

Meeting the Need for Speed - OIF Work on 100G Long Haul DWDM



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Topics

- ◆ Carriers Requirements
- ◆ Status of 100G Standards
- ◆ OIF Roles in 100G
- ◆ Key Elements of 100G ULH DWDM OIF Program
- ◆ Optical Modulation Formats
- ◆ Integrated photonic modulator/demodulator
- ◆ FEC
- ◆ 100G Transceiver Module Architecture
- ◆ Summary : OIF 100G Project Structure

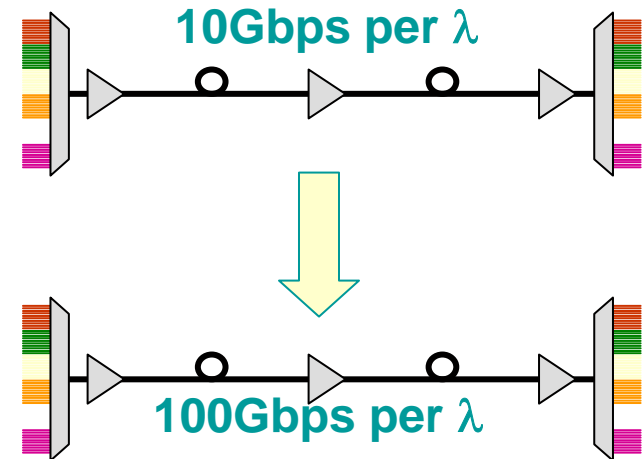
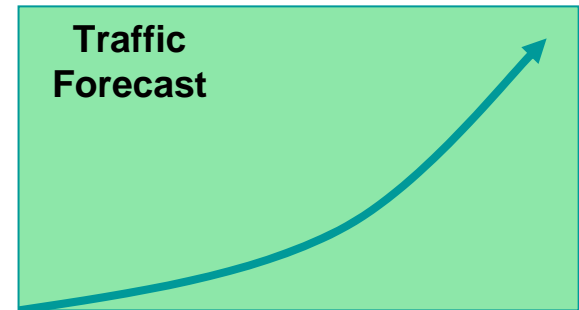
What Tier-1 Carriers are Telling Us

◆ Needs:

- More transport capacity
- Support native 100G signals
 - Big pipes for their routers/switches
 - 100G services

◆ Requirements:

- Capacity efficiency
 - More than 10G, 40G systems
 - On existing infrastructure
 - Typically 80 ch & 1500 KM
- CAPEX benefits
 - lower cost per bit than 10G and 40G
- OPEX benefits
 - Number of systems constant
 - Reduced space and power per bit



Industry Challenges - 100Gb/s

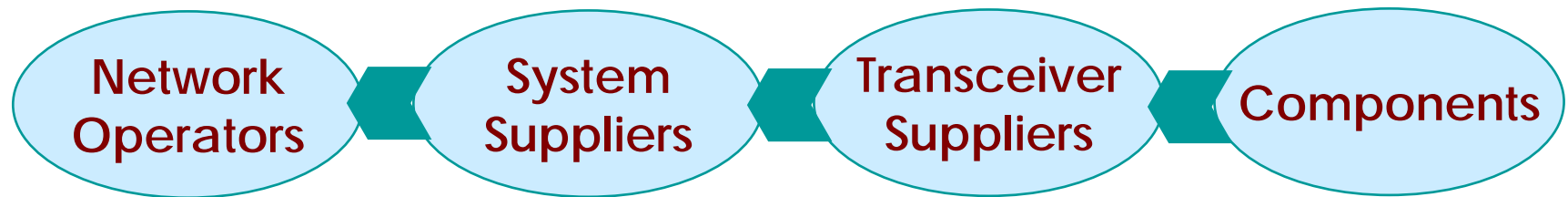
- ◆ Market need exists for 100G
- ◆ Market demands are driving carriers and NE vendors to 100G field trials in advance of standards
- ◆ Some NE vendors are developing first generation 100G product – may not be as compact as carriers need
- ◆ Component/chip suppliers must make significant investments to support 100G in the face of emerging standards
- ◆ A fragmented customer base and a modest market in the initial years of 100G

