ILT support in coherent PHYs

(in support of comments **418**, **419**, 546, 547, 548, 549, 550, 551, 552, 397, 400)

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Overview

- Coherent PMDs currently do not have a training protocol, but should still participate in the path start-up.
- As detailed in ran_3dj_02_2507, the ILT state diagrams support path start-up either with or without a training protocol.
  - If **mr_training_enable=false** then the training protocol is disabled and local_rts is indicated by transmission of a local pattern.
- There seems to be consensus that an ILT function should be included in coherent PMDs too, at least for the purpose of path start-up.
  - This presentation proposes a way to do that.
  - This proposal assumes no training protocol; one could be added later if a proposal is adopted (it is not addressed by this presentation).

How should ILT be used in a coherent PMD (with no training protocol)

- mr_training_enable=false such that the left-hand part of the diagram is always used.
- While local_rts=false, state is QUIET
  - tx_disable can be implemented using the existing PMD global transmit disable function
  - Alternatively, the PMD Tx can stay on, and the client (FEC) can generate another signal, e.g. unmodulated; but currently this is not defined
- When local_rts becomes true, it is signaled to the peer by enabling the transmitter (SEND_LOCAL)
- When the PMD receiver is locked (local_rx_ready), after propagation_timer, the transmitter goes to DATA mode (tx_mode=data).

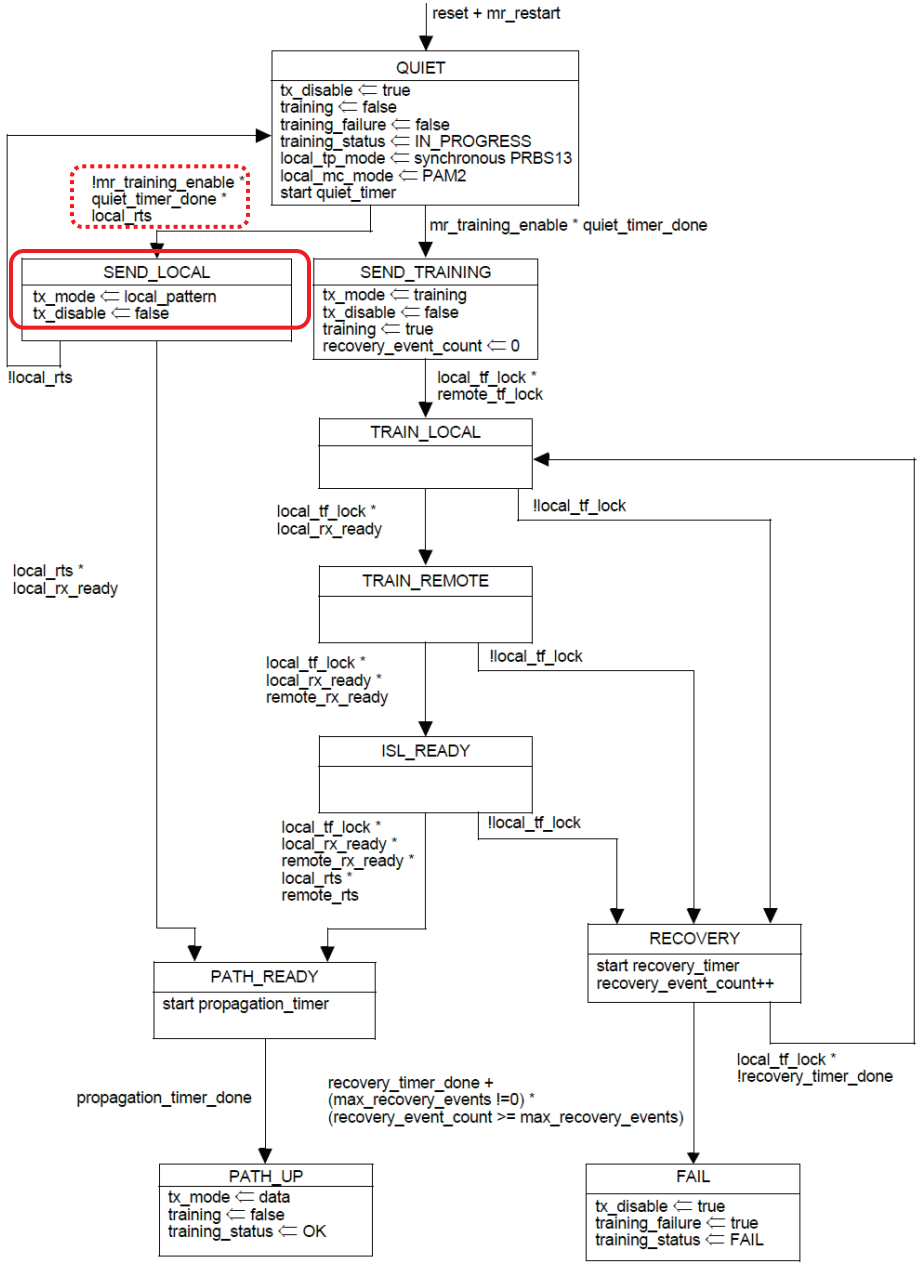

Figure 178B–8—Training control state diagram

Should coherent use training frames?

