IEEE 802.3ah

FEC frame Considerations for EPON

Lior Khermosh – Passave

Supporting:

Steve Mclaughlin –Calimetrics

Hal Roberts – ADC

Larry Rennie – National Semiconductor

lior.khermosh@passave.com

Scope

- FEC for EPON
- RS codes
- Merging FEC with Ethernet packet format options

FEC for EPON

- EPON is a link budget limited medium
- FEC improves the link budget
- FEC reduces data rate and adds delay and complexity
- FEC for gigabit optical lines is already defined in ITU- G.975

Reed Solomon Codes

- Family of (n=2^8,k=(2^8-1-2***t***),***t***) RS codes
- Over GF(2^8), each byte is a code symbol – Convenient octet format
- Correction factor of ***t*** symbols
- Well Known encoder and decoder
- The ITU G.975 uses the (255,239,8) RS code.
- (255,239,8) has BER improvement of 10^{-4} to 10^{-12} - Coding gain (@ 10^{-12}) – 5.6dB for AWGN

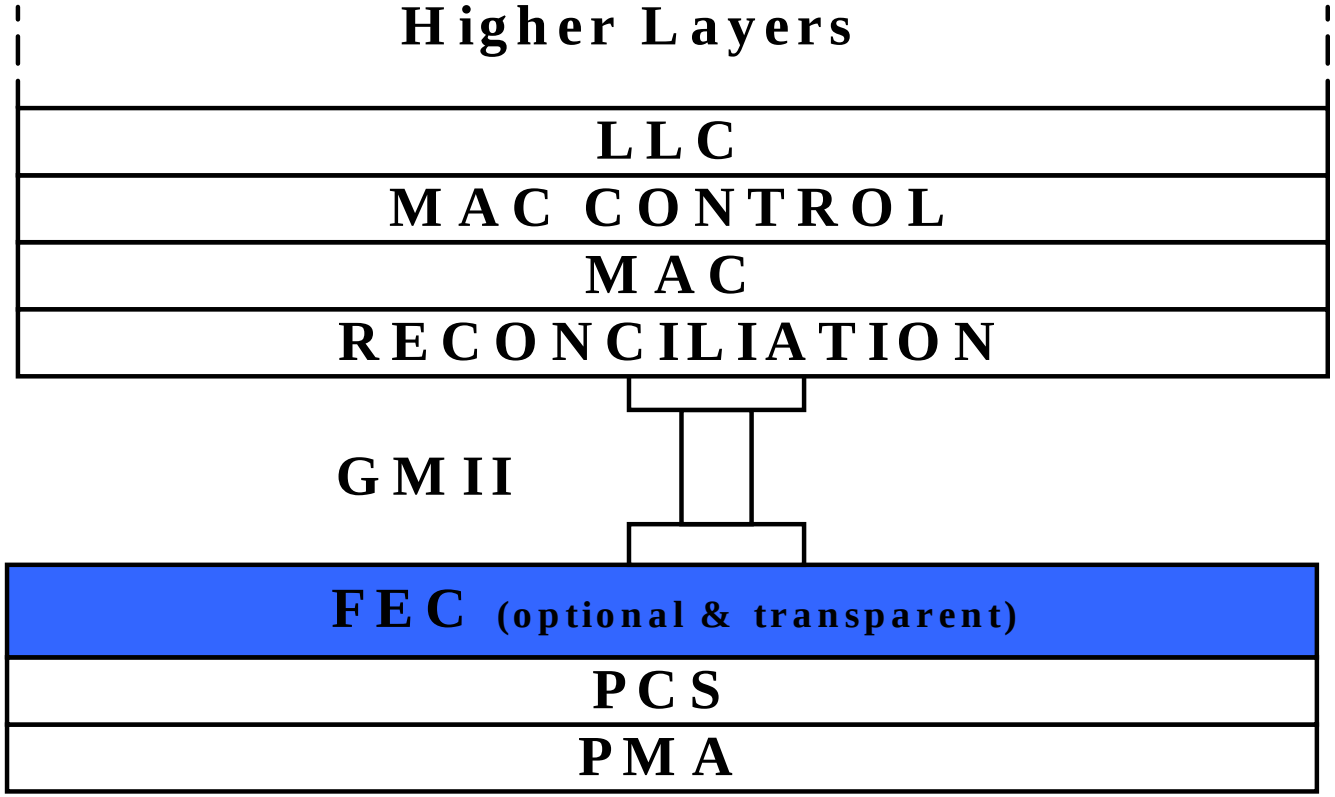
For commercial components of a PIN and APD receivers we can obtain:

