Comments on 10GBASE-T Draft 3.1

IEEE P802.3an Task Force
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Comment #42: single fixed PBO

See also comment #62 and new text prepared by Jose Tellado

- 55.4.2.5.14, page 121, line 44 (single fixed PBO in state PMA_Training_Init_M): TR

  C: There is no need for the MASTER to advance in state PMA_Training_Init_M to a "second fixed" transmit power level. The "first fixed" transmit power level corresponding to a power backoff of 10 dB will always be sufficient for the SLAVE to decode InfoFields, or otherwise reliable operation in states PCS_Test and PCS_Data cannot be achieved and the link will never work. --- Notice that for reliable decoding of LDPC-encoded 128-DSQ signals a decision-point SNR of at least 24 dB is needed. Hence, with a power back-off of 10 dB a decision-point SNR of least 14 dB must be achievable, which is well sufficient for reliable decoding of InfoFields (SNR = 14 dB -> BER = 2.7e-7 for uncoded 2-PAM). The provision for advancing in state PMA_Training_Init_M to the "second fixed" transmit power level can therefore be eliminated.

  R: Operations should be as follows. In state PMA_Training_Init_M, the MASTER starts transmission with a power back-off of 10 dB. When it has converged its echo and NEXT cancellers, the MASTER sends en_slave_tx = 1 in its InfoFields. After detecting PMA training frames from the SLAVE and appropriate adjustment of its receiver the MASTER will be able to decode InfoFields from the SLAVE. . . . .

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Comment #42: single fixed PBO, cont.

. . . . Otherwise, an error situation exists. The MASTER then sends loc_rcvr_status = OK in its InfoFields. This indicates to the SLAVE that the MASTER is able to decode InfoFields and ready to transition to the PMA_PBO_Exch state. When the MASTER receives loc_rcvr_status = OK from the SLAVE it stores this as rem_rcvr_status = OK. When loc_rcvr_status = OK and rem_rcvr_status = OK the MASTER transitions to state PMA_PBO_Exch.

The same condition is used for the transition of the SLAVE from state PMA_Training_ Init_S to state PMA_PBO_Exch. In state SILENT, loc_rcvr_status is set to NOT_OK.

Everything else in this connection should be eliminated, in particular: master_init step, maxincr_timer, slave_detect, timing_lock_OK, PBO_increase, loc_SNR_margin, state INIT_master_ init_step, the top part of the MASTER transition counter state in Figure 55-25, etc. --- It is obvious that loc_rcvr_status = OK sent by the MASTER implies that the MASTER has detected the SLAVE signal! Similarly, when loc_rcvr_status = OK is sent by the SLAVE, the SLAVE must have acquired timing!

Motion 1: Adopt single fixed PBO for state PMA_Training_Init_M

Motion 2: Fixed PBO in state PMA_Training_Init_M shall be 10 dB
**(or 8 dB, violating minimum PBO of 10 dB specified in Table 55-6
for 0 – 35 m cable?)**

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Comment #43: message field

- <u>55.4.2.5.6, page 119, line 22 (message field), TR</u>

  C: The bits in the message field are in one way redundant and in another way incomplete. It is not always possible to infer from a received message field the current state of the link partner.

  R: Adopt the following better encoding of message bits. Two state-indicator bits indicate the state of the transmitting transceiver: 00 = PMA_Training_M or _S (forget about the 'Init_'), 01 PMA_PBO_Exch, 10 = PMA_Coeff_Exch, 11 = PMA_Fine_Adjust. One bit 'loc_rcvr_status' indicates whether or not a transceiver is ready to transition to the next state. In state PMA_Training_M, the additional bit 'en_slave_tx' is needed. In state PMA_Coeff_Exch, the additional bit 'coeff_exch_done' is required; 0 indicates IF coefficient exchange format, and 1 indicates IF transition counter format and that coefficient exchange in both directions is completed. The same bit position can be used for 'en_slave_tx' and 'coeff_exch_done'. Hence, only four message bits are needed.

