Description
0x02	Enable channel
0x01	Disable channel
0x00	No action
0x01	Disable channel

CC_RESPONSE Message

Ch. Status	Description
0x31	Channel enabled; No change required
0x12	Channel remotely disabled; Action succeeded
0x01	Channel enabled; No action requested
0x40	Channel absent; Invalid command.

Channel designator as defined in Table 143-7

Channel Control Protocol

Behavior Description

ONU channel lineup discovery

- On registration of a new ONU, the OLT reads current ONU channel lineup (status) using unicast CC_REQUEST CCPDU, following REGISTER_ACK MPCPDU.

  – CC_REQUEST CCPDU has all channel action fields set to 0x00 ("No Action" means it is a query)

  – All CCPDUs are exchanged on MLID

- Once CC_RESPONSE CCPDU from ONU is received, channel status information is saved into OLT MAC Control client.

  – This completes the ONU channel lineup discovery process

- ONU channel lineup discovery may be initiated by the OLT MAC Control client on demand, at any time

- ONU may send unsolicited CC_RESPONSE CCPDU to notify the OLT about any changes in channel lineup, e.g., imminent TRx failure, power problems, etc.

ONU channel control

❑ Once ONU is registered and channel lineup is discovered, OLT MAC Control may change status of any downstream upstream channel on ONU as needed (see CC_REQUEST CCPDU)

- The actual reason for channel configuration change is out of scope.

- Channels with no configuration change needed have their associated channel action fields set to 0x00 (No Action). Channels to be disabled have their associated channel action fields set to 0x01 (Disable Channel). Finally, channels to be enabled have their associated channel action fields set to 0x02 (Enable Channel).

❑ ONU receives CC_REQUEST CCPDU, sends it to its MAC Control client, and attempts to implement requested changes

- ONU MAC Control client sends CC_RESPONSE CCPDU with the outcome of the configuration changes for each and every supported channel, using bits 4-7 in Action Result Code portion of each channel data field

- ONU updates *ChStatus* variable on receipt of each CC_REQUEST CCPDU

- Response should be sent within a specific time (TBD EQT?) to provide OLT with timely response.

ONU channel config change

❑ ONU implements channel configuration change as soon as CC_REQUEST CCPDU is received and processed.

❑ OLT implements channel configuration change for the ONU
  – When OLT enables channel on ONU, OLT would commit configuration changes only when CC_RESPONSE CCPDU is received & processed.
    • There is a chance that the ONU may not implement some of required changes, e.g., enable a channel that is down due to PMD failure.
  – When a channel is disabled, OLT may commit configuration change immediately.

❑ Channel configuration is already reflected in MCRS.
  – MCRS always processes all channels from 0 to NUM_CH-1.
  – A disabled channel will not get any envelopes assigned from MPCP and it will not receive any data from the PCS. When PMD is shut down, the PCS will fill the gap with IEI or IBI.
  – When a channel is disabled via CCPDU, MAC Control needs to clear the envelope list for that channel, pass information to MAC Control Client for higher-layer processing, statistics collection, and to shut down the PMD for the specific channel via local management path.

Thank You