# RoE mappers

### Handling of control words

The structure aware, “CPRI11” mapper has multiple “control process” mappers to process CPRI Hyper Frame control words. Table 5 lists the control process mappers, their respective naming/variable prefixes and which sub-channels they (typically) concern. The mapper definitions and variables have the common prefix **CPRI11.ctrl**. Unless otherwise stated all variables are assumed to be prefixed with **CPRI11**.

The **CPRI11.ctrl.cw\_size** defines the size of the CPRI control word (Tcw) in octets i.e. Tcw/8 for all control process mappers. The value shall be between 1 and 16. Note that in cases where the CPRI control word size (Tcw) is less that the CPRI word size (T) the CPRI basic frame mapper (see sub-clause xx) has to be configured appropriately to handle the situation i.e., the RoE container definition for the control word and for the following container.

Table 1 Control Process mappers for CPRI control words

|  |  |  |
| --- | --- | --- |
| **Mapper description** | **CPRI control words** | **Mapper prefix** |
| Synchronization and L1 protocol fields | Sub-channels 0 & 2 | CPRI11.ctrl.sync\_l1 |
| Slow C&M channel | Sub-channel 1 | CPRI11.ctrl.slow |
| Fast C&M channel | Sub-channels p->63 | CPRI11.ctrl.fast |
| Combined VSD and Ctrl\_AxC channels | Sub-channels 4->7 & 16->p-1 | CPRI11.ctrl.axc\_vsd |

The control words the “control process” mappers operate upon are structured in the same way as CPRI structures it. Areas not extracted or transported to/from the CPRI stream are assumed to be all zero (0). Figure 9 illustrates the CPRI Hyper Frame control words collection and construction for the “control process”. From the processing point of view control words are always processed in the order they arrive i.e., the first element is the control word 0 (Ns=Xs=0), the second element is the control word 1 (Ns=1, Xs=0), etc. The control process mappers are applied to the control words as they arrive and then stored into the memory as a dense array for possible second stage processing (such as placing data into RoE data packet payload field).

There are 36 control words in one hyper frame reserved for future interface protocol extensions. Reserved words are completely filled with reserved bits (reserved bits are marked with “r”). This means that a transmitter shall send 0’s for bits marked with “r”, and the receiver shall not interpret bits marked with “r”. (transmit: r = 0, receiver: r = don’t care).



Figure 1 - CPRI basic frame and "control process" interaction

Figure 2 CPRI Hyper Frame worth of Control Words

The control process mappers for Slow C&M and Fast C&M channelsblocks use the following common **container** construction:

**{**

**.cw\_sel**

**.cw\_start**

**.cw\_num**

**.cw\_size**

**.flow\_id**

**.filter\_mode**

**.hfn\_modulo**

**.hfn\_index**

**.offset**

**.value**

**.mask**

**}**

There can be, depending on the case, one or more containers per control process mapper. The control process mapper for Slow C&M and Fast C&M have the following common construction:

**{**

**.container**

**}**

The control process mapper for the combined Ctrl\_AxC and VSD has the following construction:

**{**

**.container[0..n]**

**}**

The maximum number of containers is 16.

[///Editor’s note: Need to agree on mask scheme]

The .cw\_sel is a four bit mask for selecting sub-channel words (Xs) to extract. The selected sub-channel words equal to “logical or” of corresponding sub-channel masks. See Table 6 for the mask values.

Table 2 Sub-channel word bit masks

|  |  |
| --- | --- |
| Binary mask | Sub-channel word (Xs index) |
| 0000b | sub-channel processing disabled – container not in use. |
| 0001b | Xs = 0 |
| 0010b | Xs = 1 |
| 0100b | Xs = 2 |
| 1000b | Xs = 3 |

The number of containers depend on the used control word mapper. Both the **CPRI11.ctrl.slow** and **CPRI11.ctrl.fast** have only one container e.g., **CPRI11.ctrl.fast.container.** The combination of **.cw\_sel** and multiple containers allow handling of arbitrary areas within CPRI control words as illustrated in Figure 9.