  Furthermore, the state-indicator bits provide a useful function during transceiver testing and determining error conditions.

  Bits 'trans_to_Coeff_Exch', 'trans_to_Fine_Adjust', and 'trans_to_PCS_Test' are not needed. ---- Initially in each state the transition counter shall be zero. Transitions to the next state are announced by setting the transition counter to a non-zero value. The transition occurs when the transition counter reaches the value zero. At this time the state indicator bits assume the values for the next state.

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Comment #43: message field, cont.

Message field in Draft 3.1

	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Master	Reserved	Reserved	loc_rcvr_ status	en_ slave_tx	trans_to_ Coeff_Exch	Coeff_ exchange	trans_to_ Fine_Adjust	trans_to_ PCS_Test
Slave	Reserved	Reserved	loc_rcvr_ status	timing_ lock_OK	trans_to_ Coeff_Exch	Coeff_ exchange	trans_to_ Fine_Adjust	trans_to_ PCS_Test

The message field bits are defined in 55.4.2.5.6 Message Field, in 55.4.5.1 State diagram variables, and to some extent in 55.4.2.5.14 Startup Sequence. A formal definition of en_slave_tx is missing.

In Draft 3.1 there is no clear distinction between message field bits and state diagram variables.

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Comment #43: message field, cont.

Proposed new message field

PMA_Training_Init_M	SI1 = 0	SI0 = 0	LRS	EST
PMA_Training_Init_S	0	0	LRS	reserved
PMA_PBO_Exch	0	1	LRS	PED	← added 6Mar06
PMA_Coeff_Exch	1	0	LRS	CED
PMA_Fine_Adjust	1	1	LRS	reserved

SI1, SI0 ... state indicator bits, convey to remote PHY the state of the local PHY:
00 for PMA_Training_M or S,   01 for PMA_PBO_Exch,
10 for PMA_Coeff_Exch,   11 for PMA_Fine_Adjust

LRS = 1 (0) ... conveys to remote PHY state variable loc_rcvr_status = OK (NOT_OK)
EST = 1 (0) ... conveys to remote PHY state variable en_slave_tx = OK (NOK)
PED = 1 (0) ... conveys to remote PHY state variable PBO_exch_done = TRUE (FALSE)
CED = 1 (0) ... conveys to remote PHY state variable coeff_exch_done = TRUE (FALSE),
and determines InfoField transition counter (coefficient exchange) format.

Suggested deletions: PMA_Training_~~Init~~_M / S, N~~OT~~_OK

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Use of <u>message field bits</u> and <u>transition count</u> in the InfoField

Illustration: -> PMA_PBO_Exch ->
-> PMA_Coeff_Exch ->

SI1,0	LRS	P/CED	TC (transition count)	
00	1		0	
01	0	0	0	loc_rcvr_status is reset upon entering new state
			:	
01	1	1	0	local PHY indicates (reconfirms) readiness of receive link for next state transition and PBO_exch_done
			:	
01	1	1	X ($\geq TC_{min}$)	←— local transceiver announces state transition
01	1	1	X-1	
			:	
01	1	1	2 (1)	*(alternatively, if Task Force prefers)*
01	1	1	1 (0)	transition to next state: use requested PBO setting
10	0	0	0	loc_rcvr_status is reset upon entering new state coeff_exchange_done = FALSE: InfoField in coeff. exch. format
			:	
10	1	0		local PHY indicates after local and/or remote PBO change readiness of receive link for next state transition
			:	
10	1	1	0	coeff_exchange_done = TRUE: InfoField in trans. counter format
			:	
10	1	1	X ($\geq TC_{min}$)	←— local transceiver announces state transition
10	1	1	X-1	
			:	
10	1	1	2	
10	1	1	1	transition to next state: enable TH precoding
11	0		0	

PMA_PBO_Exch

PMA_Coeff_Exch

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Comment #43: message field, cont.

