Interpretation Number: 1-07/06
Topic: 10GBASE-X Physical Coding Sublayer (PCS)
Relevant Clause: Clause 48
Classification: See responses

Interpretation Request

Question 1

IEEE 802.3ae-2002, Clause 48.2.6.1.4, cvtx_terminate definition

The cvtx_terminate is defined as:
"Conversion function used by the PCS Transmit process when Terminate is indicated to convert all Idle control characters signaled via TX to /K/ code-groups. Conversion is performed for all lanes."

This definition seems to imply that any non idle control characters, such as an /E/ or invalid control character, should not be converted to a /K/ by the cvtx_terminate function

For example, in case the following scenario occurs on the TX XGMII, where * is an invalid XGMII control code or /E/:

```
lane0 lane1 lane2 lane3
  T     I     I     *
```

should be converted by the cvtx_terminate to

Option 1

```
lane0 lane1 lane2 lane3
 /T/   /K/   /K/   /E/
```

or

Option 2

```
lane0 lane1 lane2 lane3
 /T/   /K/   /K/   /K/
```

Which is the correct interpretation, Option 1 or option 2? According to the definition of cvtx_terminate, Option 1 seems the correct interpretation, which also allows the error condition to be properly flagged instead of being masked by a /K/.

Question 2

IEEE 802.3ae-2002, Clause 48.2.6.2.1, transmit process

While in the interframe part of a TX XGMII tranmission, invalid or error control characters could appear on one or more lanes of a column, while the other lanes of the same column are sending the idle control code. For example:

```
lane0 lane1 lane2 lane3
  I     I     I     *
```

where * is an /E/ or invalid XGMII control code. The column type described in the example is neither an idle column or a ||Q||, hence it will cause a transition to the SEND_DATA state of the PCS transmit source FSM of Figure 48-6. This means the column will be encoded by the ENCODE(TX) function, but with TXC being set to 1.

What should the result of the ENCODE(TX) function?
Some options are:

Option 1

```
lane0 lane1 lane2 lane3
 /I/?  /I/?  /I/?  /E/
```

Option 2

```
lane0 lane1 lane2 lane3
 /E/   /E/   /E/   /E/
```

Option 3

```
lane0 lane1 lane2 lane3
/D7.0//D7.0//D7.0/ /E/
```

Another possibility would be to consider the errored idle column as an idle column, and encode it according to the Figure 48-6 FSM as either an ||A||, ||R|| or ||K||; this could lead to two options:

Option 4

```
lane0 lane1 lane2 lane3
 /I/   /I/   /I/   /E/
```

Option 5

```
lane0 lane1 lane2 lane3
 /I/   /I/   /I/   /I/
```

with /I/ being either /A/, /K/ or /R/.

Out of these 5 options:

Option 1 would be the logical choice, but in this case it is not clear which idle should be sent (/K/, /R/, /A/ ?)

Option 2 seems to be a good alternate option, and is currently our chosen interpretation.

Question 3

IEEE 802.3ae-2002, Clause 46.2.1, interframe and 48.2.4.2.3 idle cell insertion/deletion

The interframe is defined in this clause as:

"The inter-frame <inter-frame> period on an XGMII transmit or receive path is an interval during which no frame data activity occurs. The <inter-frame> corresponding to the MAC interpacket gap begins with the Terminate control character, continues with Idle control characters and ends with the Idle control character prior to a Start control character."

The minimum IPG is defined to be 5 octets.

This definition does not seem to be exact, as it is possible to have control characters other than idle while in the interframe period, such as sequence, transmit error propagation or invalid control characters.

a) Are these "other than idle" control characters counting towards determining the IPG value?

b) can they be deleted for clock rate adaptation if part of an otherwise idle column?

c) When an idle cell deletion occurs, 4 idle cells have to be deleted according to 48.2.4.2.3. Do these cells necessarily have to belong to the same columm?

For example if the following four columns are received:

```
column   1 2 3 4
lane0....D E E S..
lane1....D I E P..
lane2....T E I P..
lane3....I E E P..
```

d) Is the IPG = 10?

Our interpretation of the IPG definition is that the IPG is 10 (the E are counted) and not 4.

e) can column 3 be deleted?

If an idle cell deletion is required, our interpetation of the idle cell deletion rules would defer the deletion to the next interframe gap as there are no 4 idle cells to be deleted.

For example if the following four columns are received:

```
column   1 2 3 4
lane0....D E I S..
lane1....D I I P..
lane2....T I I P..
lane3....I E I P..
```

f) Can column 3 be deleted?

For example if the following four columns are received:

```
column   1 2 3 4
lane0....D E I S..
lane1....D E I P..
lane2....T I E P..
lane3....I I E P..
```

g) can the four idle cells of column 2 lane 2,3 and column 3 lane 0,1 be deleted?

our interpretation is
a)yes
b)no
c)yes
d)yes
e)no
f)yes
g)no

Question 4

IEEE 802.3ae-2002, Clause 46.2.6.1.3, deskew error definition

The definition of deskew error is:

"A boolean used by the PCS Deskew process to indicate that a lane-to-lane alignment error has been detected.
Values: FALSE; /A/ not recognized in any lane or recognized in all lanes simultaneously.
TRUE; /A/ recognized in fewer than all lanes."

This seems to imply that an ||A|| columnn that has one or more /A/ code words received with incorrect running disparity should not set deskew_error to TRUE.

However, a bit error could corrupt a non /A/ code word changing it into an /A/ code word; if /A/ code words are also checked against the expected running disparity, such an error could be detected.

So our interpretation is that an /A/ received with the incorrect running disparity is not considered a valid /A/, and would set the deskew_error if received as part of an ||A|| colunm.

