FEC Considerations for 10Gbps EPON System

WADA, Hirotaka
Takahashi, Seigo
Saeki, Naoto

September 18, 2006

NEC

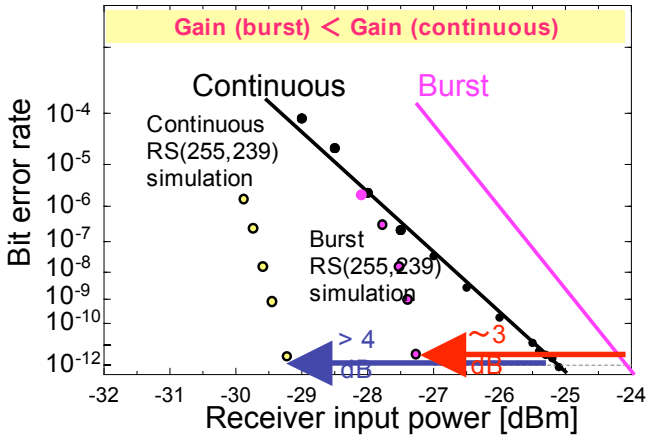
FEC scheme for 10Gbps EPON

- FEC concept

FEC codes with low latency and low cost are preferable to codes with high gain.

- High coding gain codes → long frame (G.975.1: 100K～500Kbits), large latency (especially in decoding process), high cost
- Burst transmission (upstream): BER curve of burst signal is steeper than curve of continuous signal (bit synchronization error, bias error, ..etc.)

  ⇒ Coding gain is smaller in burst transmission than in AWGN* simulation



Flexibility

- Scalability and robustness for future
- Effective utilization of bandwidth

Other factors

- Backward compatibility with GEPON standards
- Decoder cost is higher than encoder cost

  (→Simple decoder for ONU)

*AWGN: Additive White Gaussian Noise

FEC scheme for 10Gbps EPON

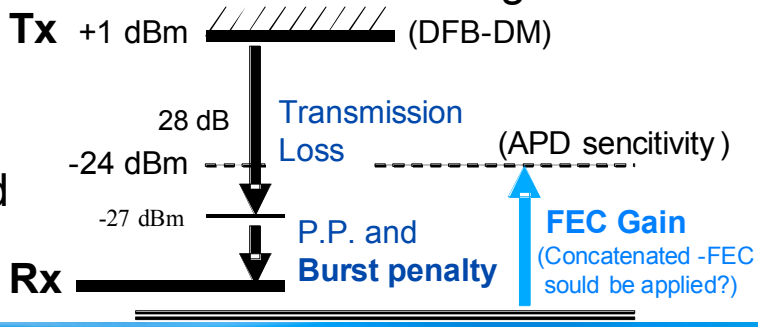
- FEC plan

Downstream: Option

- OLT with high launch power (> +5dBm) can be expected
- RS (Reed-Solomon) code may be applied (Option)
  Scalability and robustness for future
- ONU cost is priority issue
  ⇒ Simple decoder

