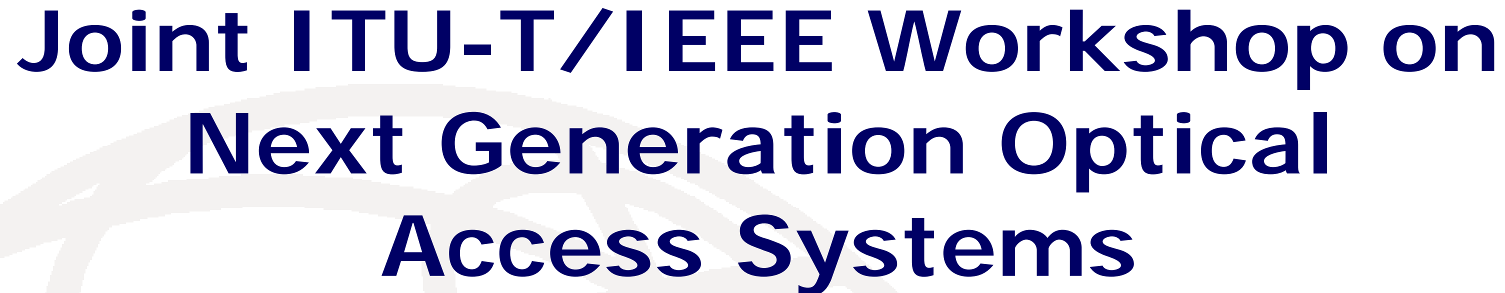


Joint ITU-T/IEEE Workshop on Next Generation Optical Access Systems

Optical Component Technology Review and Future Trends

David Li

CTO, Ligent Photonics

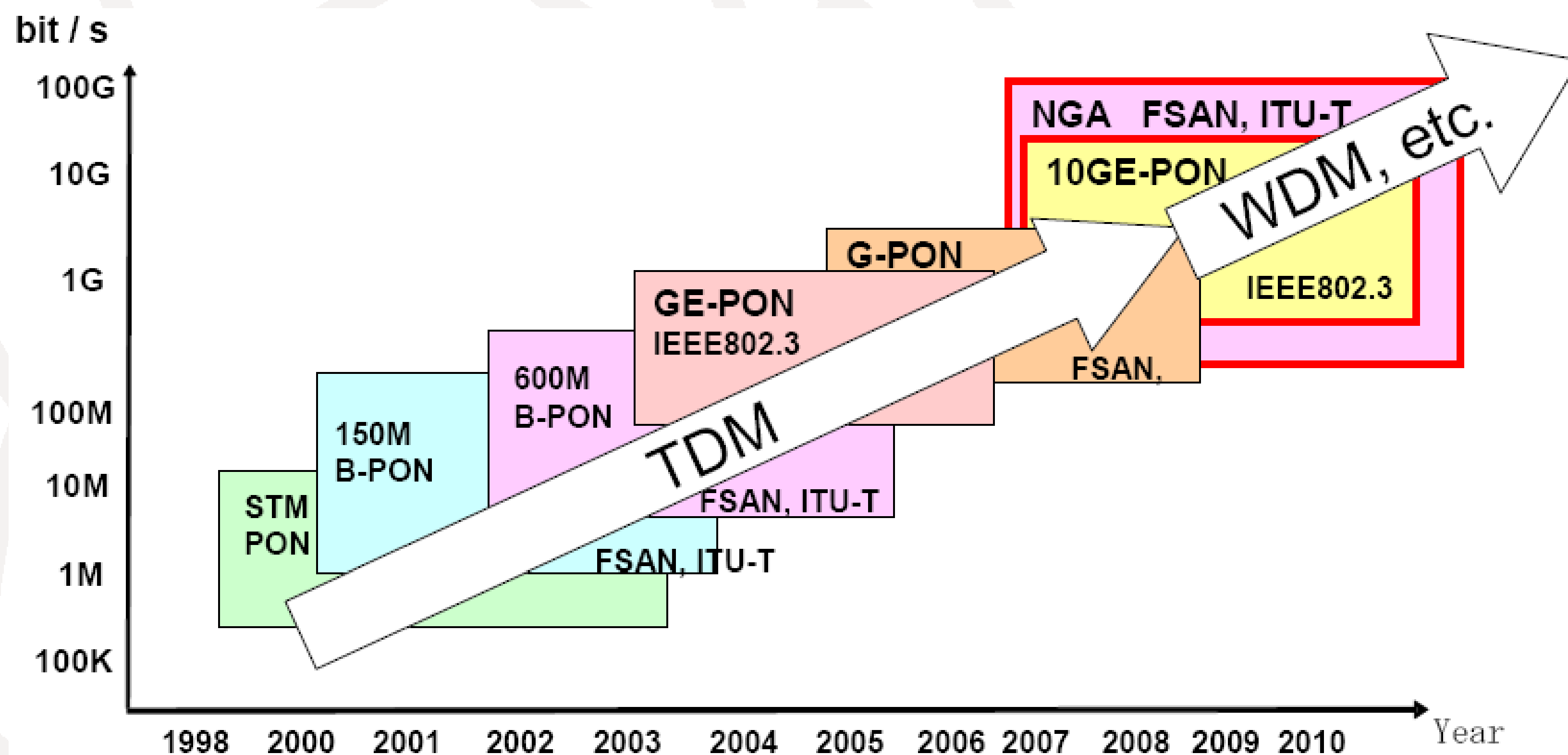