Is this correct?

Question 5

IEEE 802.3ae-2002, Figure 48-7, PCS syncrhonization state diagram

The FSM state diagram shows transitions from states COMMA_DETECT_1,2,3 to be dependent on PUDI being /COMMA/, /INVALID/, or neither of the two. What happens in case both /COMMA/ and /INVALID/ conditions are met?

Our interpretation is that /INVALID/ takes precedence over /COMMA/, since a bit error could corrupt a non /COMMA/ code word changing it into a /COMMA/ code word; if /COMMA/ code words are also checked against the expected running disparity, such an error could be detected.

So our interpretation is that a /COMMA/ received with the incorrect running disparity is not considered a valid /COMMA/, and would cause a state transition to the LOSS_OF_SYNC state.

Is this correct?

Interpretation for IEEE Std 802.3-2005

Question 1
Classification: Unambiguous.

In the definition of the cvtx_terminate function found in subclause 48.2.6.1.4 it is stated that the function is '.. used by the PCS Transmit process when Terminate is indicated to convert all Idle control characters signaled via TX to /K/ code-groups.'. Non-Idle control characters such as /E/ are therefore not converted to /K/ code-groups and option 1 is the correct interpretation.

Question 2
Classification: Unambiguous.

There are two alternatives interpretations however both enable the receiver to unambiguously detect that an error has occurred and will lead to the same end result. These two alternatives are as follows:

[Alternative 1] In the example given in question 2, there is not a full column of Idle, and therefore this cannot be considered to be a ||I|| ordered_set (see subclause 48.2.4.2). Hence these characters cannot be considered to be 'Idle in ||I||', nor for that matter 'Idle in ||T||', as defined in Table 48–2. Instead therefore they have to be considered either a reserved XGMII character or invalid XGMII character. An XGMII data character of 0x07 with the control signal TXC<i>=1 is a valid XGMII Idle character, however when it is part of an incomplete idle column it is encoded to the K30.7 PCS code group as shown in Table 48–2. Option 2 would be therefore be the interpretation for this alternative.

[Alternative 2] Subclause 48.2.4.4 states 'Error is signaled per lane since code-violations are detected on a per lane basis' therefore an alternative interpretation is that an error has been detected in an ||I|| ordered set and that this should be signaled on a per-lane basis. Option 4 would be therefore be the interpretation for this alternative.

Question 3a
Classification: Ambiguous

This represents an ambiguity in the standard. This has been brought to the attention of the Working Group for possible action at the next revision.

Also subclause 48.2.4.2.3 allows deletion of a set of 4 idles that will result in loss of a packet. Consider the following sequence of columns

```
Column    1 2 3 4 5
Lane0.... D I O I I
Lane1.... T I O I I
Lane2.... I I O I I
Lane3.... I I O I I
```

Column 1 contains a terminate, column 3 contains a sequence ordered_set. Deletion of column 2 appears to be allowed by all the criteria in 48.2.4.2.3: it is a group of 4 Idle characters and deleting it will leave a greater than five character IPG even if the ordered set is not counted. If column 2 is deleted in the unencoded domain followed by an encoded domain, the check_end function (48.2.6.1.4) will insert E in lanes 2 and 3 of the column before 1 and in lanes 0 and 1 of column 1 because the column after the ||T|| column contains code groups other than /A/ or /K/.

Question 3b
Classification: Unambiguous

Subclause 48.2.4.3 has the rules concerning what can be deleted. It states that 'Idle insertion or deletion occurs in groups of four Idle characters.'. It also states 'Sequence ordered_sets are deleted to adapt between clock rates.'. and 'Sequence ordered_set deletion occurs only when two consecutive sequence ordered_sets have been received and deletes only one of the two.'. Hence the only code group 'other than idle' that may be deleted is a sequence ordered_set that is adjacent to another sequence ordered_set.

Question 3c
Classification: Unambiguous

As stated in subclause 48.2.4.2.3 'Clock rate compensation may be performed via insertion or removal of either Idle characters in the unencoded data stream or ||R|| in the encoded Idle stream.'. Hence in the encoded data stream deletion has to be a whole column, whereas in the unencoded data stream it does not.

Question 3d
Classification: Ambiguous

See answer to question 3a.

Question 3e
Classification: Unambiguous

No, see answer to question 3b.

Question 3f
Classification: Ambiguous

See answer to question 3a.

Question 3g – part 1
Classification: Unambiguous

In respect to the encoded data stream they cannot be deleted as subclause 48.2.4.2.3 states 'Clock rate compensation may be performed via insertion or removal of .. ||R|| in the encoded Idle stream.'.

Question 3g – part 2
Classification: Ambiguous

In respect to the unencoded data stream, see the answer to question 3a.

Question 4
Classification: Unambiguous

Any code-group, including a /A/, with incorrect running disparity will be classified as /INVALID/ (see subclause 48.2.6.1.2 definition of /INVALID/ and 36.2.4.6 item [c]). Hence if this were to occur in a column of otherwise /A/ code-groups the variable deskew_error will be set to 'TRUE' as /A/ will be recognized in fewer than all lanes.

Note – the submitted question incorrectly refers to the deskew error definition in subclause 46.2.6.1.3, this definition is actually found in subclause 48.2.6.1.3.

Question 5
Classification: Unambiguous

Any code-group, including a /COMMA/, with incorrect running disparity will be classified as /INVALID/ (see subclause 48.2.6.1.2 definition of /INVALID/ and 36.2.4.6 item [c]) and would therefore cause a transition from the state COMMA_DETECT_1, COMMA_DETECT_2 or COMMA_DETECT_3 to the state LOSS_OF_SYNC in the PCS synchronization state diagram shown in Figure 48-7.