

Low-Power Solution for 10GE-PON

Hiroki Ikeda, Hitachi

Hiroki Yanagisawa, NEC

Hiroshi Hamano, Fujitsu Labs.

Supporters

Akio Tajima,

NEC

Clark Li,

APAC Opto Electronics

David Li,

Ligent Photonics

Hideki Machida,

Eudyna Devices

Mitsunobu Kimura,

Hitachi

Moonsoo Park,

OE Solutions

Shihjin Chang,

Delta Electronics

Tetsuya Yokomoto,

Fujitsu Access

Discussion

High Power vs Low Power

- Hazard
- Crosstalk
- Optics Assembly

Discussion Reminder

Summary

High-Power vs Low-Power (D/S)

	PX10	PX20	B++	λ : 157x nm
CH IL (dB)	20	24	29	
Path Penalty (dB)	1	1	1	EML-Tx, <20km
ER (dB)	9	9	9	

PIN@ONU

ONU Sensitivity	-20	-20	-20	BER<10 ⁻³ w/ E-FEC
OLT Launch (min)	+1	+5	+10	
OLT Launch (max)	+4	+8	+13	
ONU Overload	-1	-2	-2	

APD@ONU

ONU Sensitivity	-26	-26	-28	BER<10 ⁻³ w/ E-FEC
OLT Launch (min)	-5	-1	+2	
OLT Launch (max)	-2	+2	+5	
ONU Overload	-7	-8	-10	

Class 1M Laser Safety

IEC60825-1,-2 : Safety of laser products-Part1, -Part2

Class 1 : safe even viewed with instruments

Class 1M : safe if not using instruments

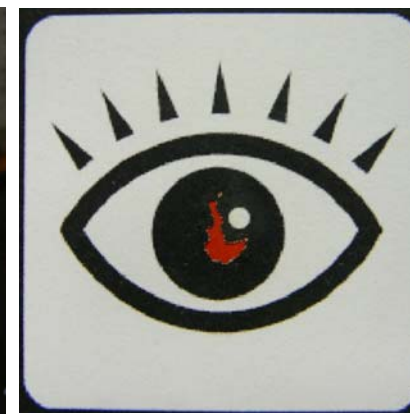
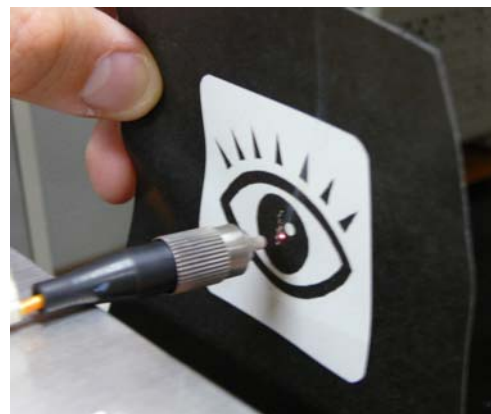
LD Class	Max. Output Power	Distance from Source
Class 1	<+10 dBm @15xxnm	>14 mm
Class 1M	<+21 dBm @15xxnm	>10 cm

3av_0611_kolesar_1.pdf

But...

- Class 1M optical power still high
- Trained and skilled hands necessary for high-power light beam handling

**+21dBm SM fiber output
burns paper within 10mm**



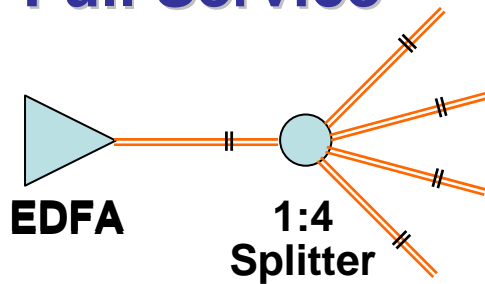
Foolproof Scheme

Optical Output Power Levels

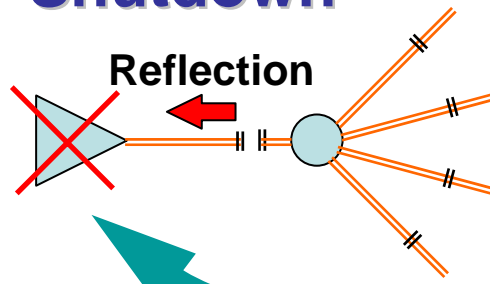
	OLT output max.	8-fiber bundle cable total	8-fiber ribbon cable total after 4-split in CO
High-power system	+13 dBm (Class 1M)	+22 dBm (Class 3B)	+16 dBm (Class 1M)
Low-power system	+5 dBm (Class 1)	+14 dBm (Class 1M)	+8 dBm (Class 1)