Status of 100G Standards: IEEE 802.3ba and ITU-T

- ◆ IEEE 802.3ba TF
 - 100GE/40GE specification progressing well (Draft D2.2 is available, approval standards July 2010)
 - one of the agreed objectives for 40GE/100GE is the appropriate support of OTN
- ◆ For 100Gb, OTN transport (ODU4) is defined in ITU-T recommendation G.709 (Approved Oct 09)
- ◆ Close cooperation between IEEE and ITU-T to meet the requirements of both groups is maintained

OIF Role in 100G

Foster an ecosystem to accelerate the availability of economically attractive 100G transmission solutions for ULH DWDM networks



Approach

- ◆ Choose application target – core backbone networks
- ◆ Build upon IEEE and ITU-T standards
- ◆ Agree on modulation format
- ◆ Identify key technology building blocks and interfaces
- ◆ Develop interoperability agreements among building blocks
- ◆ Develop Implementation Agreements for MSA transceiver module and integrated photonics module
- ◆ **“Line side” DWDM system interoperability is not a current objective**

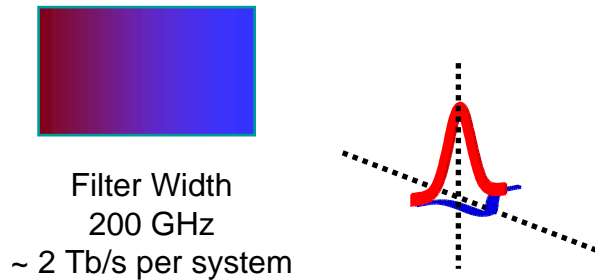
100G ULH DWDM

Key elements of the OIF 100G program

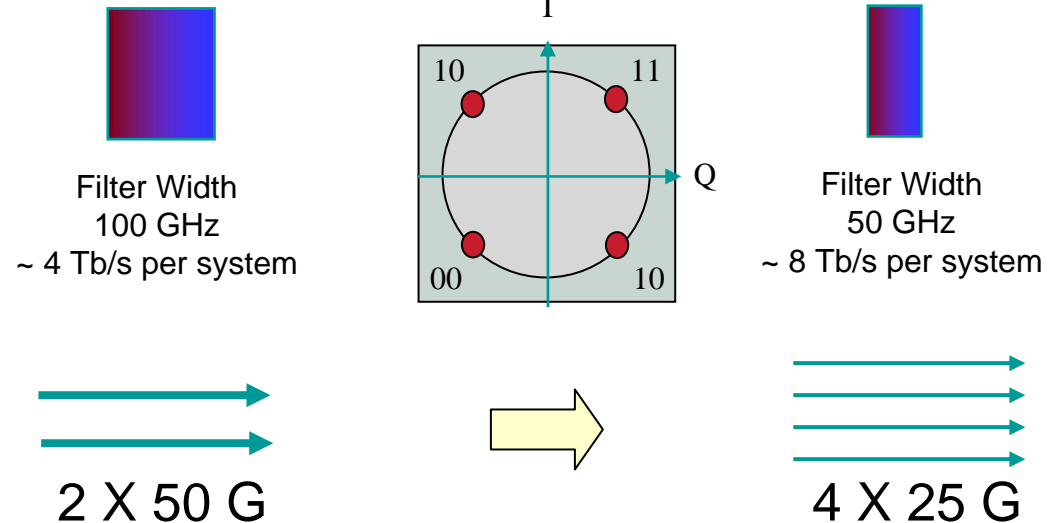
- ◆ **Dual polarization with quadrature phase shift keying modulation**
 - Spectrally efficient, improved signal/noise, CMOS electronics
- ◆ **Coherent receiver technology**
 - Improved signal/noise ratio, mitigate optical impairments in CMOS
- ◆ **Dense photonic module integration**
 - Hybrid or monolithic integration to reduce cost, space and power
- ◆ **High Performance Forward Error Correction (FEC)**
 - Improved coding gain over current 10G systems
- ◆ **Industry standard MSA transceiver module**
 - Specifying physical outline, pin-out, control, max power dissipation
 - Compatible with but not limited to DP-QPSK modulation
 - No specification for line side DWDM interoperability