Geneva, 19-20 June 2008

Outline

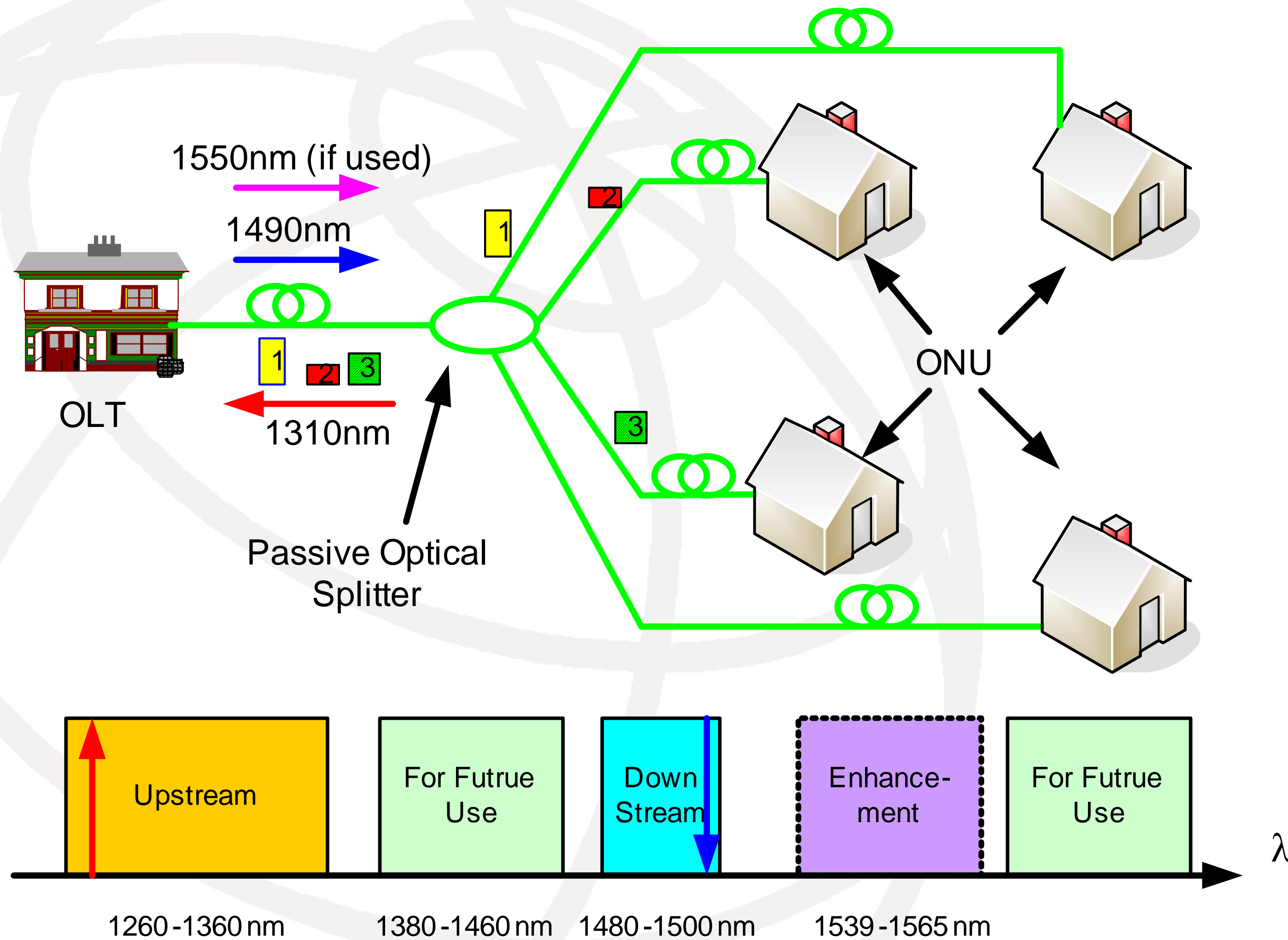
- Introduction
- Key Components in OAN
- Conventional Transceiver Technologies
- Challenges in 10GPON
- Future Trends and Optical Integration
- Summary