EDFA Shutdown

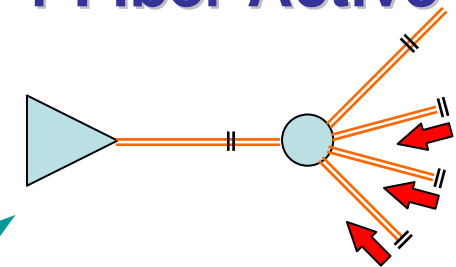
Full Service



Shutdown



1 Fiber Active



Accurate shutdown threshold necessary within 7 dB

Failsafe System

- Individual foolproof system necessary for high-power system depending on each carrier fiber plant structure
- Accurate threshold adjustment necessary for EDFA shutdown depending on the splitter connections and reflection coefficient
- Foolproof means; EDFA Shutdown and Connector Shutter, may make the hazard probability quite small

But...

Still not perfect for millions of OLTs and thousands of workmen

“Class 1” low-power system realizes the strong FAILSAFE system

- Without any foolproof tricks and
- Free from the fiber plant structure

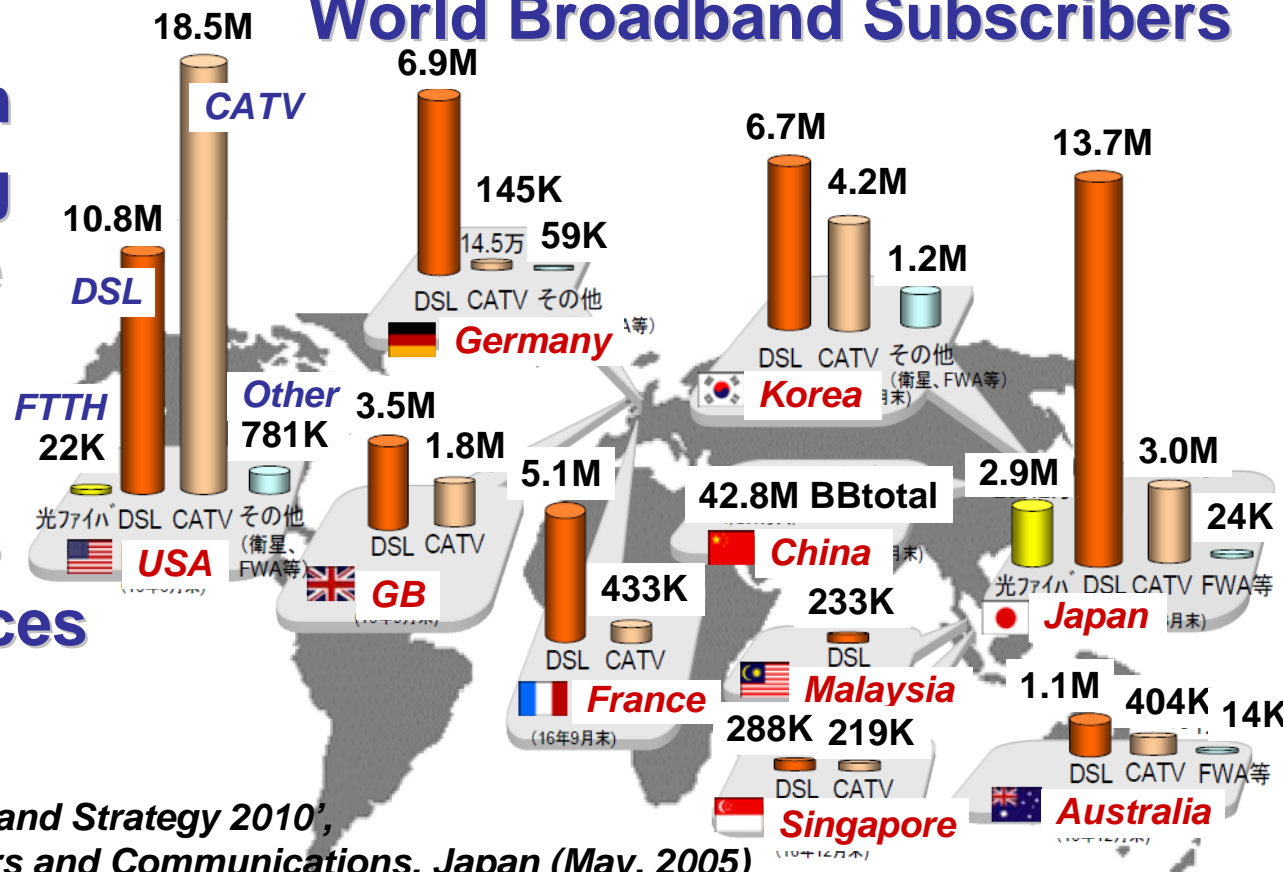
Caution : Never gaze into the fiber at any time, even if you know it is safe!!

