Preparing for Tomorrow's Optical Communications Network Too Little; Too Late?

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OIF OPTICAL INTERNETWORKING FORUM

Agenda

- What is driving the next generation networks?
- Historical perspective of DWDM long-haul development
- The OIF's approach for 100G DWDM ULH
- Beyond 100G – How should it be approached?

Are Needs Outpacing Technology Development?

Traffic has grown exponentially

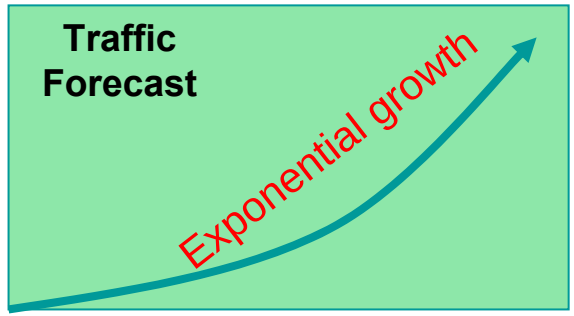
- And is expected to continue this trend

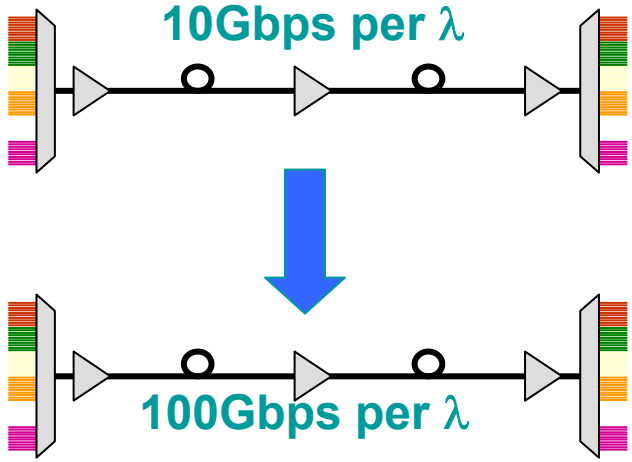
Network evolution is

- Driving capacity efficiency for LH (>1000km)
  - Using existing infrastructure
  - 10G, 40G, and 100G over same 10G channels
- Driving down CAPEX
  - Lower cost per bit than 10G and 40G
- Driving lower OPEX
  - Number of systems constant
  - Reduced space and power per bit
- And yet pricing per bit/λ/km is declining
  - Challenge is to reduce cost ever faster!

How do we ensure that the technology is ready when it is needed?

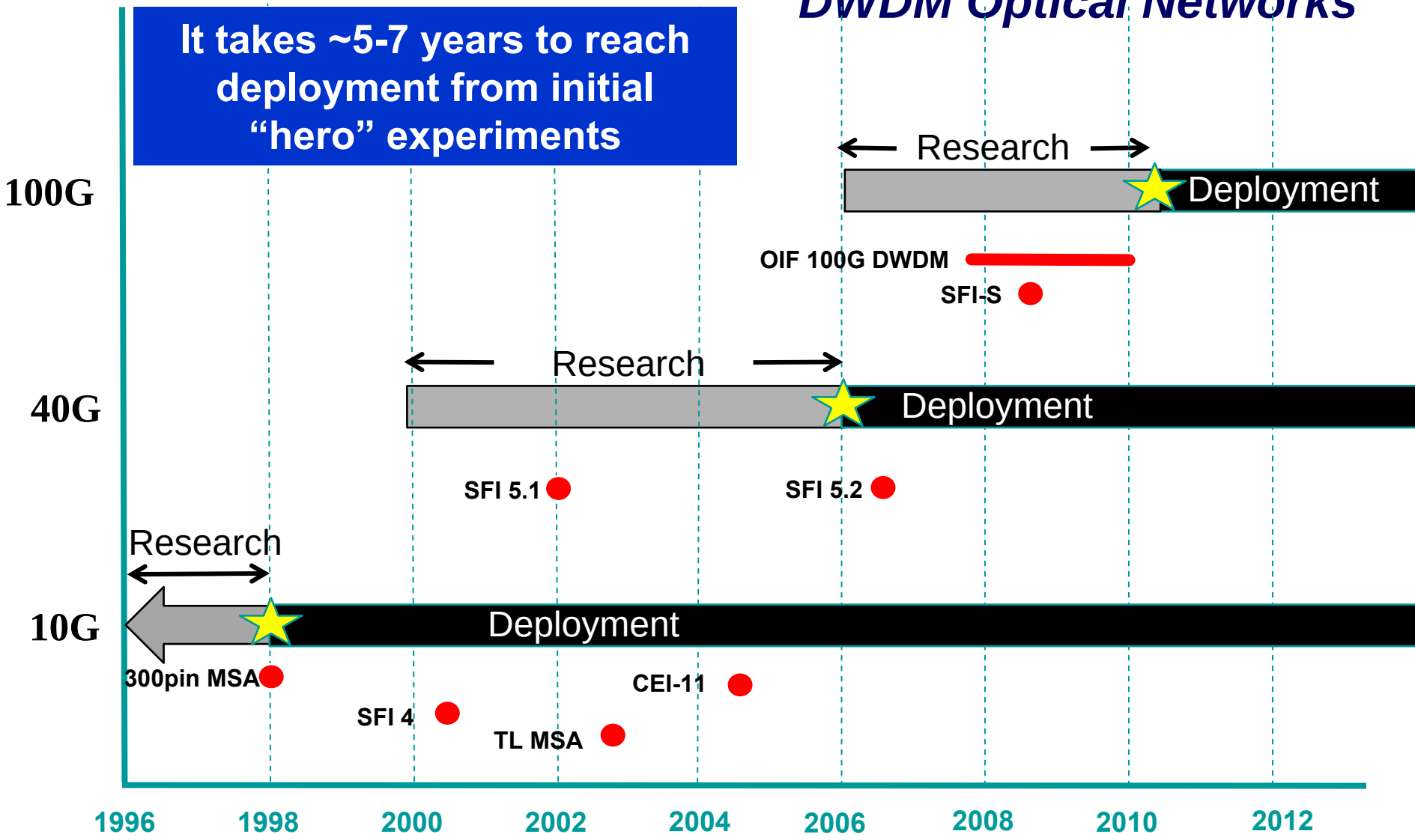
- How long does it take from research to product?