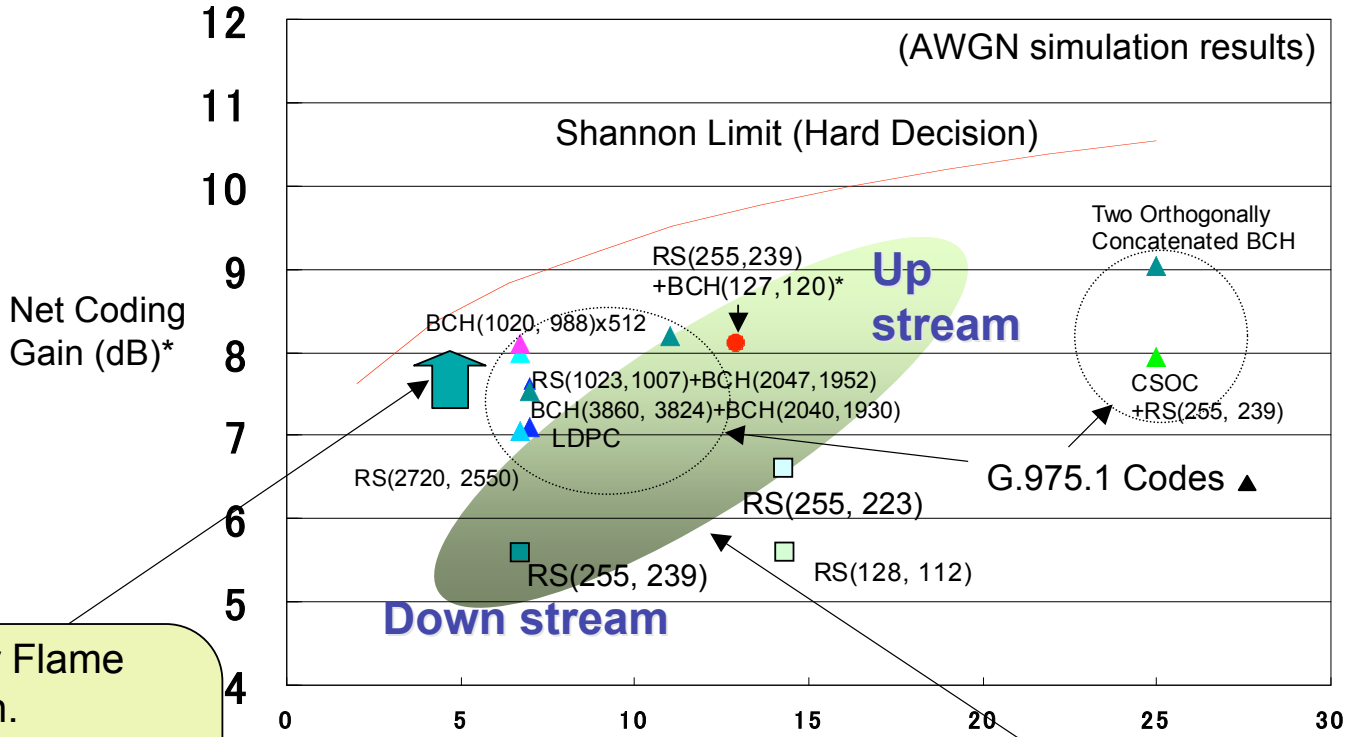
Upstream: Mandatory

- ONU with high launch power is difficult in consideration of cost
  ⇒ FEC code should be applied
- BER curve of burst signal is steeper than that of continuous signal
  ⇒ FEC codes with high coding gain as like some G.975.1 codes seem both too long and complex. RS codes or their short concatenated codes would be good choices.



FEC scheme for 10Gbps EPON

Redundancy



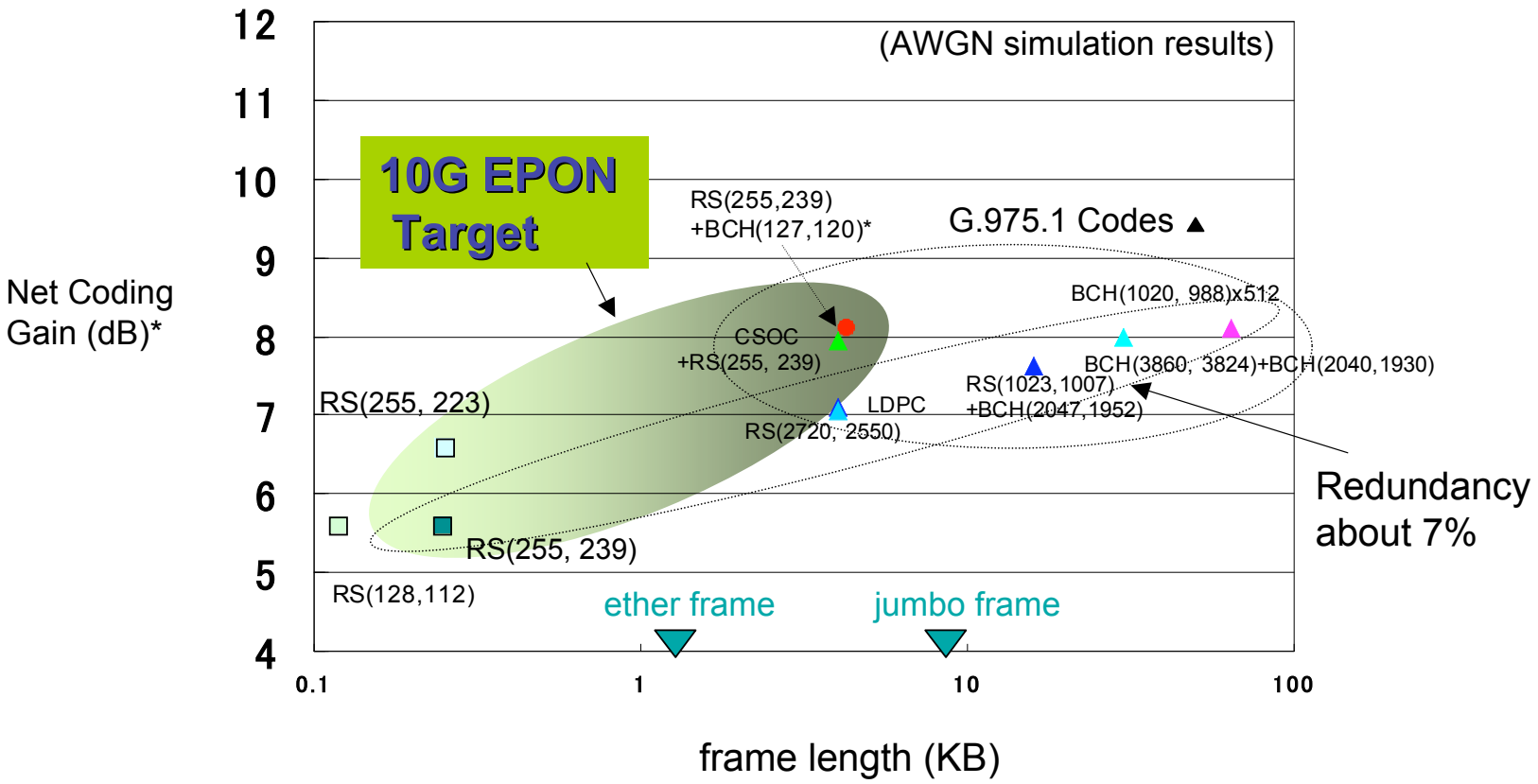
Larger Flame Length. (100K～500Kbits in G.975.1) More Iterations in Decoding

