Comments on 10GBASE-T Draft 3.1

IEEE P802.3an Task Force
Denver, March 7-9, 2006

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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. . . . .

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?)

Comment #43: message field

- 55.4.2.5.6, page 119, line 22 (message field), TR

  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.

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.

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	reserved
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 (N~~OT~~_OK)
EST = 1 (0) ... conveys to link partner state variable en_slave_tx = OK (NOK)

CED = 1 (0) ... conveys to remote PHY state variable coeff_exch_done = TRUE (FALSE), and determines InfoField transition counter (coefficient exchange) format.

✕ *suggested deletions*

Comment #43: message field, cont.

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

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

State	SI1,0	LRS	CED	TC (transition count)	
	00	1		0	
PMA_PBO_Exch	01	0		0	loc_rcvr_status is reset upon entering new state
	:				
	01	1		0	local PHY indicates (reconfirms) readiness of receive link for next state transition
	:				
	01	1		X (/ TC_{min})	← local transceiver announces state transition
	01	1		X-1	
	:				
	01	1		2 (1)	(alternatively, if Task Force prefers)
	01	1		1 (0)	transition to next state: use requested PBO setting
PMA_Coeff_Exch	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 (/ 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	

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_Exchange; 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)

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 state variable loc_rcvr_status
(b) EST conveying state variable en_slave_tx or
CED conveying state variable coeff_exch_done.

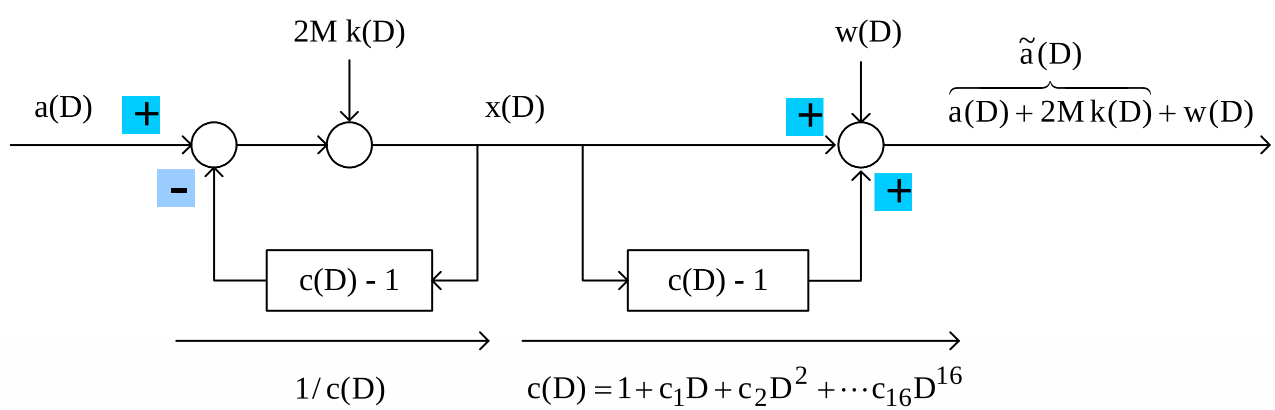
Motion 3: Eliminate trans_to_Coeff_Exch, trans_to_Fine_Adjust, and trans_to_PCS_Test. State indicator bits SD1,0 and transition count TC are sufficient to signal state transitions.

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~~’ '$\tilde{a}$' for the augmented symbols ‘a + 32*m’, and ‘x’ for the precoder output; then in equation (55-6) replace ‘a sub agmt’ by ‘~~b~~’ '$\tilde{a}$'



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

Proposed text for page 124, line 43 ff

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

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

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

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 $\tilde{a}_n = a_n + 32\,m_n$ with the integer m_n chosen such that the THP output lies in the interval $-16 \le x_n < 16$. Equation (55-5) describes the convolution of the THP output signals with the transmitter ~~impulse~~ symbol response ~~$h_1(t)$~~ $h_T(t)$ to obtain the transmit signal s(t) at the MDI. .....

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

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. ......