Historical Perspective: Research to Deployment

DWDM Optical Networks



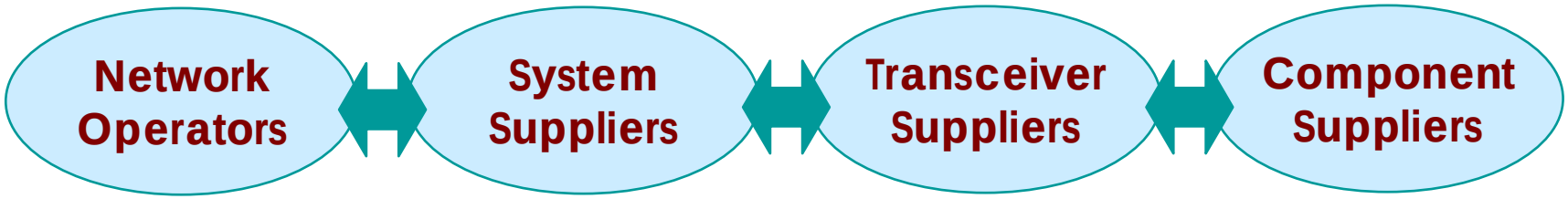
OIF's Role in 100G

Our Objective:

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

Our Approach:

For speeds lower than 100G the innovations could be tackled separately

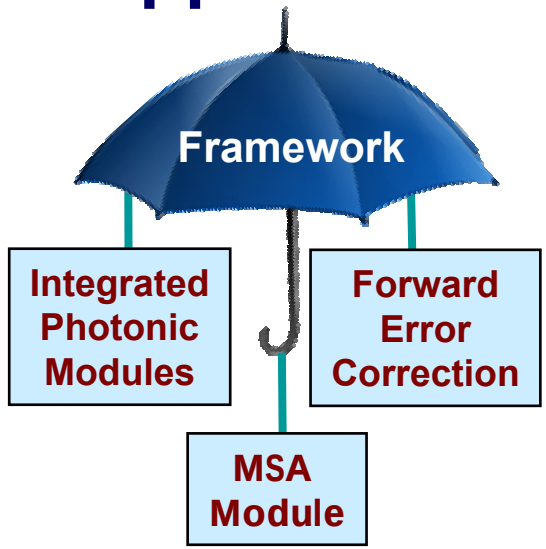


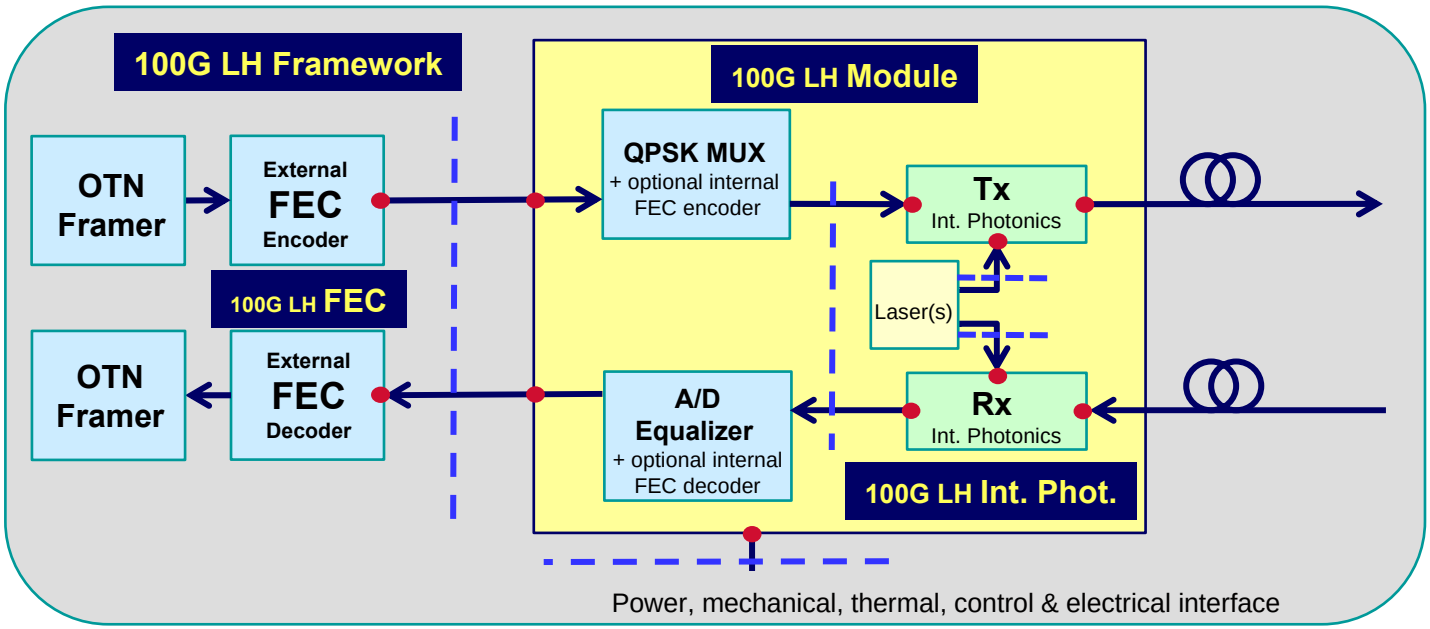
But at 100G, the innovations required coupling from all levels of the eco system to arrive at a viable solution

OIF's 100G DWDM Project Approach

Our Approach

- Select an application target – Core backbone networks
- Build upon IEEE and ITU-T standards
- Agree on modulation format
- Identify key technology building blocks and interfaces
- Develop IAs among building blocks
- Develop Implementation Agreements (IA) for MSA transceiver module and integrated photonics module
- Note that "Line side" DWDM system interoperability is not a current objective

