

# Low-Power Solution for 10GE-PON (3)

**Hiroki Ikeda, Hitachi**

**Hiroshi Yanagisawa, NEC**

**Hiroshi Hamano, Fujitsu Labs.**

# Supporters

# Discussion

## High Power vs Low Power

- Hazard
- Crosstalk
- Optics Assembly

## Discussion Reminder

## Summary

# 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

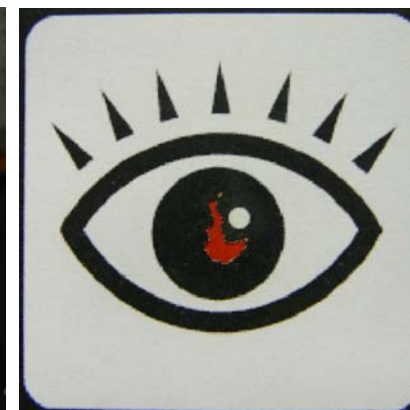
LD Class	Max. Output Power	Distance from Source
Class 1	<+10 dBm @15xxnm	>14 mm (~1/2 in.)
Class 1M	<+21 dBm @15xxnm	>10 cm (~4 in.)

*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**



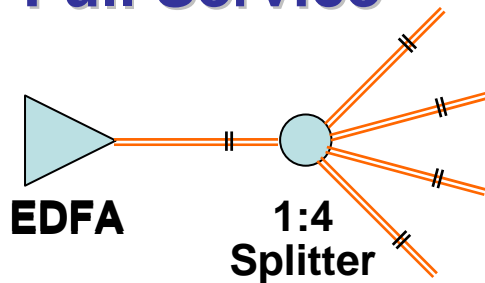
# Foolproof Scheme

## Optical Output Power Levels

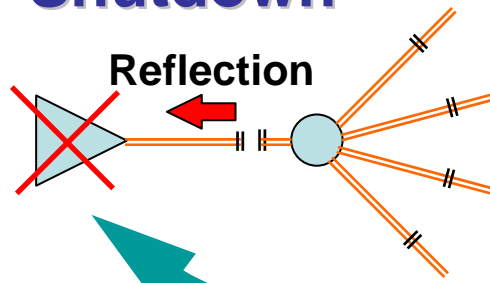
	OLT output max.	8-fiber bundle cable total	8-fiber ribbon cable total after 4-split in CO
High-power system	+13 dBm (Class 1M)	+22 dBm (Class 3B)	+16 dBm (Class 1M)
Low-power system	+5 dBm (Class 1)	+14 dBm (Class 1M)	+8 dBm (Class 1)

## EDFA Shutdown

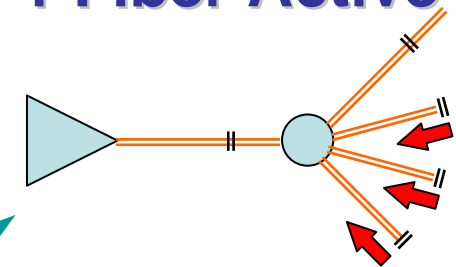
### Full Service



### 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
- 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 of APD@ONU achieves the strong FAILSAFE system**

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

**The Lower, the Safer**

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

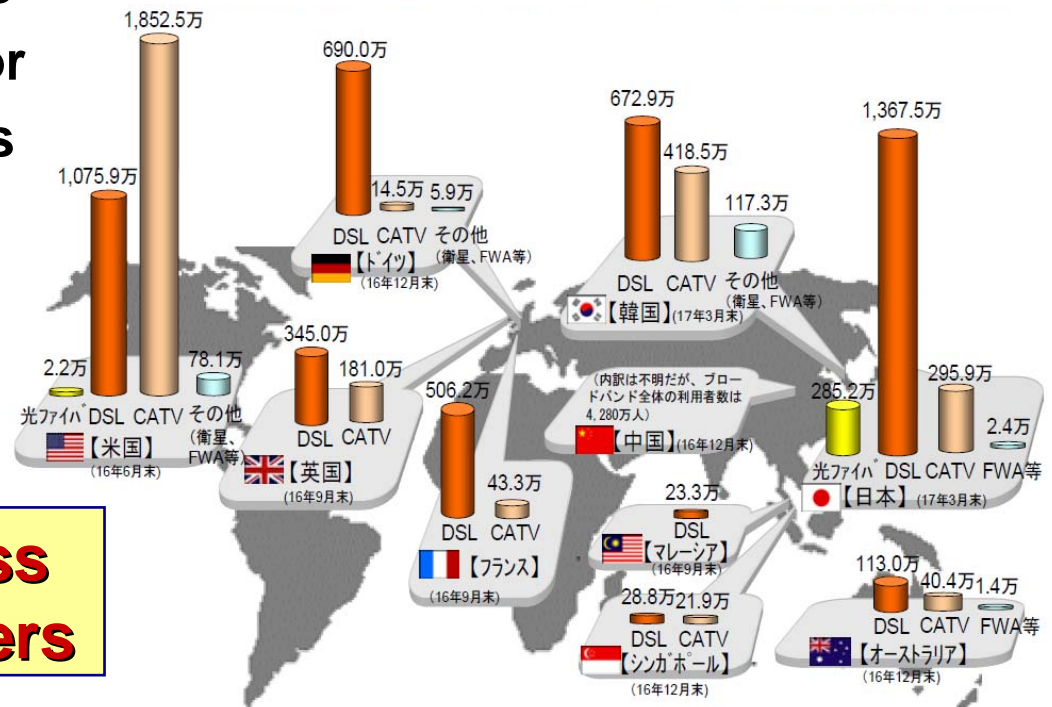


# Crosstalk to Video

- High-power 10G D/S signal interfere the existing video signal and is impossible to co-exist with current analog video service without wide wavelength distance from the video channel  
(3av\_0707\_mao\_1.pdf)