- There are advantages to using a coherent-modulated signal instead of communicating RTS via squelch.
  - Especially since squelching a coherent transmitter may be less desirable.
- A straightforward way to achieve that is to map the bits communicated by the protocol (“receiver frame lock”, “continue training” (= !RTS), “receiver ready”) onto the DSP frame or FEC sequence, and use the existing state diagrams in Annex 178B.
  - This would be the behavior when **mr_training_enable=true**.
  - It can enable more Tx optimization options, perhaps with additional bits.
  - A possible path is described in mi_3dj_01_2507 (comments 397, 400).
  - Doing that would perhaps require a more detailed proposal and isn’t addressed by this presentation.
- If such a protocol is defined, the squelch/local_pattern method described in this presentation would be a fallback option (with **mr_training_enable=false**).
  - It is still beneficial to have this method as in the other PMDs. (There is no contradiction between comments 397, 400, 418, and 419).

What's missing

- Coherent PMDs should include an ILT function, but without the training protocol defined in Annex 178B.
- tx_disable used in ILT should be supported (currently "Global transmit disable" is optional).
- PMD transmit function should include DATA and TRAINING modes.
- An adequate test pattern should be defined for each PMD in TRAINING mode.
- Service interface IS_SIGNAL.request primitives should be added in the PMDs and in their client sublayers (FEC).
  - However, unlike the IM-DD PMDs, **the IS_SIGNAL.indication should keep its current definition** (based on optical power), because it feeds the DSP lock functions. The client (FEC) generates its own SIGNAL_OK based on DSP lock.
- Diagrams should be updated where necessary.

Proposed changes

- Add ILT to the Physical Layer clause tables, Table 185–1 and Table 187–1.
- Add ILT subclauses in the functional specification subclauses 185.5 and 187.5.
- In 185.5.2 and 187.5.2, add the two modes of the transmit functions (TRAINING and DATA). TRAINING mode causes transmission of the “encoded PRBS31” test pattern.
  - In 185.5.11, PRBS31 encoded by Inner FEC (as defined in 184.6.1).
  - In 187.5.11, 800GBASE-ER1 FEC encoded PRBS31 (as defined in 186.2.3.12).
- Change the PMD global transmit disable functions (185.5.7 and 187.5.7), currently optional, to be mandatory.
- Add IS_SIGNAL.request in the service interface subclauses and diagrams.
  - In clauses 185 and 187, and also in clauses 184 and 186.

An implementation example for clause 185 is shown on the next slide.

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Implementation example – clause 185

Table 185–1—Physical Layer clauses associated with the 800GBASE-LR1 PMD

Associated clause	800GBASE-LR1
90—Time Synchronization	Optional
120F—800GAUI-8 C2C	Optional[a]
120G—800GAUI-8 C2M	Optional[a]
170—800 Gb/s RS	Required
170—800GMII[b]	Optional
171—800GMII Extender	Optional
172—800GBASE-R PCS	Required
173—800GBASE-R BM-PMA	Conditional[c]
176—800GBASE-R SM-PMA	Conditional[c]
176C—800GAUI-4 C2C	Optional[a]
176D—800GAUI-4 C2M	Optional[a]
184—800GBASE-LR1 Inner FEC	Required
178B—ILT	Required

185.3.1.4 PMD:IS_SIGNAL.request(SIGNAL_OK)

The PMD:IS_SIGNAL.request primitive is generated by the Inner FEC sublayer. Its definition is identical to the one provided in 116.3.3.4.

185.5.2 PMD transmit function

The PMD transmit function has two operating modes: DATA and TRAINING. The operating mode is controlled by the tx_mode variable of the ILT function (see 185.5.11): it is DATA when tx_mode = data, and TRAINING otherwise.

When in TRAINING mode, the PMD shall cause the Inner FEC to transmit the test pattern specified in 184.6.1.

The PMD transmit function shall convert the four analog streams (Tx_X_I, Tx_X_Q, Tx_Y_I, Tx_Y_Q) from the Inner FEC passed across the PMD service interface via the PMD:IS_UNITDATA.request primitive (see 185.3.1.1) into a single optical signal with orthogonal polarizations modulated using 16QAM and deliver them to the MDI, all according to the transmit optical specifications in this clause.

185.5.11 Inter-sublayer link training (ILT) function

A PMD shall provide the ILT function specified in Annex 178B. The ILT variable mr_training_enable is always false. ILT is used to coordinate the transition to DATA mode.

The ILT variable local_rx_ready shall be set to the value of the alignment_valid variable of the inner FEC (see 184.7.2.2).

The ILT variable tx_disable shall have the same effect as PMD_global_transmit_disable (see 185.5.7).

Note: other changes may be required as a result.

That’s all

Questions?