100 G Modulation Format

Dual Polarization



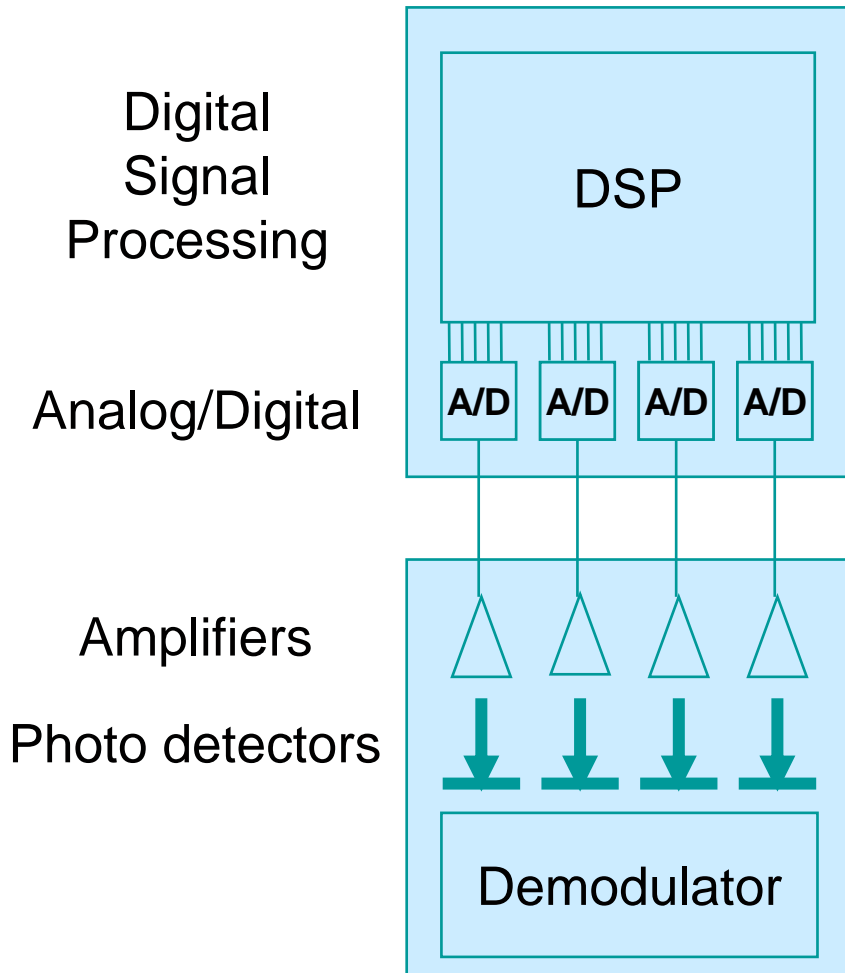
Quadrature Phase Shift Keying



Trade speed for parallelism, then attack parallel complexity with photonic integration

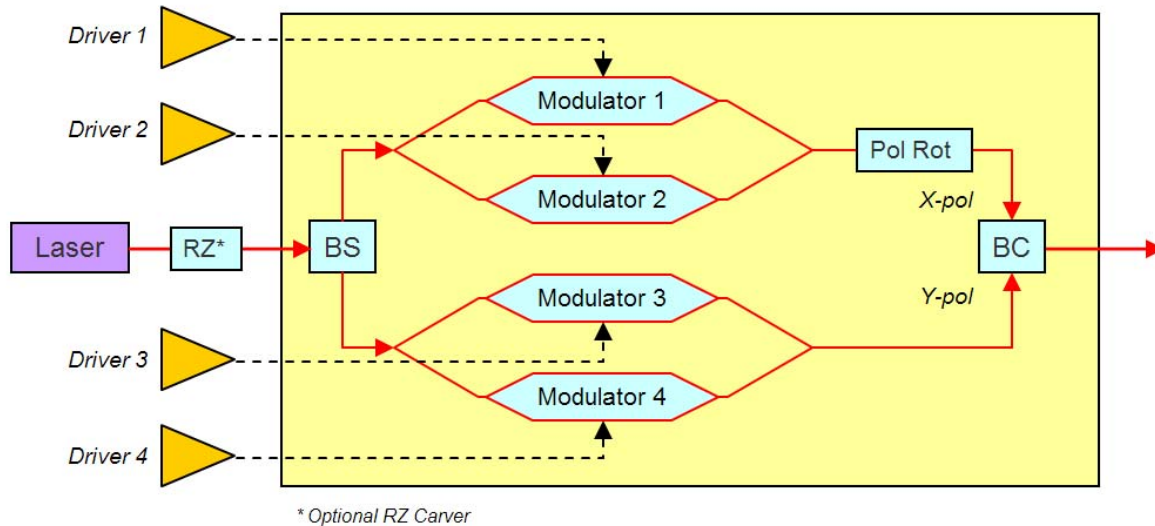
- ◆ **Two independent polarizations**
 - Same optical frequency
 - Halves the data rate
 - Halves the spectral width
 - Doubles components
- ◆ **Data encoded into 4 phase states**
 - Phase symbol – 2 bits of data
 - Halves the symbol rate
 - Halves the spectral width
 - Doubles components

