EPoC PMD Structure

Solving the EPoC Generation Problem

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Summary

- EPoC is intended to operate over multiple channels of 192MHz each (with some exclusion bands) to provide the aggregate bandwidth of up to approx. 10 Gbit/s
- Contribution mallette_3bn_01_0313.pdf presented an operators view on multiple generations of EPoC. It is desirable to have a single product generation (supporting up to 4 channels) without mandating complex load balancing scheme.
- Support for multiple channels can be solved through product differentiation: some products will support only one, some 2, others 3 and other yet – 4.
- No need to guarantee that products with different number of channels can operate on a single CLT port. This flexibility will have substantial impact on complexity of devices and PMD design.
- Decision on PMD name can be also taken: 10GPASS-XR is suggested.

EPoC and Support for multiple channels

Technical decisions so far

- Multiple OFDM channels of 192 MHz to be supported on a single port (up to 4) per operator provisioning.
- Each 192 MHz OFDM channel has independent exclusion bands to work around other services, noise sources, etc.
- Each 192 MHz OFDM channel in downstream to support up to 1.6 Gbit/s at 4096 QAM encoding
- Each 192 MHz OFDM channel in upstream to support up to 0.4 Gbit/s at 1024 QAM encoding
- The total supported data rate can be up to 10 Gbit/s downstream and up to 10 Gbit/s upstream
- Upstream and downstream data rates, modulation formats, QAM encoding, etc., are configured independently.

Support for EPoC Generations (1)

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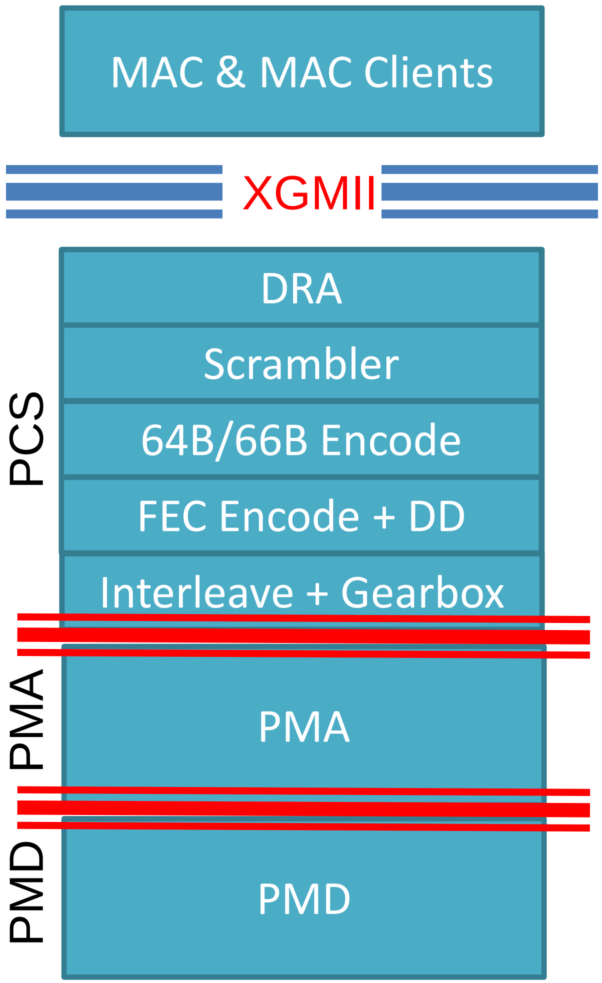
- Flexibility to support multiple channel configuration on a single CLT port comes with a price: complex load balancing schemes between channels, destination-aware PCS, complex multicast and broadcast support, etc.
- A lot of these problems go away if all CNUs connected to a CLT port support the same number of OFDM channels in downstream and upstream: 1, 2, 3, or 4.
- IEEE P802.3bn TF can then design a single PMD to operate on 192 MHz OFDM channel in downstream and 192 MHz OFDM channel in upstream, as well as PCS and MAC Control layers to connect to 1, 2, 3, or 4 PMD instances.
- Similar PCS designs are used in multi-lane 40GE and 100GE PMDs designs defined in book 6 of 802.3-2012.