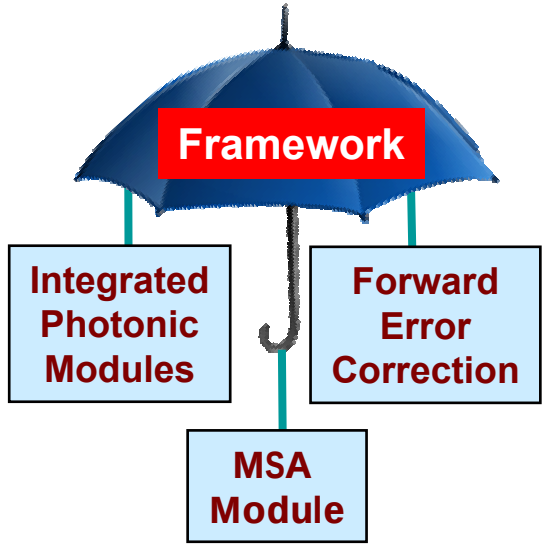


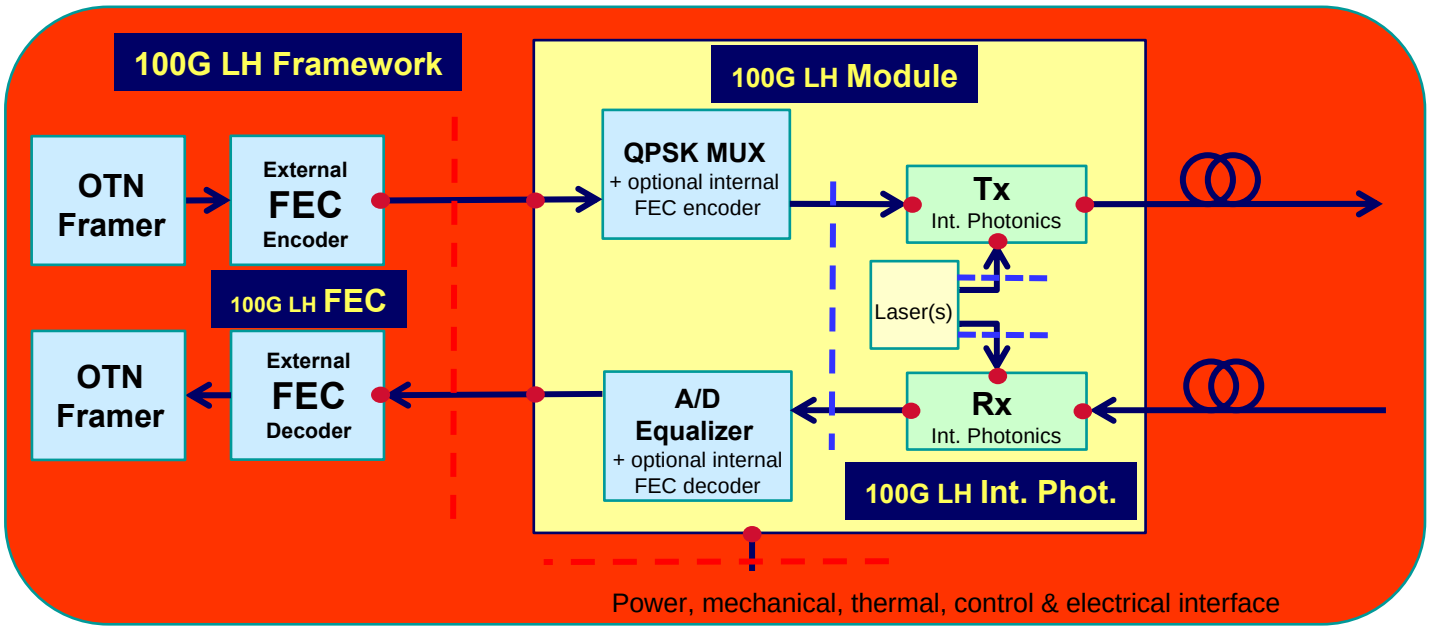


OIF's 100G DWDM Framework

Framework

- Starts with carrier requirements
- Creates consistent interfaces between blocks
- Provides:
  - An application description
  - A high level transceiver architecture
  - A transceiver modular decomposition