Crosstalk to Video

- Non-linear crosstalk can have significant impact on low frequency amplitude modulated CATV signal quality with high-power 10G D/S signal at wavelengths from 1420-1660 nm (3av_0707_mao_1.pdf)

Low-power system with full coexisting nature can only be acceptable as a world-wide FTTH, esp. in the regions where CATV services are widely spread

World Broadband Subscribers



Source: 'Next Generation Broadband Strategy 2010', Ministry of Internal Affairs and Communications, Japan (May, 2005)

Downstream Tx/Rx choices

Assumptions:

- PIN sensitivity = -16dBm, PIN+FEC sensitivity = -19dBm
- APD sensitivity = -25dBm, APD+FEC sensitivity = -28dBm
- Link budget = 31dB (29dB channel loss + 2dB dispersion penalty)

	1425nm	1600nm	1540nm	1640nm	1570nm	1530nm
Tx SRS limit (dBm)	9.44	6.76	6.31	5.98	5.04	4.76
Link budget (dB)	31	31	31	31	31	31
Proposed Tx power (dBm)	3	3	3	3	3	3
Proposed Tx Type	EML	EML	EML	EML	EML	EML
Proposed Rx Type	APD+FEC	APD+FEC	APD+FEC	APD+FEC	APD+FEC	APD+FEC

Only APD can be used at ONU due to Tx launch power limitation

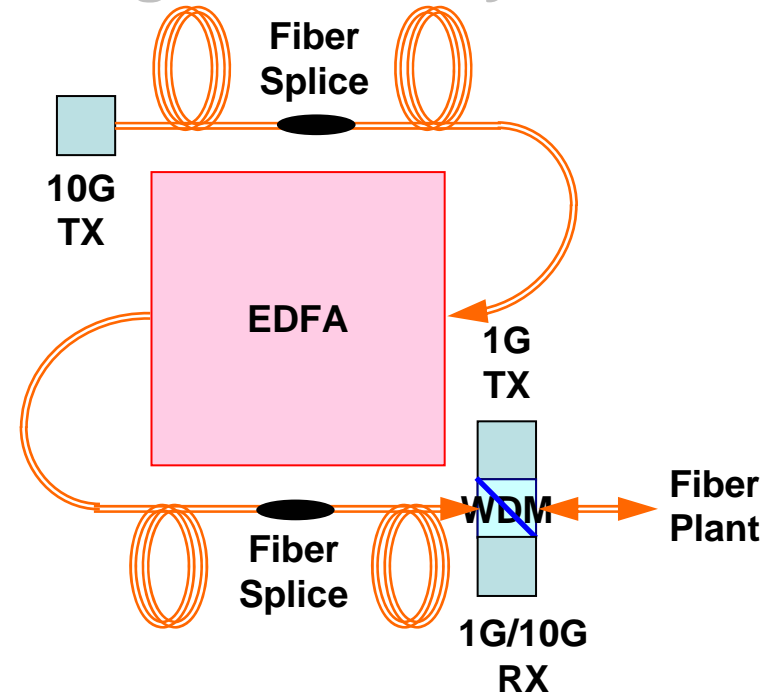
Optics Assembly

Totally separate optics by using EDFA needs lots of space margins, assemble time, and cost