Optical Access Network Trends

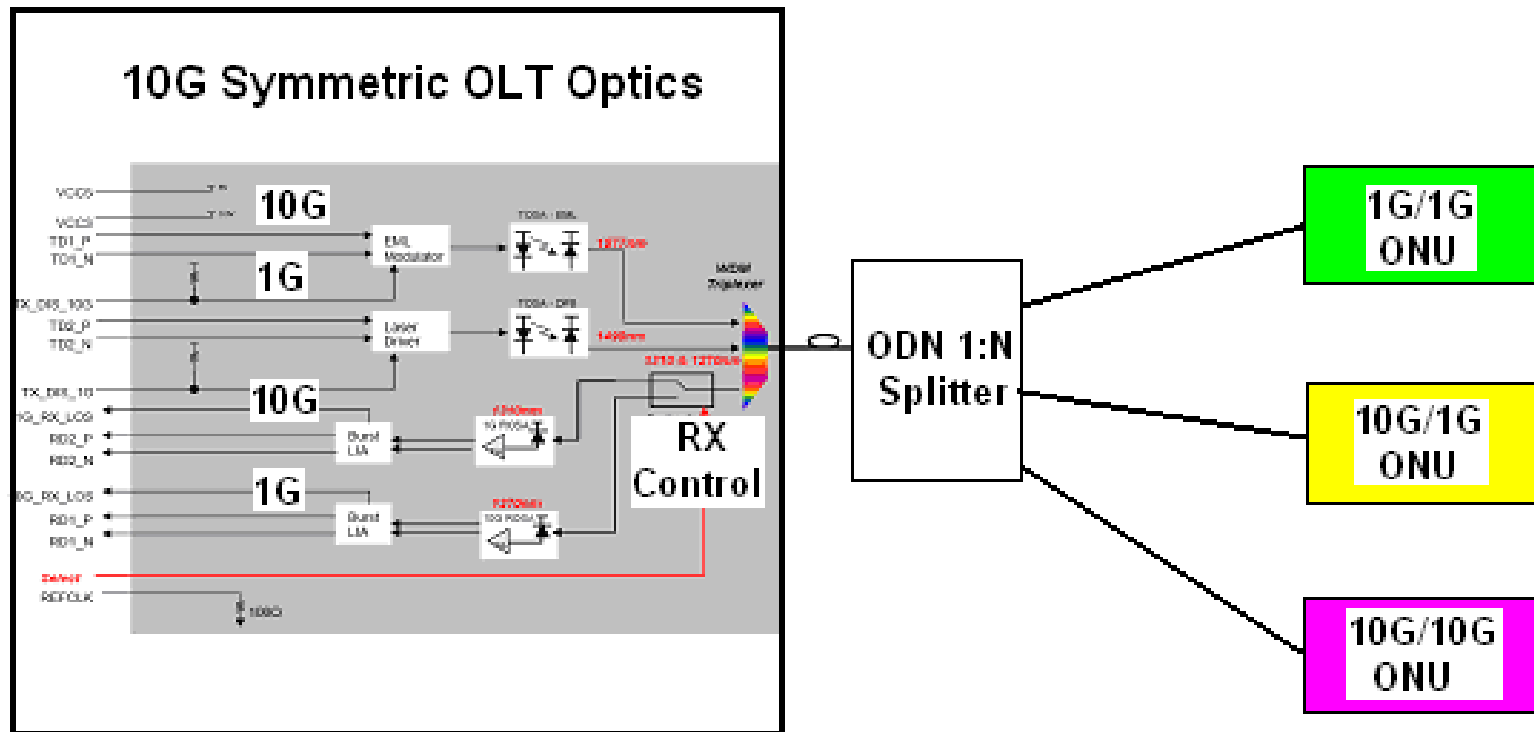
- Higher bandwidth/capacity technologies are required for HDTV, IPTV, VOD, PVR, digital home, etc.



Passive Optical Network Structure



10GEPON Quadplexer Structure

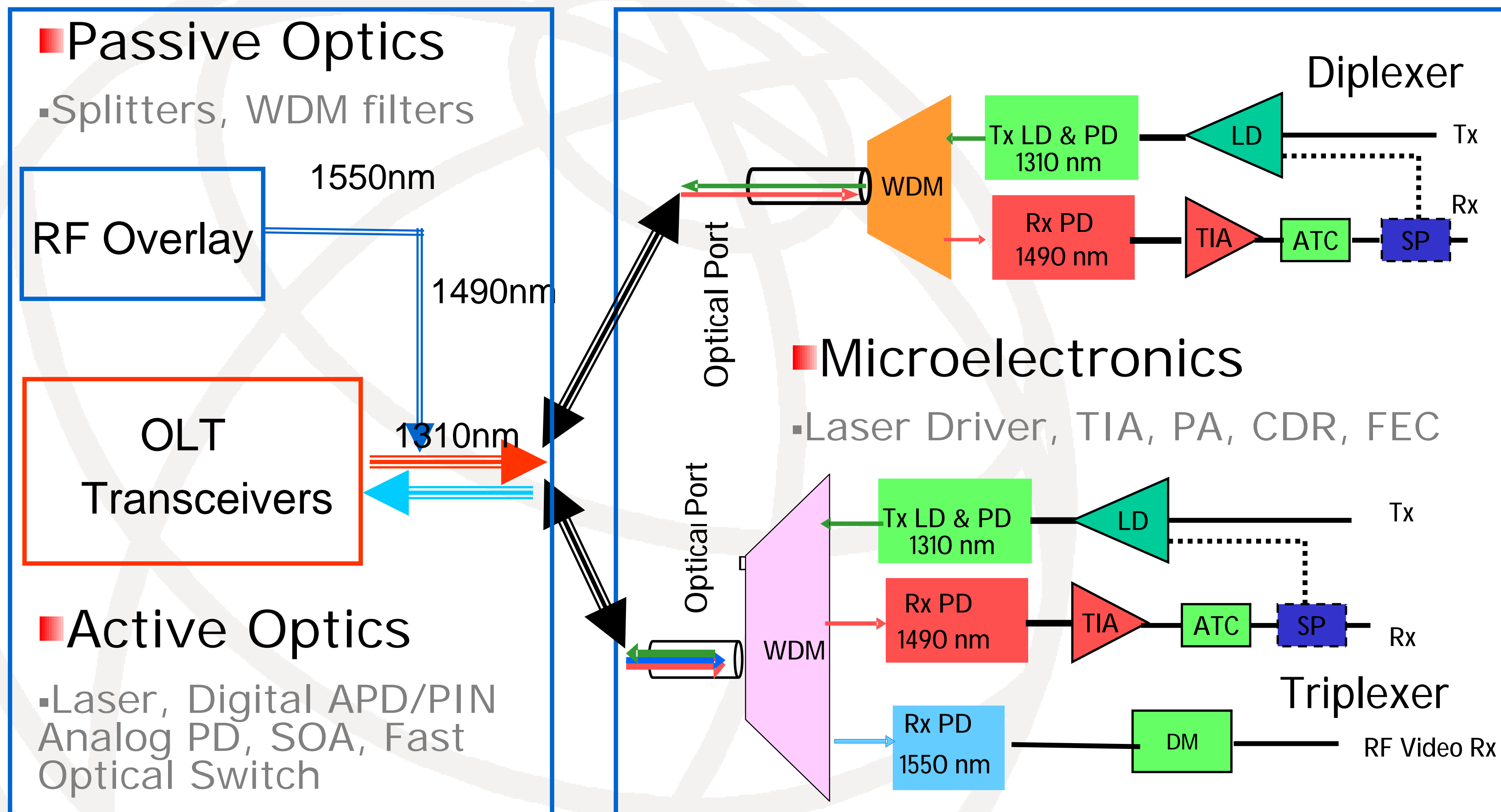


- 10GEPON and 1GEPON must be able to coexist in the existing fiber distribution network