[///Editor’s note: Range is a function of line rate. 64 is valid for 4.9GHz]

The .cw\_start defines the start of sub-channel (Ns) and has the valid range from 0 to 63. The .cw\_size defines the number of extracted sub-challes and the valid range is from 1 to 64. The mask defined by .cw\_sel applies to the “area” defined by the .cw\_start and .cw\_num, The specific mapper definitions may have more specific restriction to the ranges. If there are multiple containers the areas they define shall not overlap each other.

The **.flow\_id** maps to RoE header **flow\_id** field.

The .filter\_mode specifically concerns the control process mapper when it has to generate a RoE packet. See Table 7 for further details.

Table 3 Hyper Frame filtering options

|  |  |
| --- | --- |
| .filter\_mode | Description |
| 0 | Filtering is disabled. RoE packet is generated on every Hyper Frame. |
| 1 | Non-zero content i.e., the extracted content has non-zero values. |
| 2 | Periodic generation according to modulo logic. |
| 3 | Extracted content has changed since the previously generated RoE packet. |
| 4 | Pattern match. |

Note that when the “.filter\_mode” is set to 0 (filtering disabled) the packet can be generated and sent as soon as the required amount of control word data has been collected. There is no need to wait until the entire hyper frame has been received.

The .hfn\_modulo operates on the entire extracted (Hyper Frame size) CPRI control words area and combined with .hfn\_index allows selecting specific Hyper Frames for further processing. The .hfn\_modulo has the valid range from 1 to 150. The .hfn\_index has the valid range from 0 to 149. The modulo logic is synchronized with the current Hyper Frame Number (HFN). For example current\_HFN%.hfn\_modulo would select Hyper Frame control words for control process mapper processing when the reminder of the modulo operation equals to .hfn\_index.

The .offset, .value and .mask concern the pattern match .filter\_mode. The .offset has valid range from 0 to 4095. Both .value and .mask are 32 bit values. The pattern match is applied to the Hyper Frame after applying other parser options such as .cw\_sel, .cw\_start and .cw\_size. The offset is relative to the extracted (dense array or buffer of) control words. The match is true when the 32 bit value extracted from the memory equals to the .value after applying a “logical and” to it using the .mask.

Whenever parameter configurations refer to a value “p” that refers to the pointer in CPRI control word Z.194.0 indicating the start of Fast C&M channel sub-channels.

Table 4 summarizes the variable for the “control process” stage container definitions and their sizes for the CPRI11.ctrl.sync\_l1, CPRI11.ctrl.slow, CPRI11.ctrl.fast and CPRI11.ctrl.axc\_vsd mappers.

Table 4 - CPRI control word mapper container variables

|  |  |  |
| --- | --- | --- |
| Variable | Bits | Description |
| .cw\_sel | 4 | A four bit mask for selecting sub-channel words (Xs) to extract. Bit 0 corresponds to Xs word with index 0 and Bit 3 to Xs =3. The selected sub-channel words equal to “logical or” of corresponding sub-channel masks. |
| .cw\_start | 6 | The first sub-channel allocated for parser. Valid range is from 0 to 63. |
| .cw\_num | 6 | Number of consecutive sub-channels allocated for the control data. Valid range is from 0 to 63. Value of 0 selects/extracts no sub-channels. |
| .cw\_size | 5 | Number of bytes per control word to extract. Valid values are 0 to Tcw/8 and the maximum is 16 bytes. The extracted bytes are in network order. |
| .flow\_id | 8 | The flow\_id used in the generated RoE packets. |
| .filter\_mode | 3 | Controls the generation of the RoE packets from the extracted CPRI control words. |
| .hfn\_modulo | 8 | Modulo operation applied to current CPRI hyper frame number. Valid range from 1 to 150. Whether the modulo is applied depends on the “.filter\_mode” setting. |
| .hfn\_index | 8 | The index to match after the modulo operation. Valid range from 0 to 149. |
| .offset | 12 | The offset into the extracted control word buffer for masking and value comparison operation. Valid range from 0 to 4095. Whether the offset-based mask and value comparison is applied depends on the “.filter\_mode” setting. |
| .value | 32 | The value to compare agaist after the mask operation. |
| .mask | 32 | The bit mask (logical AND) for the offset-based comparison operation. |

