Address 10G EPON Tech. Feasibility and Economics Using Advanced 10G PHY

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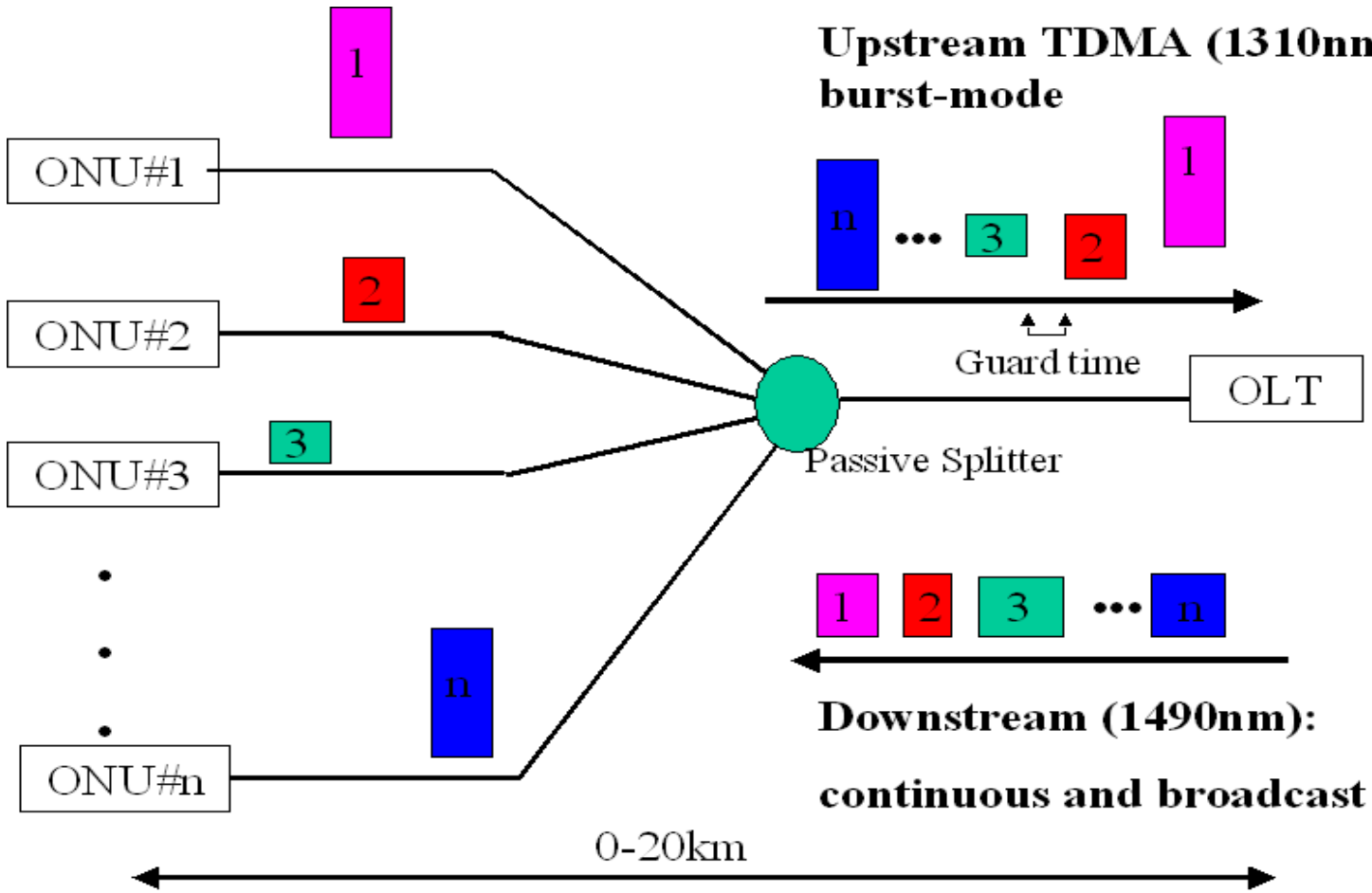
GEPON Architecture for FTTx Scenario