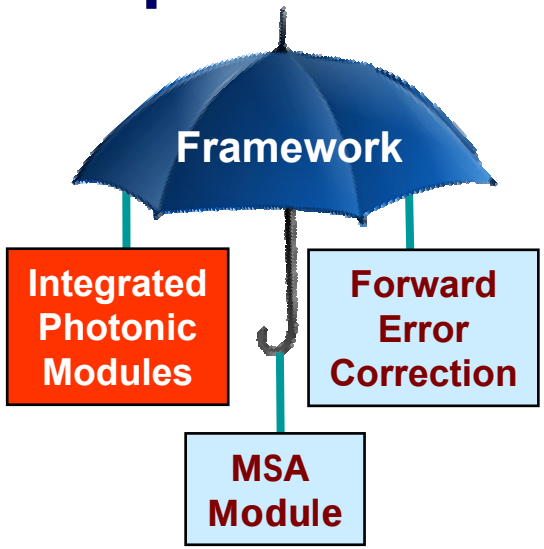


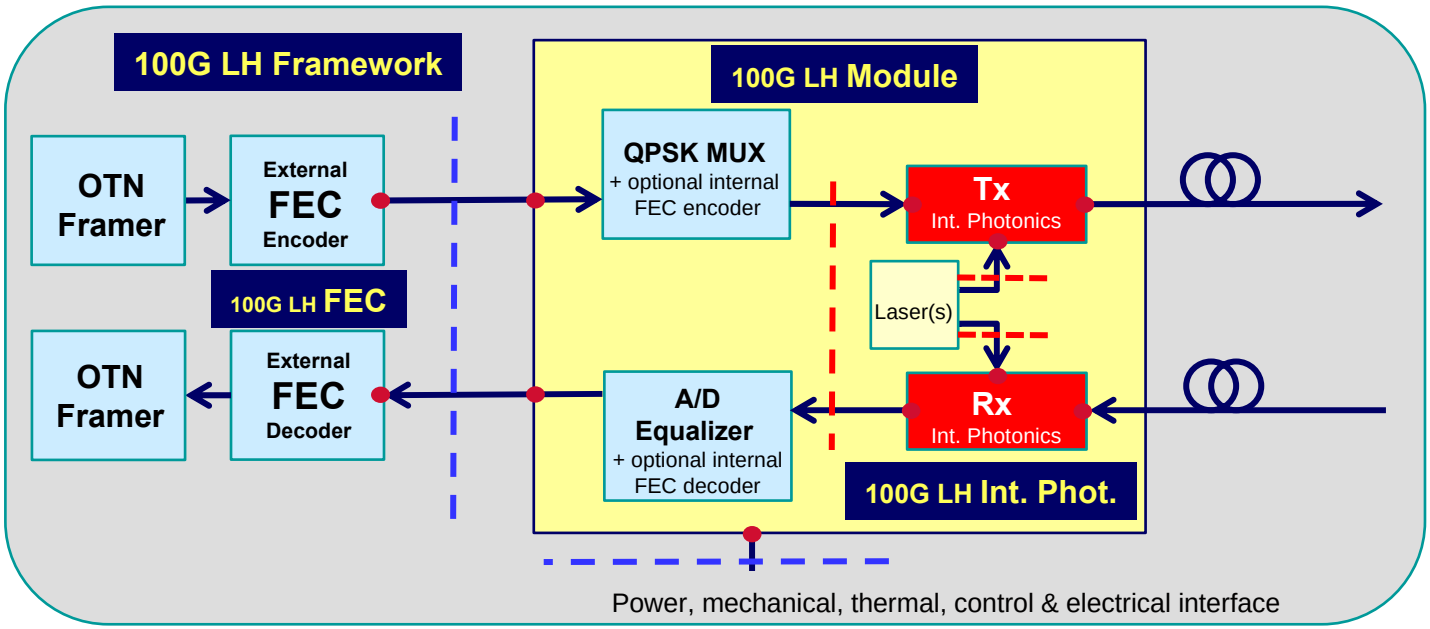


OIF's 100G DWDM Photonic Components

Framework
Integrated Photonic Modules

- Define the blocks and their key interfaces
  - Transmitter Module IA
  - Receiver module IA

