EPON over Coax

EPoC Feature Matrix and Specification Impact

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Scope of the presentation

- This presentation aims at analyzing the impact to MAC/RS and PCS layers (and their interactions) of some features that have been discussed and raised as requirements for MCS and adaptive bit-loading
- In particular, the focus of the presentation is to illustrate the impact of those features on the specification
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DOWNSTREAM

Feature analysis: Fixed MCS or bit-loading per plant in DS

- This configurations assume one common bit-loading curve or one common MCS for all the CNUs in DS
- For each CNU the number of bits that can be transmitted in DS for each OFDM symbol is fixed and is the same
  - The amount of data that is sent in a time window equal to the OFDM symbol is independent from the destination CNUs

Example of solution

- Time-to-time/frequency mapping in the PHY layer of the CLT can be used to transmit data
  - It is sufficient for the MAC control to know the data rate for IDLE insertion
  - RS-PCS interface just transfer data to the PHY
- When a CNU newly register to the plant, it may happen that the selected MCS would need to be changed and all other CNU needs to be informed

Feature Matrix - Downstream

Features	MAC/MPCP		PHY		Comment
	MPCP protocol (message format)	MAC control	RS/PCS interface	PCS	
Fixed MCS per plant (no bit loading) – DS	--	CLT aware of PHY layer rate	--	Time-to-time/frequency mapping in CLT	Need to inform CNUs in case of changed MCS
Bit-loading per plant – DS	--	CLT aware of PHY layer rate	--	Time-to-time/frequency mapping in CLT	

Feature analysis: MCS or bit-loading per CNU in DS

- The MCS (or bit-loading curve) is different for each CNU (or CNU group) in DS
- For each CNU the number of bits that can be transmitted for each OFDM symbol can be different
  - The amount of data that is sent in a time window equal to the OFDM symbol is dependent from the destination CNUs

Example of solution

- Time-to-time/frequency mapping in the PHY layer of the CLT can be used to transmit data
  - It is sufficient for the MAC control to know the data rate for IDLE insertion for each destination CNU
    - IDLE insertion can be done packet-by-packet - no significant complexity added
  - RS-PCS interface just transfer data to the PHY
  - The PCS need to map to the proper MCS the packets received from the MAC layer based on the packet destination

Time – to – time/frequency mapping in DS

- In this presentation the time-to-time/frequency mapping has been considered to minimize the impacts to MAC control
  - With this feature gating is assigned only using time domain
- For DS with bit loading per CNU this solution has an issue on the idle insertion
  - Idle insertion can be done per packet, i.e. the idle are inserted for each packet to map the XGMII rate with the one on the physical channel. This depends on
    - The destination CNU
    - The portion of the spectrum where the packet is sent
  - Assuming the same amount of frame bytes, the number of idle inserted in a OFDM symbol time window is not constant
- As a consequence, idle insertion requires the MAC control to be aware of the beginning of the OFDM symbol and the bit-loading profile for each CNU
  - This implies extensions to the RS/PCS interface

Feature Matrix - Downstream

Features	MAC/MPCP		PHY		Comment
	MPCP protocol (message format)	MAC control	RS/PCS interface	PCS	
Bit-loading per CNU group – DS	--	CLT aware of MCS or bit-loading profile for each CNU	CLT-OFDM symbol start	Proper coding per CNU destination + Time-to-time/frequency mapping in CLT	Coding not considered
MCS per CNU group – DS	--	CLT aware of MCS or bit-loading profile for each CNU	--	Proper MCS based on CNU destination + Time-to-time/frequency mapping in CLT	Coding not considered

UPSTREAM

Feature analysis: Fixed MCS per plant in US

- This configuration assumes a common MCS for all the CNUs in US
- For each CNU the number of bits that can be transmitted in US for each OFDM sub-carrier is the same
  - The amount of data that is sent in a time window equal to the OFDM symbol is
    - Independent from the spectrum chunk used by the CNU
    - The same for all the CNU