Symmetric 1.25G/1.25G

Continuous (CM) Downstream
Burst-mode (BM) Upstream

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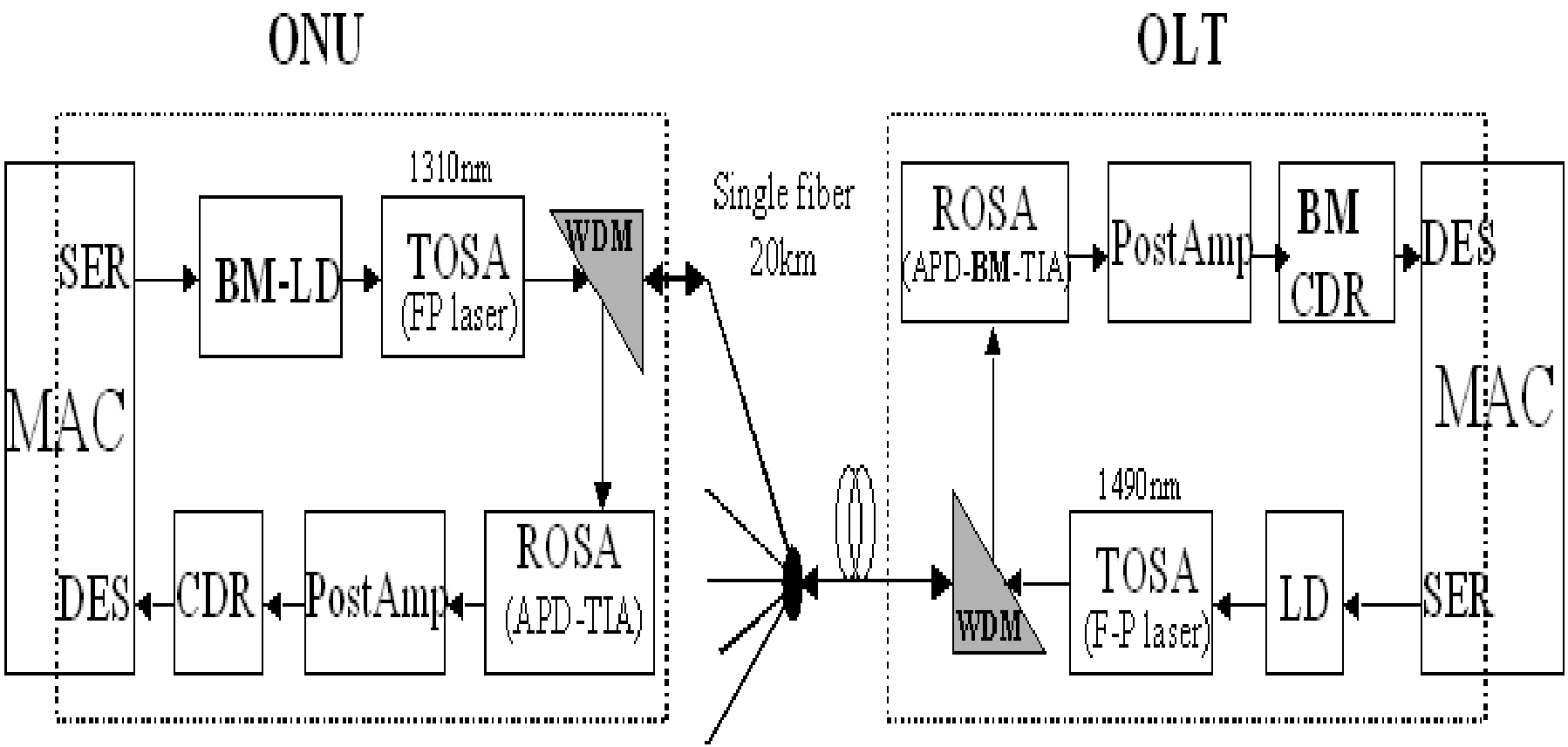
EPON functional PHY chipset



Downstream CM PX20 1490nm: Tx power +2dBm(min) to Rx sens -27dBm (max.)

FP is assumed in specs but DFB is actually used for better disp. tolerance

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IEEE 802.3ah GEPON System requirements
PX20 20km 1.25Gb/s Upstream

Description	Unit	Single fber
		ONU Tx (optical interface TP2)
Bit rates	Gbd	1.25
Center wavelength range (a)	nm	1260-1360
Average lauching power	dBm	min. -1; max. +4
Extinction ratio	dB	>6
Launching OMA	dBm	>-0.22
Max. Tx enable	ns	512
Max. Tx disable	ns	512
Max. TWTP	dB	1.8
		ODN uplink: 0.5m to 20km (b)
Attenuation range	dB	min. 10; max. 24
		OLT Rx (optical interface TP3)
BER		1E-12
Average Rx power	dBm	max -6
Max. Rx sensitivity (c)	dBm	<-27
Max sensitivity in OMA	dBm	-26.2
Signal detect threshold	dBm	-45
Stress Rx sensitivity	dBm	<-24.4
Treceiver_settling	ns	<400
Rx dynamic range (d)	dB	>21

(a) Fabry-Perot (FP) laser is assumed. The allowed max. RMS spectral linewidths are listed in Table 60-4.
(b) ODN (optical distribution network) PX10: 0.5 to 10km; 5-20dB. PX20: 0.5-20km; 10-24dB
(c) Including the chromatic dispersion penalty which is expected to be below 1.5dB when all link parameters are simultaneously at worst case values.
(d) Rx dynamic range is also known as loud/soft ratio.