- 4.5dB for APD, 3.5-4dB for PIN -Sufficient for adding a splitter

Reed Solomon Codes – Cont'd

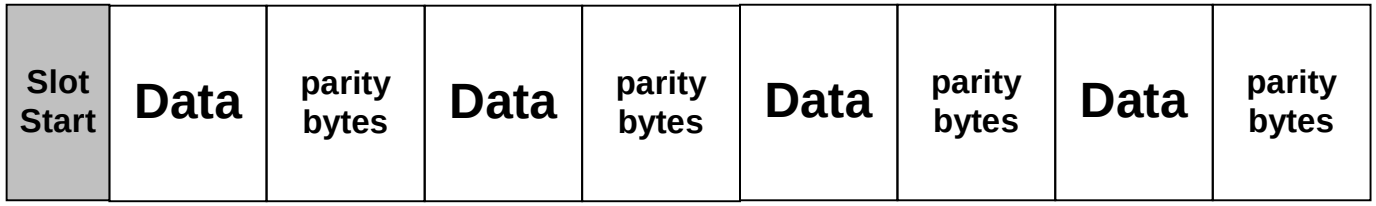
- The (255,239,8) RS code has a rate loss of 6%, line rate may be increased.
- The (255,239,8) has a code latency of 6.1usec ("Cost effective High Split Ratio for EPON" – Hal Roberts (ADC) / July01)
- Synchronization time may increases with coding gain factor – increases uplink grant preamble (worse case 4dB = 2.5 times)

Merging FEC with Ethernet packet format



Ethernet FEC Packet Format – Option 1

- Use FEC on data stream
- FEC is above the 8B/10B code
- Systematic code form – enables comma detection
- Parity check bits at block end
- Synchronize FEC with Slot Start
- Special 10B code words are coded as 8 bits. Feedback from the PCS clears ambiguity



Ethernet FEC Packet Format– Option 2

- Optional use of FEC.
- Compatibility with FEC disabled devices
- Using systematic code – visible data bytes
- All of the packet is decoded including preamble, address and FCS.
- Parity check bytes should be added at the end of the packet.

/R/K28.5/ D21.2/S/	Preamble	SFD	Header	Data: 46-1500 byte	FCS	/T/R/ K28.5/ D21.2/T/ R/	$\left(2\cdot t\cdot\left\lceil\frac{64}{k}\right\rceil\right)$ to $\left(2\cdot t\cdot\left\lceil\frac{1518}{k}\right\rceil\right)$ code parity bytes	/T/R/ K28.5/ D21.2/T/ R/	IPG

Ethernet FEC Packet Format - Option 2 - Cont'd

- Shortened last frame – virtually zero padded
- Additional delay of a packet size – up to 12usec. Net Round trip delay is 100usec for 10Km.
- FEC is above the 8B/10B code
- Special 10B code words are not FEC coded.

Protecting Special 10B words in option 2

- Protect special 10B words by duplicating and correlating.
- Should be transparent to FEC disabled state machine.
  - /K28.5/ - comma is in the idle word and is duplicated many times – remains the same
  - /S/ - Start_of_Packet - ex: /R/K28.5/D21.2/S/
  - /T/ - End_of_Packet (and end of parity check bytes) - ex: /T/R/K28.5/D21.2/T/R/

Conclusion

- Optional use of FEC
- Preferred RS (255,239,8) code
- Two options for Ethernet FEC frame:
  - Option 1 – FEC frames with slot sync. –low delay and memory, constant rate loss.
  - Option 2 – Parity check bytes at the end of the Ethernet packet – Transparent to non FEC Ethernet, shortened block for packet end