Support for EPoC Generations (2)

- How does it work?
  - During device initialization, the MAC Control layer discovers (through capability registers) how many PMD instances are connected to PCS and what maximum effective data rate can be supported.
  - During the PHY discovery phase, the MAC Control further identifies what the actual effective data rate is, taking into account exclusion bands, pilot structure, CP size, and other OFDM overhead elements.
  - Once done, MAC Control can properly contribute the Data Rate Adaptation function to make sure no more data is being sent from queues across PMD than the PMD can actually handle. Large part of this function is already in place in Clause 101.

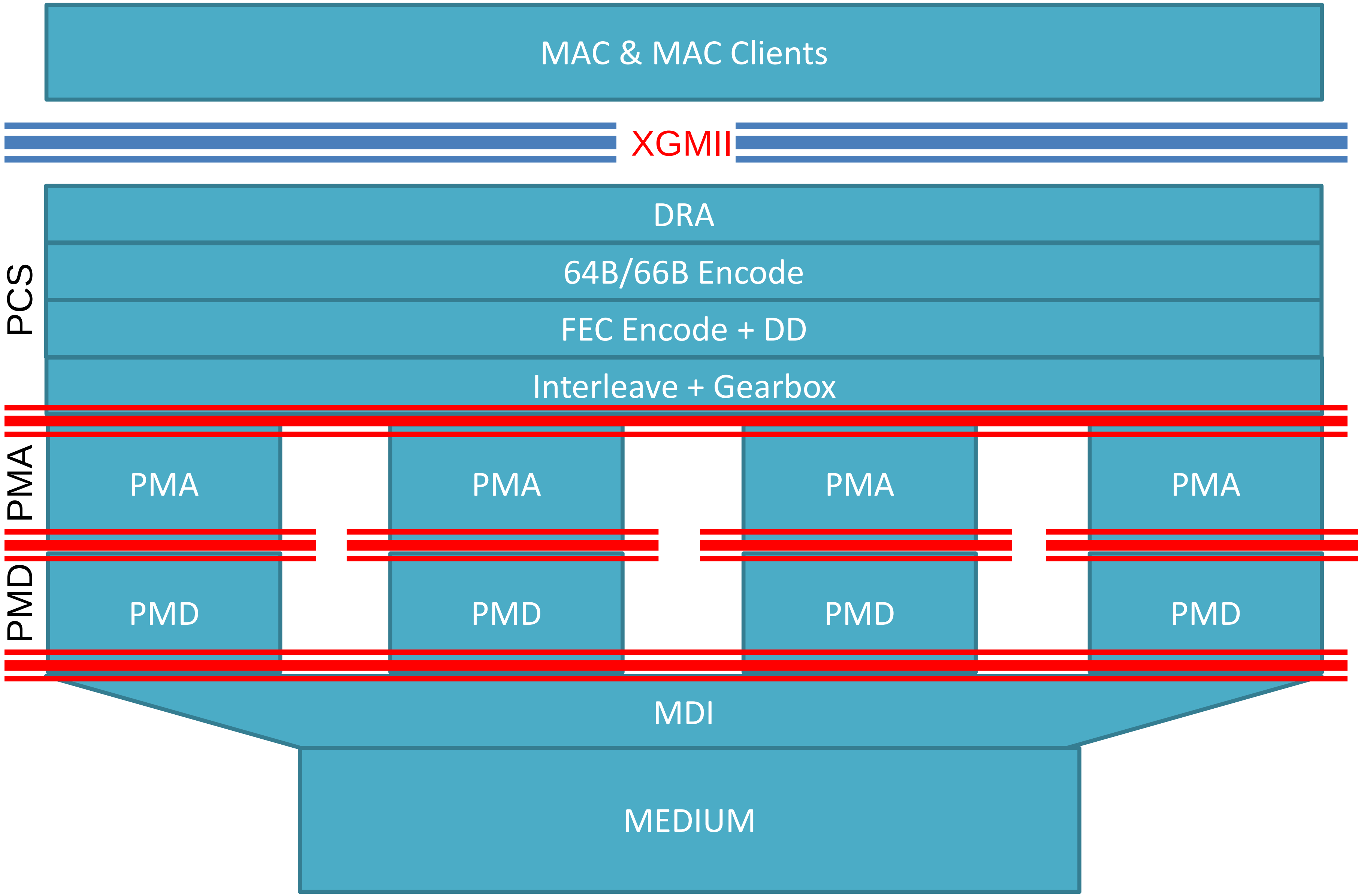
- Once the configuration is done, PCS is aware into how many OFDM channels and at what effective data rate to spread the bit stream coming down from 10G MAC