Example of solution

- Time-to-time/frequency mapping in the PHY layer of the CNU can be used to transmit data
  - It is sufficient for the MAC Control to know the data rate for IDLE insertion
  - RS-PCS interface just transfer data to the PHY
  - MPCP gating can be performed on the time domain only

- When a CNU newly register to the plant, it may happen that the selected MCS would need to be changed and all other CNU needs to be informed

Feature analysis: MCS per CNU in US

- This configurations assume different MCS for the CNUs in US
- For each CNU the number of bits that can be transmitted in US for each OFDM sub-carrier is the same
  - The amount of data that is sent in a time window equal to the OFDM symbol is
    - Independent from the spectrum chunk used by the CNU
    - Different for the CNUs

Example of solution

- Time-to-time/frequency mapping in the PHY layer of the CNU can be used to transmit data
  - It is sufficient for the MAC control to know the data rate for IDLE insertion
  - RS-PCS interface just transfer data to the PHY
  - MPCP gating can be performed on the time domain only

Feature Matrix - Upstream

Features	MAC/MPCP		PHY		Comment
	MPCP protocol (message format)	MAC control	RS/PCS interface	PCS	
Fixed MCS per plant (no bit loading) – US	--	CNU aware of PHY layer rate	--	Time-to-time/frequency mapping in CNU	Need to inform CNUs in case of changed MCS
MCS per CNU group – US	--	CNU aware of PHY layer rate	--	Time-to-time/frequency mapping in CNU	

Time – to – time/frequency mapping in US

- In this presentation the time-to-time/frequency mapping has been considered to minimize the changes to MAC and MPCP
  - With this feature gating is assigned only using time domain
- For US with bit loading this solution has an issue
  - For a CNU the number of bits that can be transmitted in US for a given time window can change
- Additional interaction/extensions are required to enable this feature (see next slide)

Solutions enabling US bit-loading

- Approach a)
  - Usage of time – to – time/frequency mapping
    - Gating is performed at time domain only
      - MPCP gate include only grants on the time domain
      - Time domain is mapped in time/frequency at the PHY layer
  - CNU - MAC control awareness of
    - OFDM symbol window start instant
      - This requires extensions to RS/PCS interface
    - Bit-loading profile
    - Time-to-time/frequency mapping
  - CNU MAC control uses the inputs to find out the number of bits that can be sent to the PHY when using the grant

- Approach b)
  - No usage of time – to – time/frequency mapping
  - Gating performed on time and frequency
    - Grant allocates time and frequency windows
    - CLT allocates grants in frequency and time
  - The CNU MAC control indicates to the PHY layer the frequency portions where packets must be allocated

Feature analysis: bit-loading in US

- Two possible configurations
  - Bit-loading per plant
    - Different sub-carriers for a CNU can transmit different amount of bits
    - The same sub-carrier for different CNUs transmit the same amount of bits
  - Bit-loading per CNU
    - Different sub-carriers for a CNU can transmit different amount of bits
    - The same sub-carrier for different CNUs can transmit different amount of bits
- Approach a) and b) can be used for both configurations
  - Bit-loading per plant requires update of bit-loading profile upon entry/exit of CNUs

Feature Matrix - Upstream

Features	MAC/MPCP		PHY		Comment
	MPCP protocol (message format)	MAC control	RS/PCS interface	PCS	
Bit-loading per plant – US	Approach b) grant of Gate message with frequency allocation	CNU aware of PHY layer bit-loading profile	Approach a) CNU- OFDM symbol start Approach b) CNU- indicate frequency mapping of packets	Approach a) Time-to-time/frequency mapping in CNU	Need to inform CNUs in case of changed MCS
Bit-loading per CNU – US					

Conclusions

- An impact survey of possible extensions required to cope with bit-loading/adaptive MCS has been provided
- The usage of MCS per plant or MCS for different (group of) CNUs (in DS and US) requires changes to:
  - MAC control
  - PCS
- The usage of bit-loading per plant or bit-loading for different (group of) CNUs (in DS and US) requires changes to:
  - MAC control
  - PCS
  - RS/PCS interface

THANK YOU