Changes in 55.4.5.1 State diagram variables

loc_rcvr_status *(meaning and wording changed)*
    Indicates correct or incorrect operation of the receive link; communicated to the remote PHY
    via message-field bit LRS; reset to NOK when entering new state.
    Values: OK: the receive link operates reliably with sufficient SNR
                  margin for the current state and the next state (LRS = 1).
           NOK: the above statement cannot yet be made (LRS = 0).

en_slave_tx *(missing in 55.4.5.1 of D3.1)*
    Set in state PMA_Training_M; communicated to remote PHY via message-field bit EST.
    Values: OK: SLAVE may advance to state PMA_Training_S (EST = 1).
              NOK: SLAVE must stay in state SILENT (EST = 0).

coeff_exch_done *(wording changed)*
    Set in state PMA_Coeff_Exch; communicated to remote PHY via message-field bit CED.
    Values: TRUE: local PHY has received all THP coefficients from remote PHY
               and the remote PHY indicates reception of all THP coefficients
               from the local PHY (CED = 1).
          FALSE: coefficient exchange still in progress (CED = 0)

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Comment #43: message field, cont.

Changes in 55.4.5.1 State diagram variables

transition_counter *(meaning and wording changed)* *(missing in version of 5Mar06)*

A 10-bit counter variable whose value is communicated to the remote PHY in the TC (transition count) subfield of InfoFields in transition counter format. In order to announce a state transition to the remote PHY, the local PHY sets transition_counter to a non-zero value not smaller than TC_{min}. The value of transition_counter is decremented by one after each transmission of an InfoField until the value zero is reached. The announced state transition occurs immediately after transmission of the InfoField in which TC = 1.

Values: 0 – 1023.

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Comment #43: message field, cont.

Motion 1: Adopt inclusion of state-indicator bits in message field.

Motion 2: Let other message field bits be:
(a) LRS conveying loc_rcvr_status to remote PHY
(b) EST ... en_slave_tx (PMA_Training_M), or
  PED ... PBO_exch_done (PMA_PBO_exch), or
  CED ... coeff_exch_done (PMA_Coff_exch).

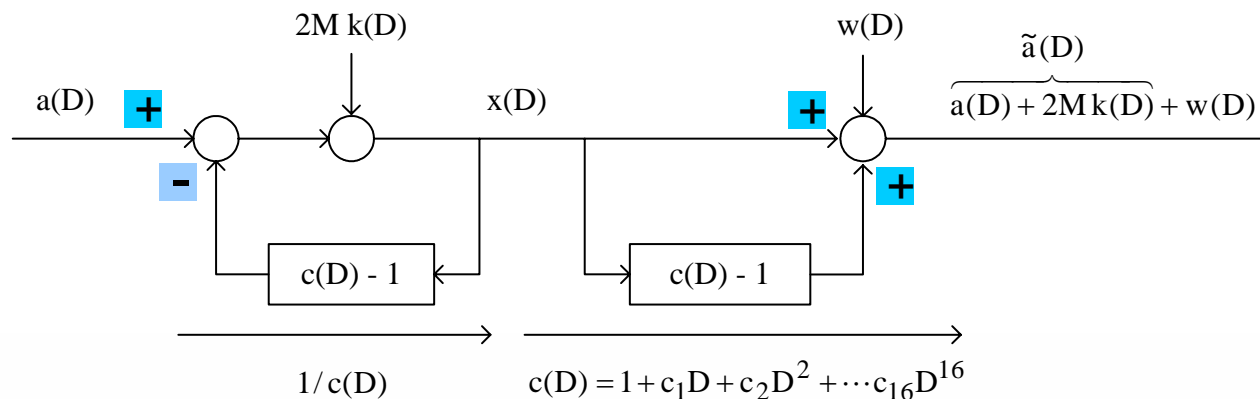**Motion 3:** Eliminate trans_to_Coeff_Exch, trans_to_Fine_Adjust, and trans_to_PCS_Test.