Coherent Receiver



- ◆ Improved signal/noise ratio
- ◆ Preserves optical phase info
- ◆ Electronic solution for
 - polarization separation
 - phase resolution
 - chromatic dispersion
 - polarization mode dispersion (PMD)
- ◆ Silicon economics

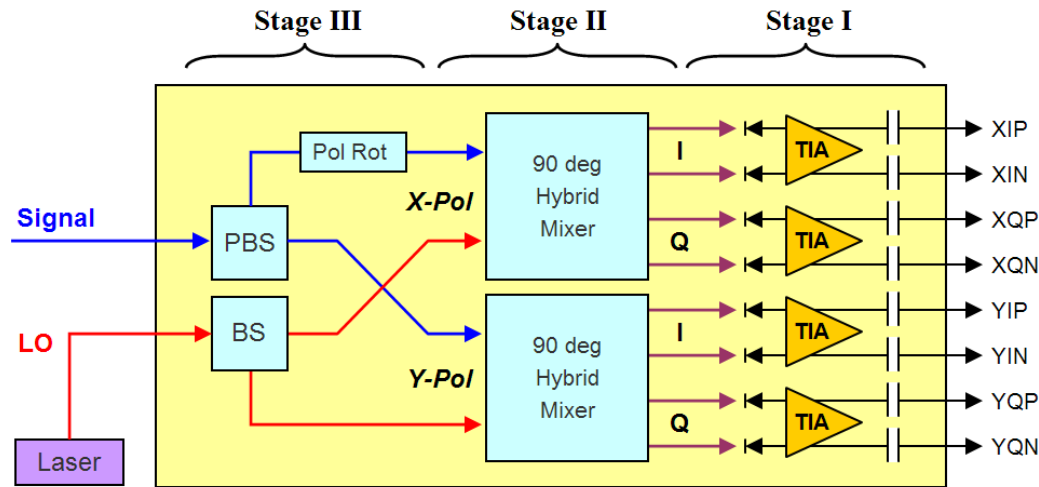
Integrated Photonic Modulator



- ◆ **Current photonic transmitter module composition**
 - **Modulators and other optical components integrated**
 - **Integrated drivers on separate module(s)**
 - **Transmit laser using OIF ITLA***
- ◆ **Future possibility of further integration**

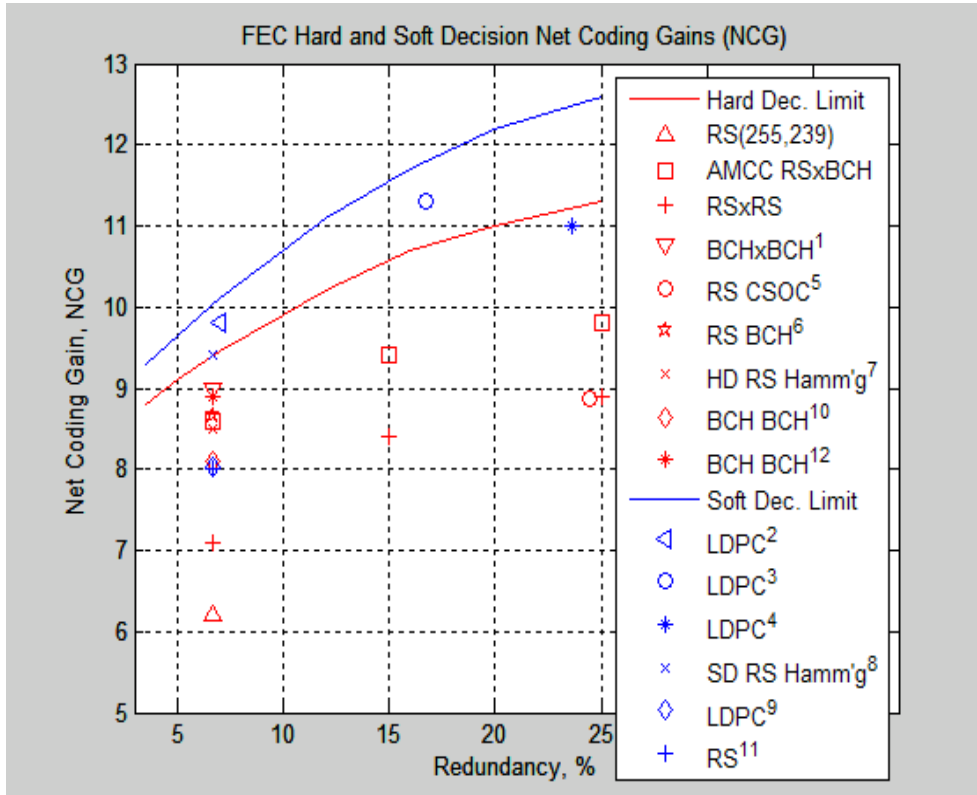
*Integratable Tunable Laser Assembly Implementation Agreement