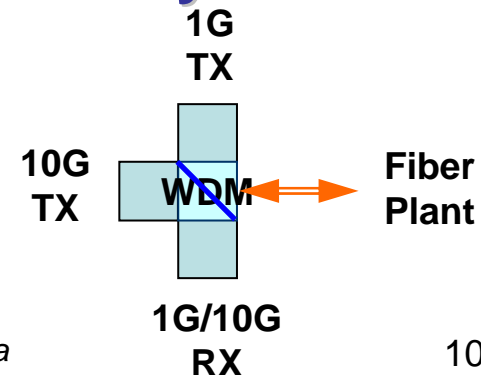
- Integrated optics impossible
Current BIDI/XFP (SFP+) assembly not fully applicable
- Big EDFA size
+10dBm compact L-band EDFA with uncooled 1480nm pump commercially not available
- Additional space necessary
Fiber splices or connectors and fiber handling

Current simple BIDI/XFP assembly is available only for low-power system

High-Power System??



Low-Power System

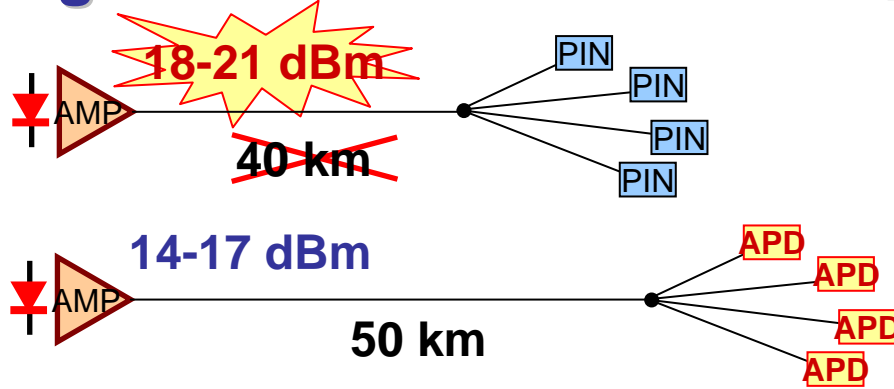


Discussion Reminder

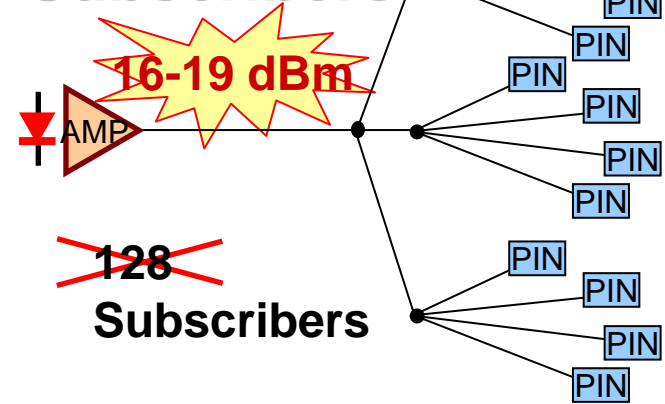
	Low-Power System (APD@ONU)	High-Power System (PIN@ONU)
Component availability	<ul style="list-style-type: none"> - Hi.-pow. EML commercially available - APD in outdoor OK 	<ul style="list-style-type: none"> - +10dBm compact L-b. EDFA not avail. w/ uncooled 1480nm pump - SOA not yet in the field
Laser safety	<ul style="list-style-type: none"> - Class 1 strong failsafe sys. - No failsafe tricks necessary 	<ul style="list-style-type: none"> - Need additional foolproof means - Failsafe design depends on each carrier fiber plant
Co-existence	<ul style="list-style-type: none"> - Full co-existence OK (GEPON, GPON, Video) 	<ul style="list-style-type: none"> - Crosstalk spoils analog video
Optics Assembly	<ul style="list-style-type: none"> - Current BIDI / XFP applicable - GEPON OLT size feasible 	<ul style="list-style-type: none"> - Separate optics doomed and BIDI not fully applicable - Big EDFA size w/ fiber handling - OLT footprint increase costs replacement OPEX
Upgrade possibility (Green field)	<ul style="list-style-type: none"> - Long reach (>20km) - More splits (>4x) (using optical amp. booster) 	<ul style="list-style-type: none"> - Dangerous and difficult (No room for higher power)
Cost	<ul style="list-style-type: none"> - Cost effective up to @16 split - Initial CAPEX very small - Replacement OPEX small 	<ul style="list-style-type: none"> - Slightly cheaper only @32 split (Total optics cost assumption)
Early service penetration	<ul style="list-style-type: none"> - Easy due to small initial CAPEX 	<ul style="list-style-type: none"> - OLT cost not carrier friendly
World service	<ul style="list-style-type: none"> - Full service available 	<ul style="list-style-type: none"> - Rejects analog video users