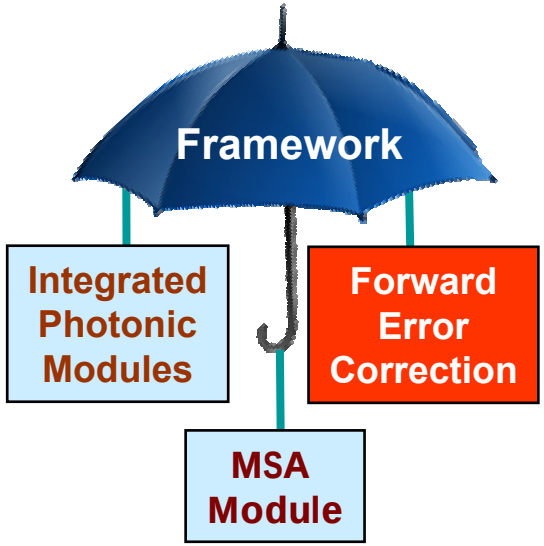


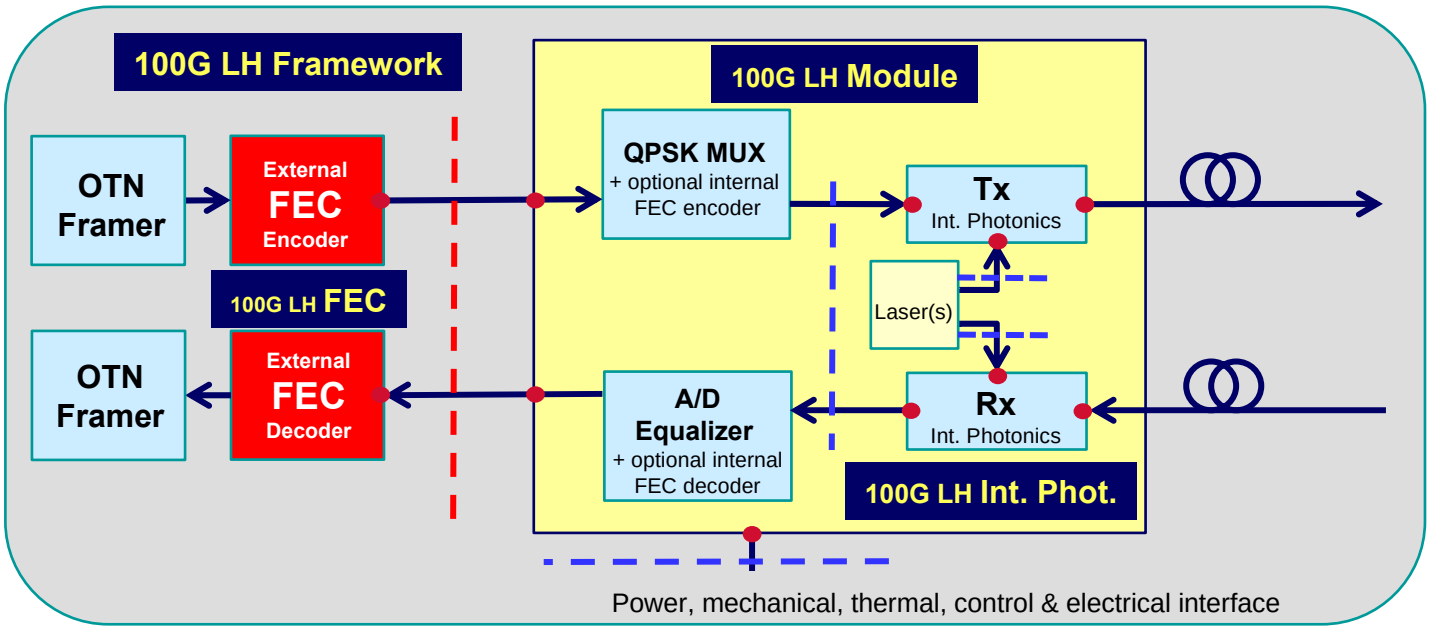


OIF's 100G DWDM Forward Error Correction

Framework
Integrated Photonic Modules
Forward Error Correction

- Determine the needs for FEC in the LH link
- Develop a channel model to answer key questions
- Study coding approaches
- Develop performance estimates