EPON/GPON/10GEPON Review

	EPON		GPON		10GEPON
	PX-10	PX-20	Class B+	Class C+	PR-30
Link Budget	23dB	26dB	28/30dB	32/33dB	29dB
Data rate	1.25G	1.25G	2.5G/1.25G	2.5G/1.25G	10.3G
TX Laser	FP/DFB	DFB	DFB	H DFB	H EML H DML
RX PD/TIA	PIN/TIA	PIN/TIA	APD/TIA	H Sen. APD/TIA	APD+ TIA(S)+ FEC
Driver	Discrete/Integrated		Discrete	Discrete	Discrete
PA			Discrete	Discrete	Discrete
Cost	Low	Medium Low	High	High+ (OLT)	High++++ (ONU/OLT)

Key Components in the OAN

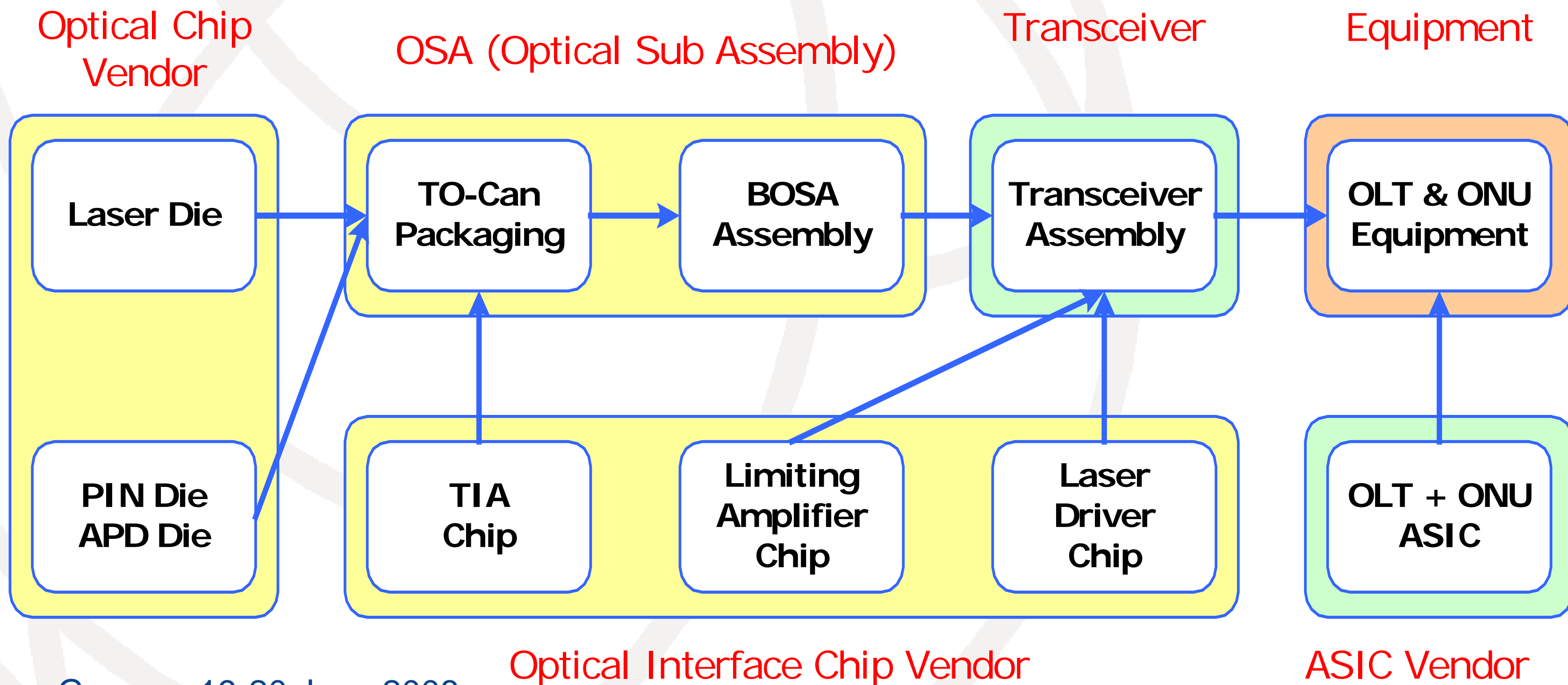


Key Issues in EPON/GPON Transceiver

- Microelectronics
  - Burst mode, short response time for detection and threshold adjustment
  - Large dynamic range
  - High sensitivity for small signal detection
  - Relative high speed, up to 2.5Gbit/s
  - Intelligence (e.g., FEC, EDC, Monitoring, etc.)
- Active Optics
  - Transmit laser diodes (high power, narrow spectral width, wide temperature, low noise, high speed, etc.)
  - Receive photo diodes (high sensitivity, high linearity, high SNR, etc.)
- Passive Optics
  - Low loss
  - Low polarization dependence
  - Low temperature dependence
- Operating Temperature Range and Power Consumption

Low Cost, High Performance, and High Volume

FTTH Equipment Value Chain



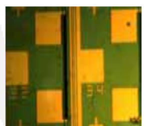
Conventional Transceiver Technologies

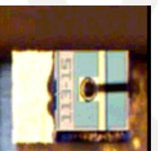
- Complex, robust, improving, and yet reaching limit?