10G EPON Target

*** RS(255,239)+BCH(127,120) result from a KDDI draft at 802.3 plenary meeting, July 2006**

FEC scheme for 10Gbps EPON

Frame length



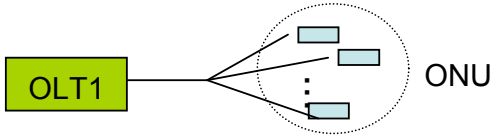
*** RS(255,239)+BCH(127,120) result from a KDDI draft at 802.3 plenary meeting, July 200**

FEC scheme for 10Gbps EPON

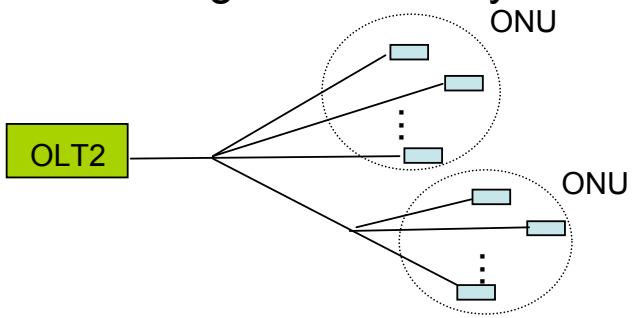
Flexibility

Rate Compatible FEC seems to be able to make PON systems more flexible.

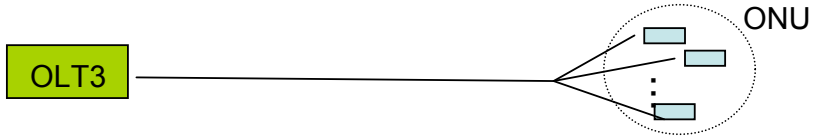
(a) standard – low redundancy FEC



(b) many ONU's – high redundancy FEC



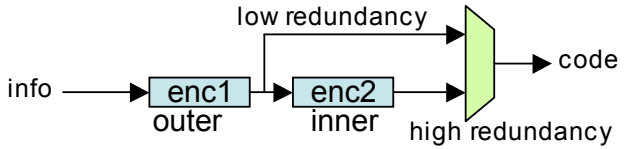
(c) long distance – high redundancy FEC



Further Discussion

Rate-Compatibility Mechanism Examples

- concatenated code case:



- punctured code:
  Some of parity bits are not transmitted (redundancy down).
  major technique for convolutional codes.
  ex. mobile phone, satellite, ...

Issues of Optical Amplifier for OLT Receiver

- Optical amplifier has some issues
  - **SNR**:
    - OLT could not be applied narrow band pass filter because signal wavelength from uncooled LD widely distribute (e.g. up to 40 nm: gain bandwidth).
      - ∅ Large ASE noise will degrade SNR in receiving signal.
  - **PDG** (polarization depending gain) **in SOA**:
    - PDG in SOA depend on signal wavelength.
    - Achieving polarization independent characteristics over wide wavelength range seems to be difficult?
      - ∅ It might potentially increase dynamic range of arrival frame.
  - **Gain un-stability** (depending on carrier relaxation time):
    - When receiving different optical amplitude frame from previous one, gain will fluctuate for a while.
      - ∅ Controlling receiver threshold to follow the fluctuation is difficult.
  - **Cost**:
    - Silicon can be expected less expensive than optical components.
      - ∅ FEC might be better solution for expanding power budget?

Empowered by Innovation