OIF's 100G DWDM 100G MSA Module

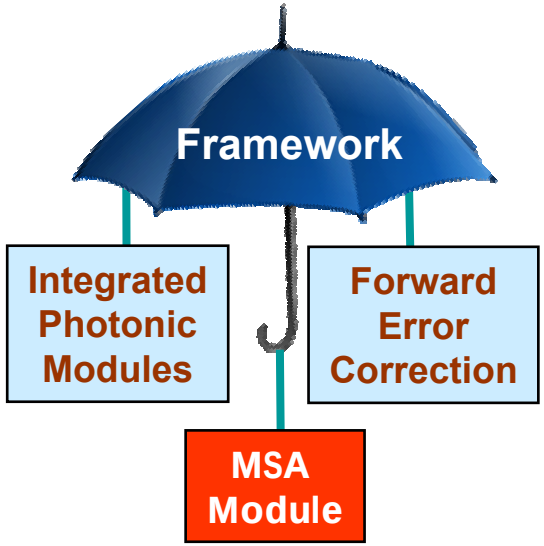
Framework

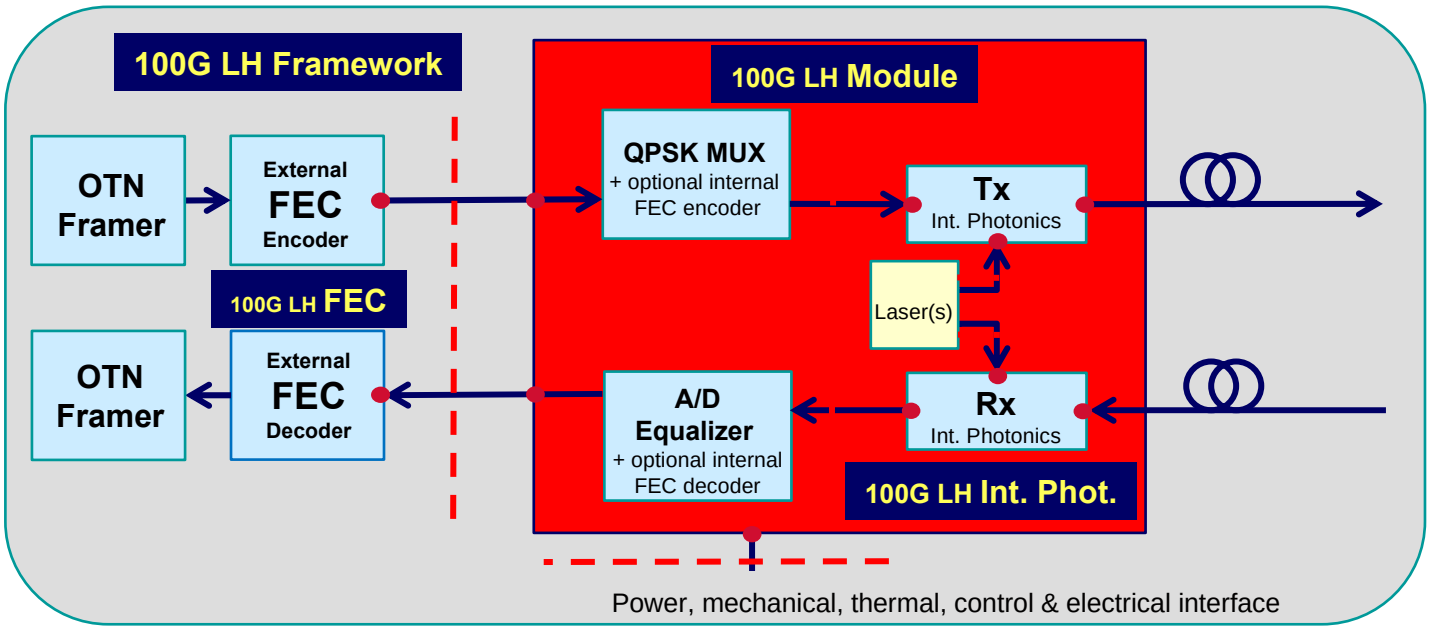
Integrated Photonic Modules

MSA Module

Define a modulation independent module

- Mechanical dimensions, electrical connector
- Max power consumption
- High speed data & management interfaces