Extension and Cost

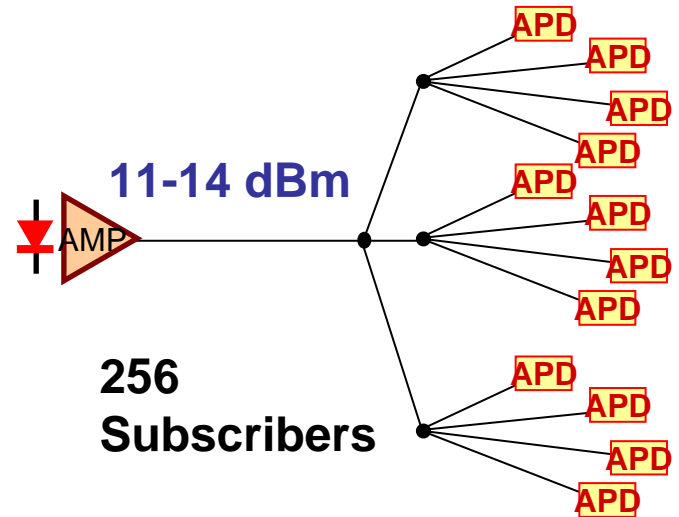
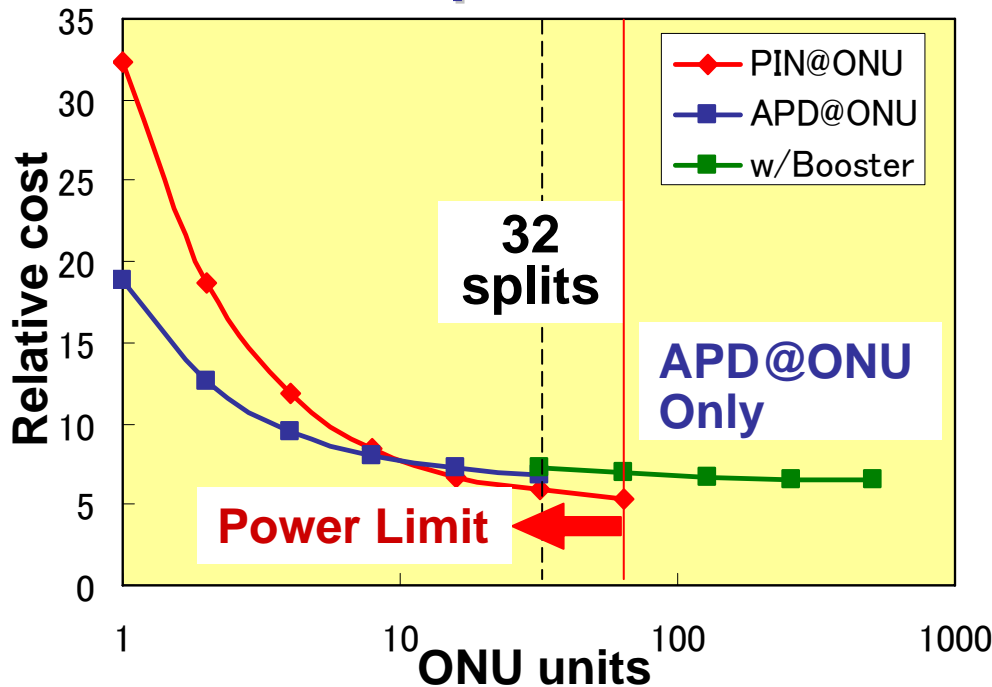
Longer-Reach



More-Subscribers



Total Optics Cost



Summary

Low-Power Solution for 10GE-PON is

- **Perfect Failsafe and Fiber-Plant Independent**
with “Class 1” optical output
- **Fully Compatible and World-Wide Acceptable**
with existing video overlay
- **Small and Simple**
applying current BIDI/XFP-ready assembly
- **Just Fit and Suitable**
for the IEEE standardization Goal
for the world-wide total service flexibility