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Upgrade to 10G EPON Down/Upstream

- **Natural migration path to 10G, support existing GE-PON fiber plant**
  - SMF 20km, link budget 26-29dB, 16/32 split ratio.
  - 10G EPON is fully compatible with GEPON.

- **Quite likely 1310nm(U)/1550nm(D) since off-the-shelf 10G optics available, rule out 1490nm in wavelength plan.**
  - 10GbE optics still expensive, 1-4G optics in volume
  - Large spilt ratio is required to drag 10G system cost down.
  - CFI didnot mention RF video overlay, is it a must?

- **CFI poorly handle burst mode feasibility – BW efficiency**
  - Throughput for US only 4Gbps in KDDI results.
  - Long 10GbE guardtime, burst idletime and latency
    Guardtime (100us), idletime (130us) and latency (650us)
  - Current BM PHYs available confined to <2.5Gb/s

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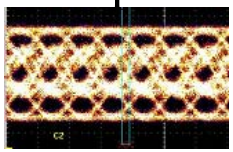
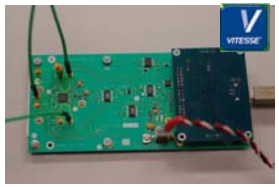
10G PHY and Enabled Form Factors

Input



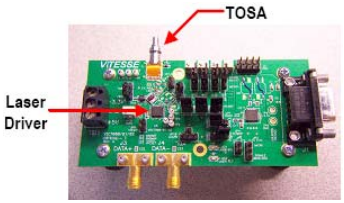
EDC chip



Output

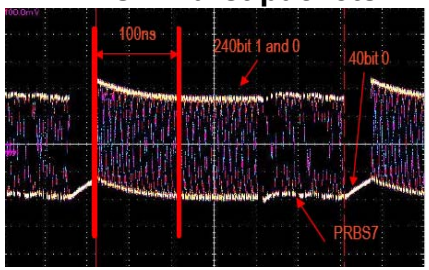
EDC correct ISI due to BW limitation and dispersion

BM Driver



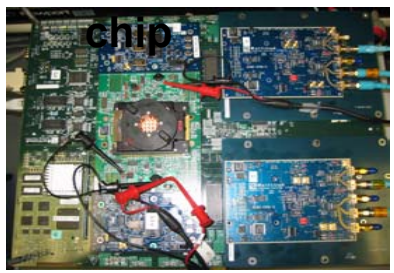
BM TIA (TO ROSA)

EPON Burst packets

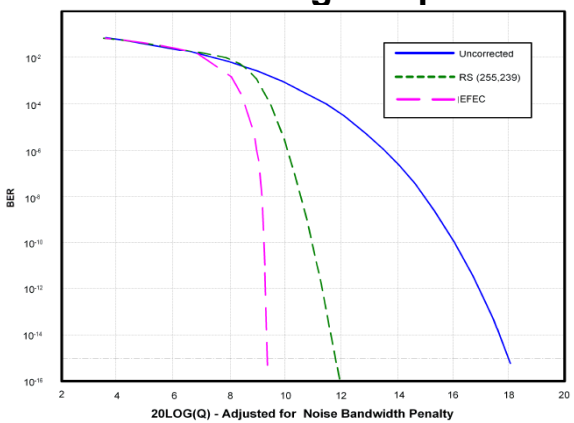


Current BM PHY IC limited up to 2.5Gb/s.

G.709 FEC chip



eFEC vs. gFEC perf.



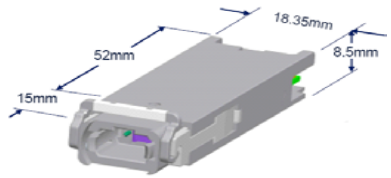
Xenpak

X2

XFP

SFF/P (GEPON choice)

QSFP concept (Apr'06)



SFP+ (still in talks??)

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Feasibility and Cost Consideration

- **Support migration deployment to 10G EPON**
  - 1G EPON (IEEE802.3ah) in commercial deployment with volume
- **10GbE start ramping, but 10G optics still expensive, leveraged with advanced PHY**
  - EDC correcting ISI allows low-bandwidth TOSA to work as 10G
    - Take cheaper 4G DFB or VCSEL TOSA as example
  - FEC allow large split ratio of 1:64 and beyond, no SOA or EDFA required?
    - Generic FEC has typically 3.5dB sens. gain (NECG~6dB)
    - Enhanced FEC provide extra 2dB on top of that (NECG~8.5dB)
    - FEC DS is beneficial, FEC US needs further work
- **Challenging BM PHY at 10G, suggest parallel optics**
    - CFI consider LX4 based approach with FPGA.
- **Form factor consideration**
  - X2/XFP: small size, low power, fundamentally lower cost
  - QSFP/SFP+: potentially high port density

    SFP+ as the option for optical modules, increasing investment in 10G data center and Ethernet will help drive cost down.

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