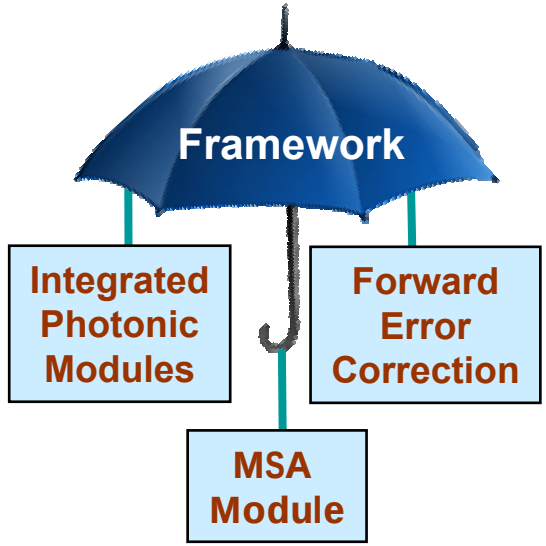


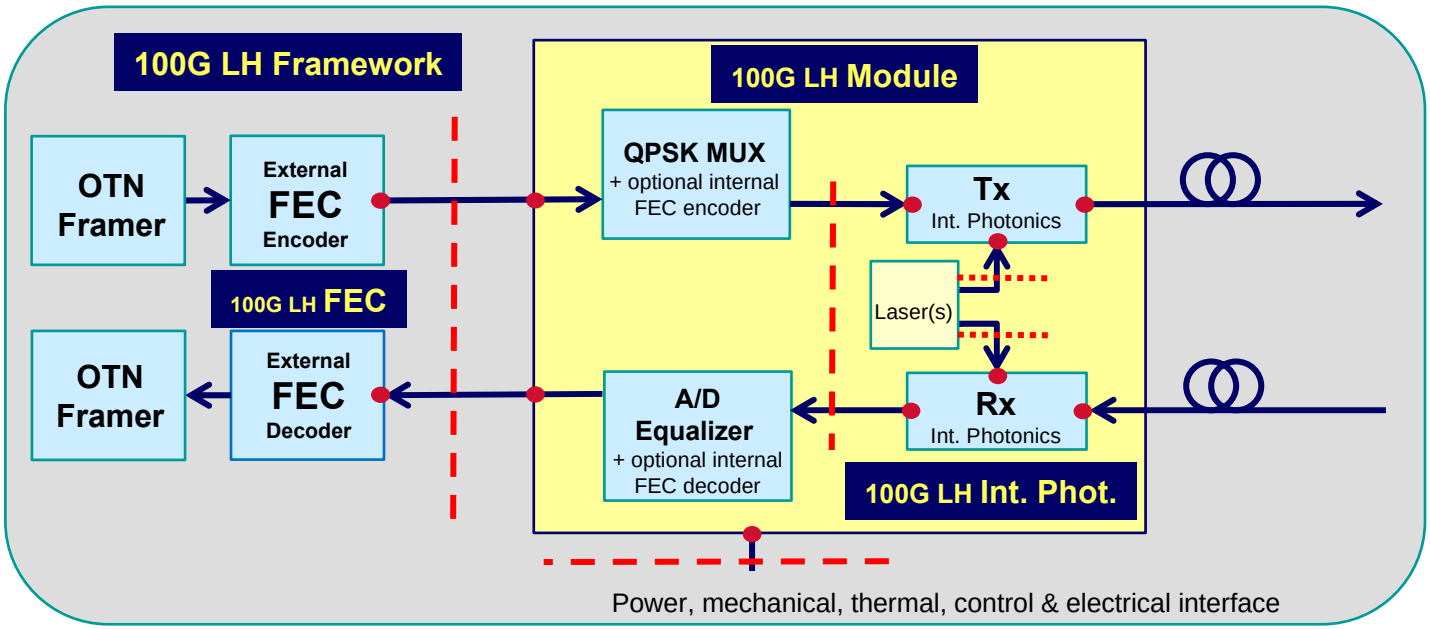
Summary : OIF 100G Project Structure

Result

A closely coupled set of projects which enables an eco system to provide products which meet the carriers' needs for 100G LH DWDM transport

Can our 100G approach be used for >100G?





Challenges beyond 100G DWDM are even more difficult

- Moving from 40G to 100G LH with the existing infrastructure, resulted in a -4dB OSNR deficit
  - The OIF's solution compensates for this deficit through the application of higher gain FEC, advanced DSP technologies, and advanced modulation techniques
- Moving beyond 100G LH to increase the capacity results in additional OSNR deficits when using the same infrastructure
  - It appears that there is very little room left for innovations in FEC, DSP, and advanced modulation techniques to compensate