### Synchronization and L1 protocol fields

CPRI Synchronization and L1 protocol fields are not transported over the RoE. They are only provided for the local use by the “control process”. The following information is supported (using CPRI control word notation):

1. HFN (Hyperframe number) at location Z.64.0 i.e., control word 64.
2. BFN (CPRI 10ms frame number) at locations Z.128.0 and Z.192.0 i.e., control words 128 and 192.
3. Protocol version at location Z.2.0 i.e., control word 2.
4. HDLC bit rate at location Z.66.0 i.e., control word 66.
5. L1 signaling at location Z.130.0 i.e., control word 130.
6. Ethernet pointer at location Z.194.0 i.e., control word 194.

### Slow C&M Packet (pkt\_type 000100b)

The Slow C&M channel is mapped into a RoE data flow.

The Slow C&M channel shall have the following parameterization:

1. **CPRI11.ctrl.slow.container.cw\_start**=1
2. **CPRI11.ctrl.slow.container.cw\_num**=1
3. **CPRI11.ctrl.slow.container.flow\_id**=0 (or some other value depending on the deployment)
4. **CPRI11.ctrl.slow.container.cw\_size**=based on the HDLC bit rate

The Slow C&M channel should have the following parameterization:

1. **CPRI11.ctrl.slow.container.cw\_sel**=1111b but may differ based on the HDLC bit rate
2. **CPRI11.ctrl.slow.container.filter\_mode**=0

The rest of the parameters depend on the deployment. Figure X illustrates a construction of RoE pkt\_type=000100b based on the configuration given above.



Figure 3 - Example RoE packet for transporing CPRI Slow C&M flow

The use of sequence number shall be consistent with the corresponding data flow.

1. **seqNumPMax**=150\*256/**CPRI11.numBasicFramesPerPacket**-1
2. **seqNumPInc**=1
3. **seqNumPIncProp**=1
4. **seqNumQMax**=4095
5. **seqNumPInc**=1
6. **seqNumPIncProp**=1

### Fast C&M channel packets

The “control process” shall extract the control words for the Fast C&M channel and create an appropriate Ethernet packet out of the extracted Ethernet packet data (e.g., discarding SSD, ESD and IDLE bit sequences). The Fast C&M channel is sent/received as native Ethernet traffic. The used Physical Coding Sublayer (PCS) shall be according to the underlying link and the mapper is responsible of doing possible required conversions.

The Fast C&M channel shall have the following parameterization:

1. **CPRI11.ctrl.fast.container.cw\_start**=**p** (refer CPRI control word Z.194.0 for “**p**”)
2. **CPRI11.ctrl.fast.container.cw\_num**=64-**p**
3. **CPRI11.ctrl.slow.container.cw\_size**=**Tcw**/8

The Fast C&M channel should have the following parameterization:

1. **CPRI11.ctrl.fast.container.filter\_mode**=0

The rest of parameters are not needed. Figure X illustrates an overly simplified construction of Fast C&M Ethernet packet based on the configuration given above. If the Fast C&M embedded Ethernet packet does not align into CPRI basic frame boundaries or does not fit into a single basic frame, it is the “control process” responsibility to buffer requirent amount of data to make a successful conversion between CPRI control words and the native Ethernet packets.



Figure 4 – A naïve example of CPRI Fast C&M transport over native Ethernet

### Ctrl\_AxC and VSD packet (pkt\_type 000000b subtype 00000100b)

TBD