Integrated Photonic Demodulator/Receiver



- ◆ **Current photonic receiver module composition**
 - **Beam splitters, hybrids, photodetectors and TIAs**
 - **Separate local oscillator based on OIF ITLA**

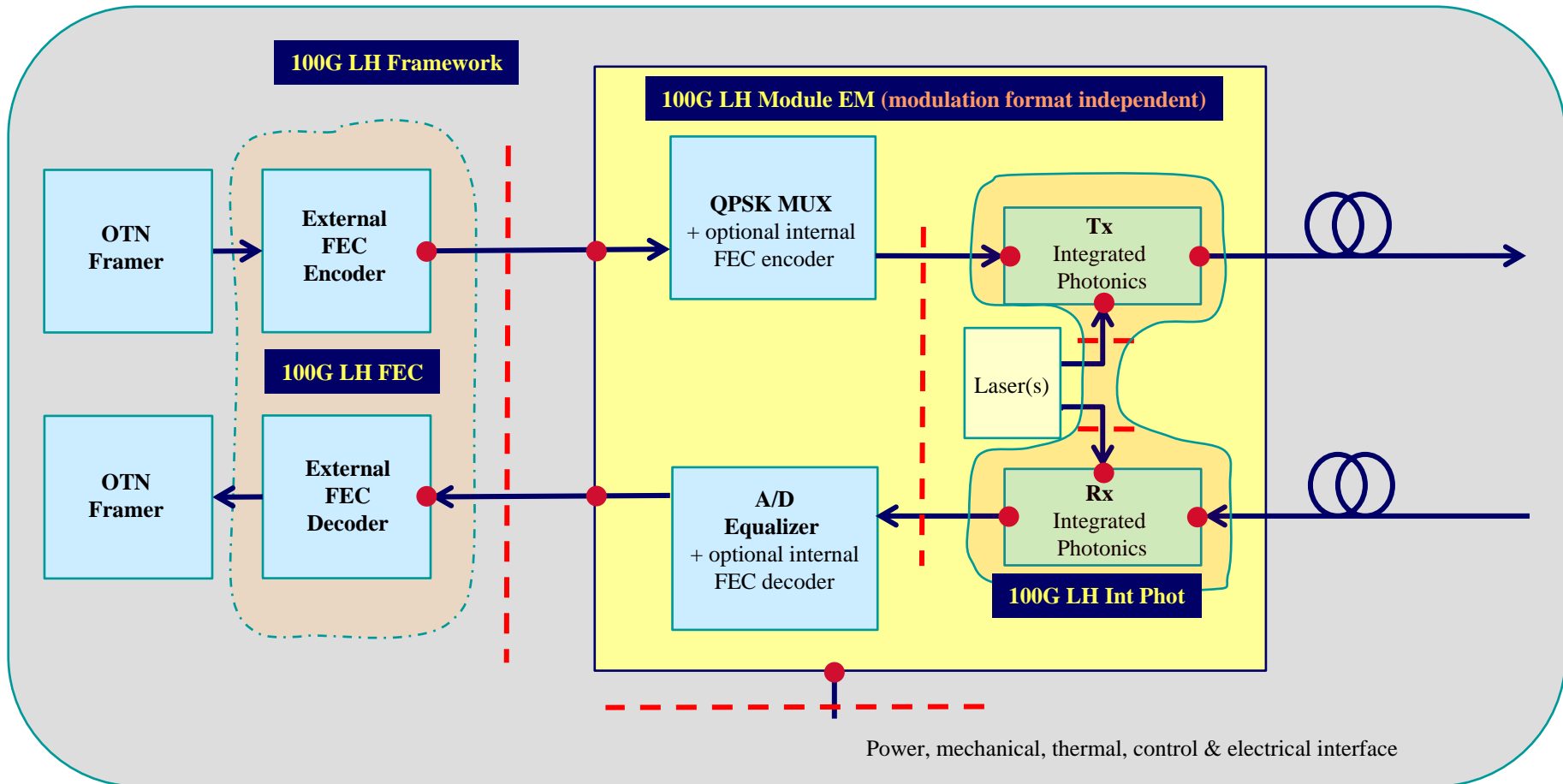
Forward Error Correction for 100G



- ◆ ITU standard FEC (G.975)
 - Not mandatory
 - Basis for interoperability
 - Coding gain about 6db
 - ~ 7% overhead
- ◆ Enhanced FEC codes
 - Widely used at 10G and 40G
 - Many solutions available
 - Coding gain 8-9 db (7% OH)
- ◆ OIF 100G FEC studies
 - Higher overhead rates
 - Impact of 50 GHz optical filters
 - Soft decision* vs. hard decision decoding

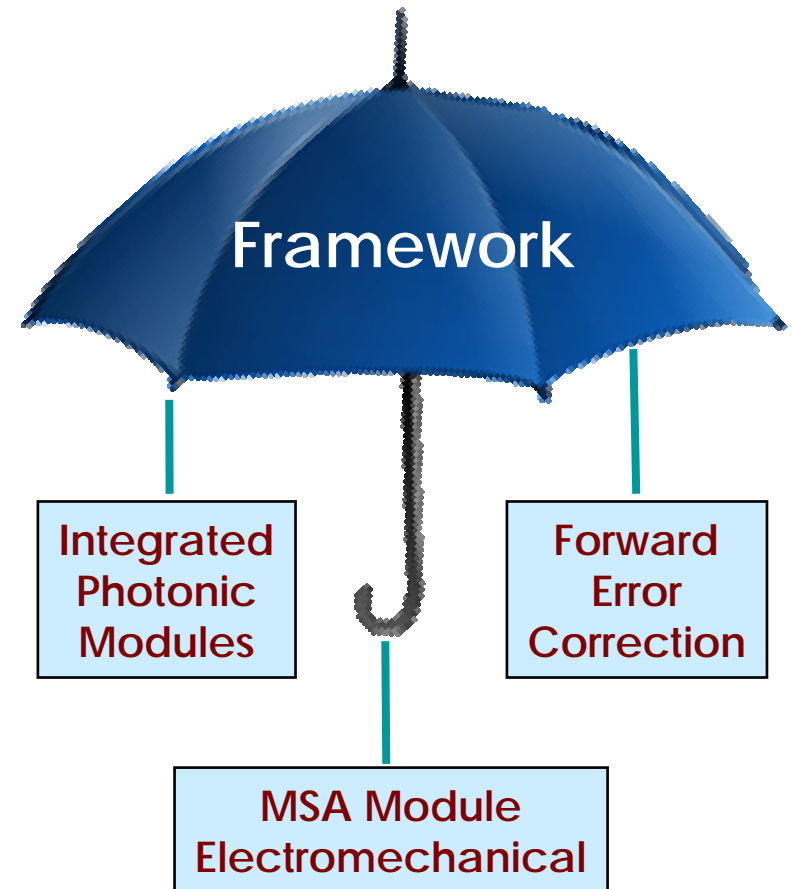
*Soft decision error correction decoding operates on more detailed signal level information than does hard decision decoding, in which an information symbol is either a “0” or “1”

100G Transceiver Module Architecture



Summary : OIF 100G Project Structure

- ◆ **Framework**
 - Application description
 - High level transceiver architecture
 - Transceiver modular decomposition
- ◆ **Integrated Photonic Modules**
 - Transmitter Module IA
 - Receiver module IA
 - Foundation for MSA Module IAs
- ◆ **Forward Error Correction**
 - Channel model
 - Studies of coding approaches
 - Performance estimates
- ◆ **Module - Electromechanical**
 - Mechanical dimensions
 - Electrical connector
 - Max power consumption
 - Communications interface



For more information please visit
www.oiforum.com