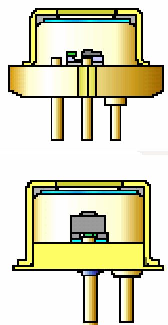
- Discrete chips for LD, PD, lens, etc.
- Stand-alone TO-cans for TX & RX
- TX, RX and bidirectional optical sub-assemblies based on coaxial-packages
- Separate integrated MICs for analog and digital functions
- Manual module assembly and testing

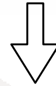
MIC Chip

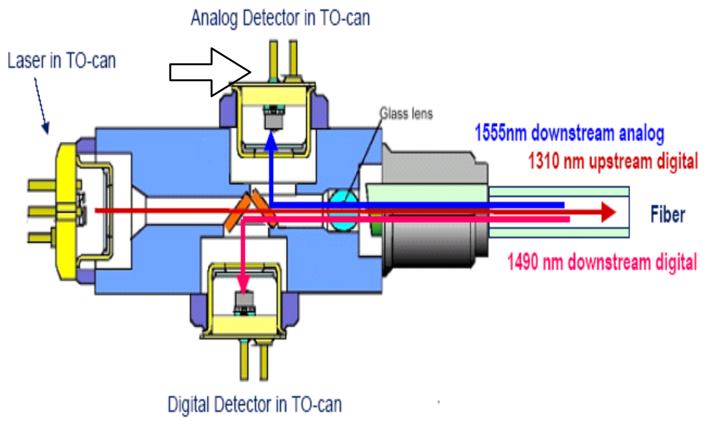
OE Chips → TO-Cans → BOSA → Module

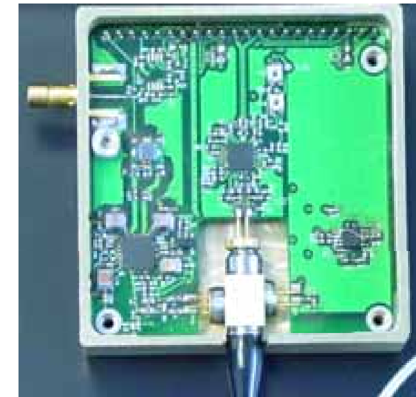












Capital intensive,
Automated fab,
Manual processing

Capital intensive,
Automated assembly,
Manual test

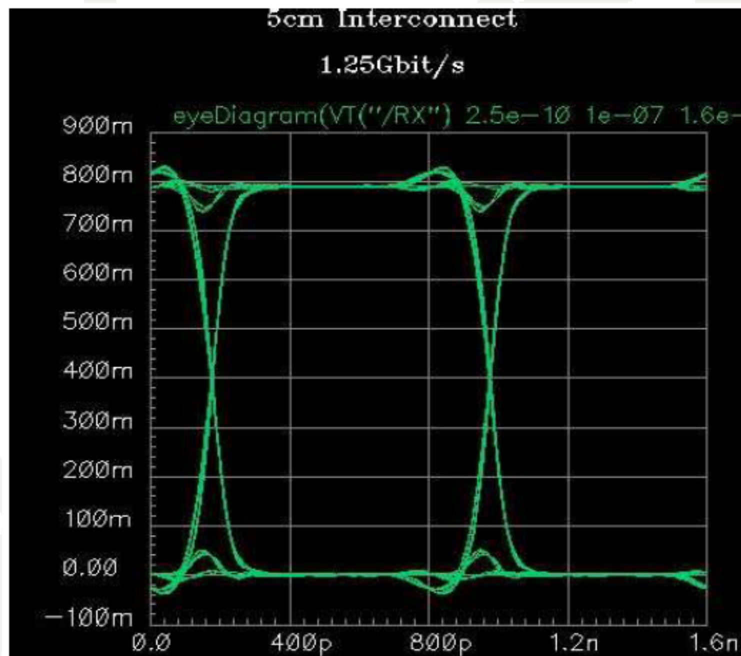
Labor intensive,
Manual assembly,
Manual test

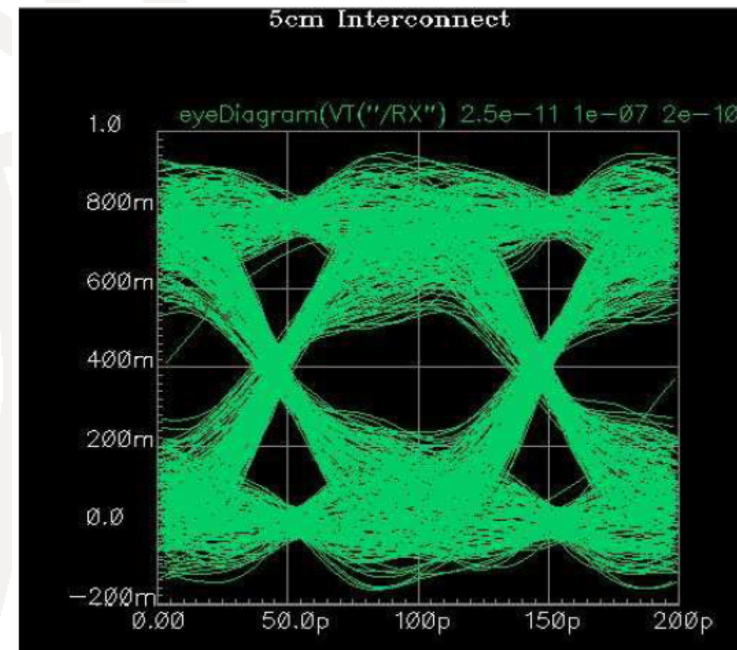
Labor intensive,
Manual assembly,
Manual test