State indicator bits SD1,0 and transition count TC are sufficient to signal state transitions.

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Comment #47: equation (55-4), etc.

- <u>55.4.3.1, page 124, line 46: TR</u>

C: The sign preceding the summation in equation (55-4) ~~is wrong~~ disagrees with THP literature and is unnatural. ---- For TH precoding the overall channel from the precoder output to the output of the adaptive feedforward equalizer in the receiver is equalized towards a causal monic response c(D) = 1 + c1*D + c2*D^2 + c3*D^3 + ... The TH precoder prefilters the sequence of transmit symbols a(D) by 1/c(D) and adds to each symbol an integer multiple of 2M such that the precoder output lies in the interval [-M,+M], where M = 16 in the case of 10GBASE-T. Writing the precoder output as b(D) = a(D)+2M*m(D) – [c(D)-1]*b(D) corresponds to b(D) = [a(D)+2M*m(D)]/c(D), where m(D) is a sequence of integers.

R: Hence, the sign preceding the summation in equation (55-4) should be minus (-).   ---- Suggested further notational changes: use '~~b~~'ã' for the augmented symbols 'a + 32*m', and 'x' for the precoder output; then in equation (55-6) replace 'a sub agmt' by '~~b~~'' 'ã'

$$2M\,k(D)$$

$$w(D)$$

$$\widetilde{a}(D)$$

$$a(D)$$

$$x(D)$$

$$\overbrace{a(D) + 2M\,k(D)} + w(D)$$

$$c(D) - 1$$

$$c(D) - 1$$

$$1/c(D)$$

$$c(D) = 1 + c_1 D + c_2 D^2 + \cdots c_{16} D^{16}$$

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Proposed text for page 124, line 43 ff

.... PMA Transmit generates a pulse-amplitude modulated signal on each pair as follows:

$$x_n = M\left(a_n - \sum_{k=1}^{16} c_k x_{n-k}\right) = \underbrace{(a_n + 32m_n)}_{\tilde{a}_n} - \sum_{k=1}^{16} c_k x_{n-k} \qquad (55\text{-}4)$$

$$s(t) = \sum_n x_n h_T(t - nT) \qquad (55\text{-}5)$$

In equation (55-4) a_n is the ~~1DSQ128~~ PAM16 modulation symbol from the set $\{-15, -13, -11, -9, \cdots -1, +1, +3, \cdots +13, +15\}$ to be transmitted at time n, and x_n is the THP output signal generated at time n. Each of the 16 THP coefficients $c_1, c_2 \cdots c_{16}$ per wire pair is represented in two's complement form by 8 bits as described in 55.4.2.5. The nonlinear THP operation given by $M(\alpha) = (\alpha + 16) \bmod 32 - 16$ corresponds to changing the modulation symbol a_n to an augmented modulation symbol $\tilde{a}_n = a_n + 32m_n$ with the integer m_n chosen such that the THP output lies in the interval $-16 \leq x_n < 16$. Equation (55-5) describes the convolution of the THP output signals with the transmitter ~~impulse~~ symbol response ~~$h_t(t)$~~ $h_T(t)$ to obtain the transmit signal s(t) at the MDI. .....

Proposed text for page 125, line 47 ff

Signals received at the MDI can be expressed for each pair as pulse-amplitude modulated signals corrupted by additive noise as follows:

$$r(t) = \sum_n \tilde{a}_n h_R(t - nT) + w(t) \qquad (55\text{-}6)$$

In equation (55-6) $\tilde{a}_n = a_n + 32\,m_n$ are the augmented ~~DSQ128 (?)~~ PAM16 modulation symbols described in 55.4.3.1, $h_R(t)$ denotes the ~~impulse~~ symbol response of the overall channel from the ~~transmit symbol source (?)~~ TH precoder input in the transmitter to the MDI at the receiver, and $w(t)$ represents the ~~contribution~~ sum of various noise sources including uncancelled crosstalk. ......