- Low-power system with full coexisting nature can only be acceptable for world-wide FTTH systems esp. in North America where the CATV services are widely spread all over the country

## World Broadband Service Subscribers



**The Greatest Happiness of the Greatest Numbers**

# 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 or XFP (SFP+) assembly not fully applicable

- Big EDFA size

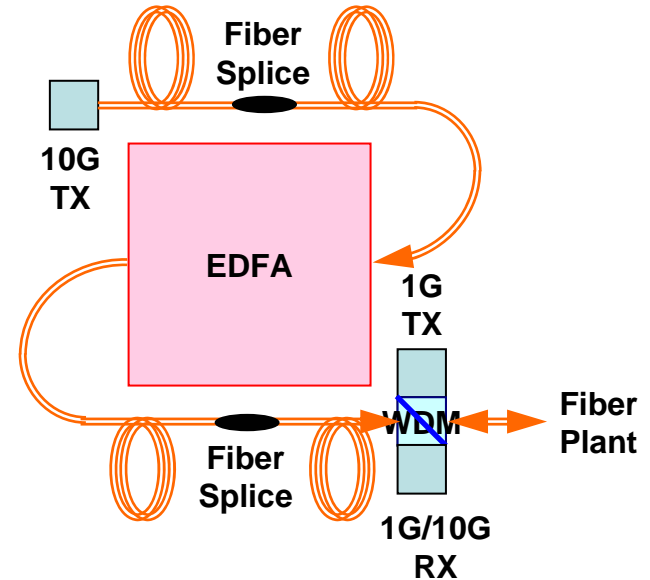
+10dBm EDFA with uncooled 1490nm pump commercial availability doubtful

- Additional space necessary

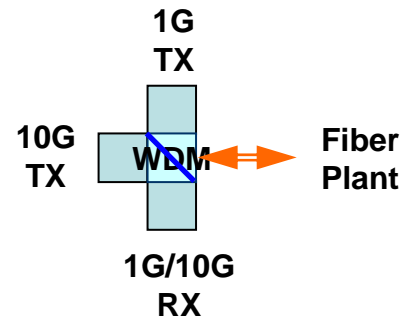
Fiber splices or connectors and fiber handling

**Low Power Uses Simple BIDI or XFP**

## High-Power System??



## Low-Power System



# Discussion Reminder

	Low-Power System	High-Power System
Component availability	<ul style="list-style-type: none"> <li>- Hi.-pow. EML commercially available</li> <li>- APD in outdoor OK</li> </ul>	<ul style="list-style-type: none"> <li>- +10dBm EDFA doubtful w/ uncooled 1490nm pump</li> <li>- SOA not yet in the field</li> </ul>
Laser safety	<ul style="list-style-type: none"> <li>- Class 1 strong failsafe sys.</li> <li>- No failsafe tricks necessary</li> </ul>	<ul style="list-style-type: none"> <li>- Additional foolproof means needed</li> <li>- Failsafe design depends on each carrier fiber plant</li> </ul>
Co-existence	<ul style="list-style-type: none"> <li>- Full co-existence OK (GEPON, GPON, Video)</li> </ul>	<ul style="list-style-type: none"> <li>- Crosstalk spoils analog video</li> </ul>
Optics Assembly	<ul style="list-style-type: none"> <li>- Current BIDI / XFP applicable</li> <li>- GEPON OLT size feasible</li> </ul>	<ul style="list-style-type: none"> <li>- Separate optics doomed</li> <li>- BIDI not fully applicable</li> <li>- Big EDFA size w/ fiber handling</li> <li>- Bigger OLT footprint costs replacement OPEX</li> </ul>
Upgrade possibility (Green field)	<ul style="list-style-type: none"> <li>- Long reach (&gt;20km)</li> <li>- More splits (&gt;4x) (using optical amp. booster)</li> </ul>	<ul style="list-style-type: none"> <li>- Dangerous and difficult (No room for higher power)</li> </ul>
Cost	<ul style="list-style-type: none"> <li>- Cost effective up to @16 split</li> <li>- Initial CAPEX very small</li> <li>- Replacement OPEX small</li> </ul>	<ul style="list-style-type: none"> <li>- Slightly cheaper only @32 split (Total optics cost assumption)</li> </ul>
Early market penetration	<ul style="list-style-type: none"> <li>- Easy due to very small initial CAPEX</li> </ul>	<ul style="list-style-type: none"> <li>- OLT cost not carrier friendly</li> </ul>
World market	<ul style="list-style-type: none"> <li>- Full service available</li> </ul>	<ul style="list-style-type: none"> <li>- Rejects analog video users</li> </ul>



# Summary

**Low-Power Solution** for 10GEPON with APD@ONU 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 or XFP-ready assembly
- **Just Fit and Suitable**  
for the IEEE standardization Goal  
for the world-wide total service flexibility

**Low Power**

**is**

**COOL!!**