Availability of 10GPON Components

- Now 10GE CM transmission technologies and 1G/2G BM technologies are mature
- Challenges in 10GEPON BM components
  - ✓ Special 10G lasers to meet the IEEE802.3av requirements
    - 1577nm high power 10G EML laser for OLT
    - Low cost 1270nm 10G DML laser
  - ✓ 10G burst mode drivers
  - ✓ 10G/1G selective burst mode TIA and post amplifier
  - ✓ 10G burst mode CDR and signal conditioner

Problem for 10G Eye Pattern





3av_0804_benamram_2

10G signal is much noisy

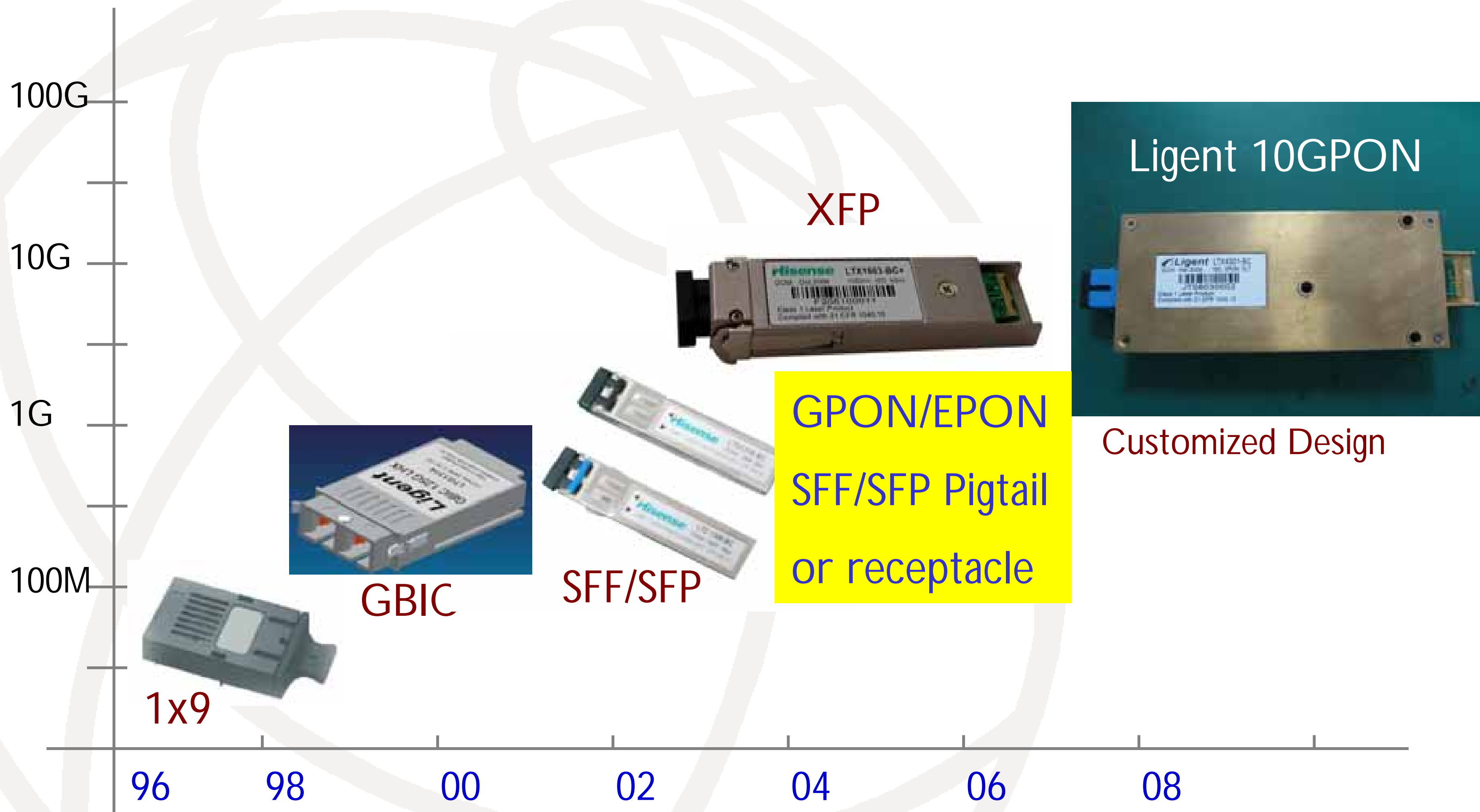
– Electrical, Optical, Test Equipment

Challenges in 10GPON

- Signal degradation at 10G
- Link budget – 29dB
- TX power – high
- RX sensitivity – high
- BM 1G/10G switching
- OSA - Integration
- Cost - low