Support for EPoC Generations (3)



- PCS is located between XGMII and PMD
- PCS is responsible for conditioning MAC data stream for transmission across the coaxial medium
- EPoC PCS functions include: 64B/66B encoding, FEC encoding, data rate adaptation, interleaving, etc.
- EPoC PMA functions are still under discussion (see kliger_3bn_01a_0913.pdf for downstream flow structure for EPoC)
- The effective EPoC stack structure with support for multiple PMDs is shown on next slide(s).

Support for EPoC Generations (4)



How does it work? (1)

- MAC Control discovers the number of connected PMDs and their effective data rates
- Knowing that, the Data Rate Adaptation (DRA) function is configured accordingly at MAC Control and at the top of PCS
  - PCS-based DRA can read configuration parameters from registers
- Data flowing from queues through MAC Control, MAC and XGMII is the processed through DRA, 64B/66B encode and FEC encode processes.
  - excess Idle control characters are removed
  - FEC parity and CRC40 is inserted into the data stream
- Data stream is then spread across individual PMD instances within Gearbox

How does it work? (2)

- Given multi-lane transport is used , alignment markers might need to be inserted into the data stream within Gearbox
  - this approach was used in multi-lane 40GE and 100GE PMDs
  - it facilitates data alignment and skew compensation between individual data lanes (PMDs)
- The applicability of alignment markets for EPoC needs to be studied in more detail
  - Need to examine propagation speed delta for extreme spectrum allocation, e.g., one channel at low frequencies (0-192MHz) and another channel at very high frequencies (1GHz+)
  - Target distance is also of importance here
  - Need to assess the impact of FDD amplifiers on skew between individual channels (is it known?)

EPoC PHY Name

EPoC PHY Name

- Why it matters?
  - We're beginning to get seriously involved in the draft development and in multiple locations, PHY name will be needed to refer to the THING we are developing
  - PHY name should be descriptive and meaningful to the group as well as the world outside.
  - PHY name carries information type of encoding used in PHY, modulation format, medium type, data rate, etc. and is a mnemonic summary of PHY capabilities.
- Is this a good time to pick a name for EPoC PHY?
  - The sooner, the better – we have most needed information about EPoC PHY already (64B/66B encoded, OFDM modulation, operating on coax, at the variable rate of up to 10G)
  - Once settled, it will be used in the draft, presentations, etc., and become a de-facto calling card for EPoC

EPON PHY Naming Explained

Symmetric (1G/1G) PMD — 1000BASE-PX10-D

1G-EPON

- P for PON
- X for 8b/10b coding
- Power budget [10,20]
- Location [D > OLT, U > ONU]

Asymmetric (10G/1G) PMD — 10/1GBASE-PRX-U1

10/1G-EPON

- P for PON
- R for 64b/66b coding
- X for 8b/10b coding
- Location [D > OLT, U > ONU]
- Configuration [1,2,3]

Symmetric (10G/10G) PMD — 10GBASE-PR-D1

10/10G-EPON

- P for PON
- R for 64b/66b coding
- Location [D > OLT, U > ONU]
- Configuration [1,2,3]

EPoC What ?

- Here is what we know about EPoC PHY:
  - Operates at the data rate up to 10Gb/s: 10G
  - Operates with OFDM modulation: PASS
  - 64B/66B encoded: R
  - Operates over coax: X (?)
  - Number of PMD instances: x (1-4)
- Putting it together: **10GPASS-XRx**
- X is used for coax, since C is already used for backplane media operating also over copper channels.
  - It is unfortunate, but suggest to avoid overlap with backplane PMDs
- x indicates the number of PMD instances in the given PHY (1-4) and indicates the effective data rate capability for the PHY