High TX Power, High RX Sensitivity, Price

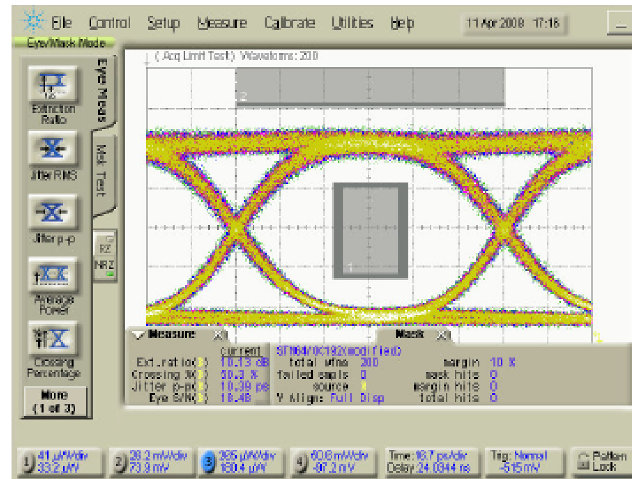
Optcal Module Packaging



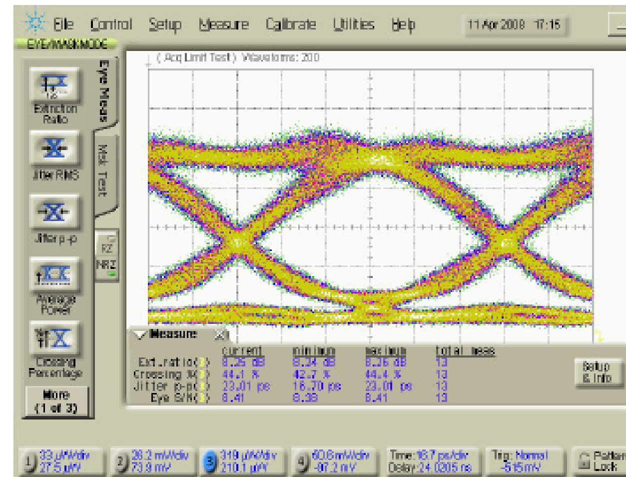
Small, Pluggable, High Density, Low Power

Progress on the 10GEPON Laser

Back to back (with filter)

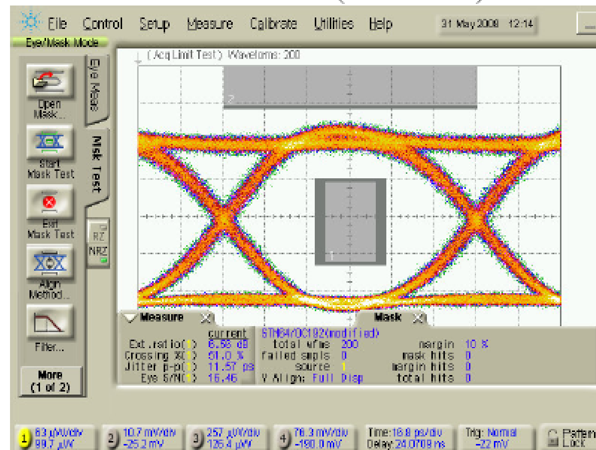


After 50km SMF transmission



Pave = 5.06dBm, WL=1577.655nm, Rext = 10.34dB, Dp=1.03dB (50km)

Back to back (with filter)



Pave = 5.05dBm, WL=1275nm, Rext = 6.56dB

Eudyna Devices, 06.02.2008

Integration Platform Technologies

Functionality & Performance

Box Level

Pre-packaged devices connected by fibers

Present

Board Level

Chips and sub-components assembled on silicon bench, and/or metal carriers

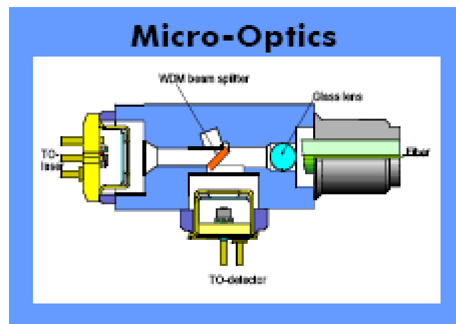
Next

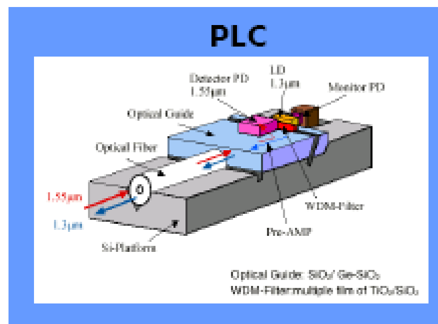
Chip Level

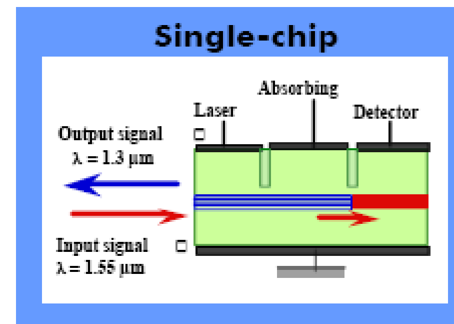
Chips connected with each other by hybrid or monolithic integration

Future

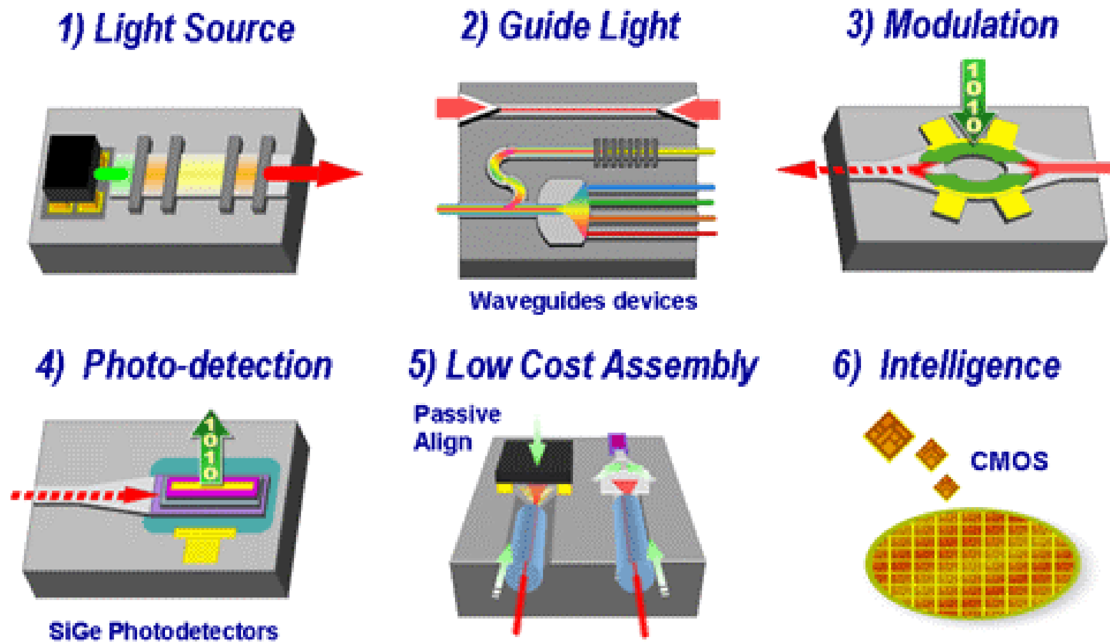
- Hybrid or monolithical PLC
- InP-based
- Silica-based
- Silicon-based







Basic Building Blocks for PICs

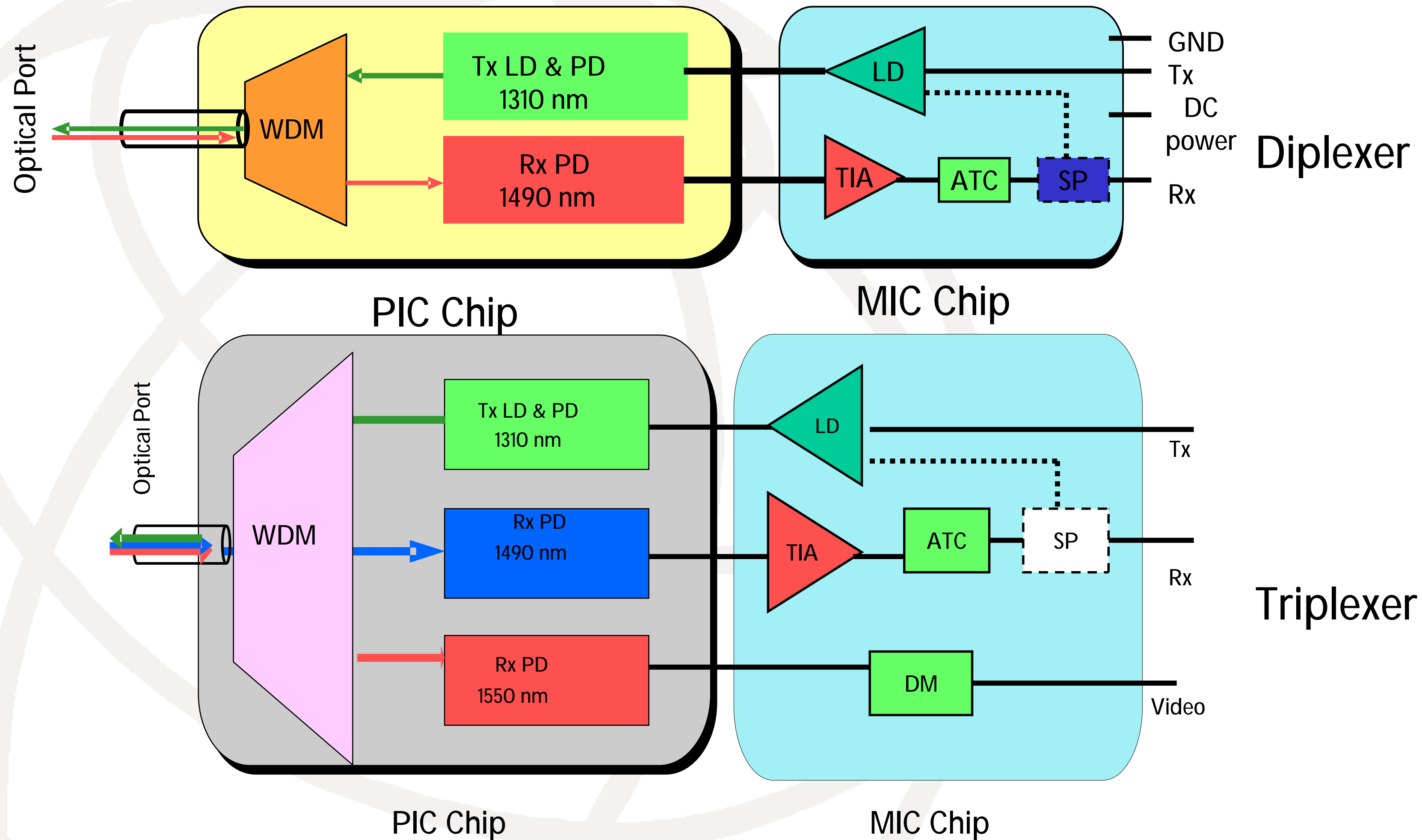


Challenges for Optical Integration

- Design and Fabrication
  - Multi-Functionality
  - Complexity
  - Redundancy
- Yield
  - Wafer uniformity
  - Coating
  - testing
- Packaging
  - Coupling to Fibers
  - Electrical Control
  - Thermal Management
  - Hermetic issue
  - **Low cost assembly**

The Dream Device:

Integrated Optical Transceivers based on Two-Chips



W.P.Huang, **OSA Optics Express, Vol. 14, 2006**

Summary

- The design and manufacturing of optical module in the access networks follows a process from discrete components to optical sub-assemblies and microelectronic chips, to module assembly and test
- The conventional transceiver technologies based on discrete optoelectronic chips and coaxial packaging are still the key enabler and continue to improve
- The emerging technologies based on planar packaging, hybrid/monolithic optical integration are under development and will have significant (not immediate) impact on the cost and performance
- The WDM, and other approaches are necessary for next generation access network beyond the 10Gbps.