  - Additionally, the narrow 50GHz link pass bands further complicate the picture
  - In fact, it isn't even clear what innovations might be targeted to make required improvements
- Given the 5-7 year delay between hero experiments and product availability, the time to start working on research to find solutions is now

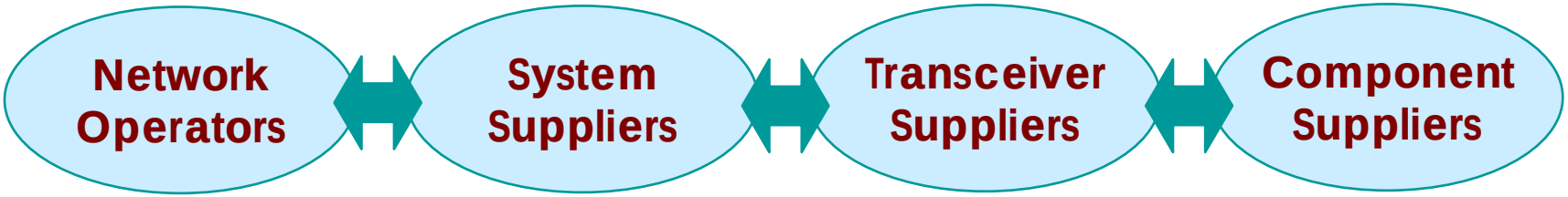
Beyond 100G

What approach should be taken for beyond 100G?

- For speeds below 100G, the innovations could largely be tackled separately
- At 100G, given the carrier requirement of increased capacity using existing infrastructure, many of the innovations (modulation format, FEC, coherent receiver, electronic compensation) have already been employed
- For capacities beyond 100G, it isn't clear to us what tradeoffs or innovations will be required to achieve an economically viable solution. Will it require e.g. new fiber or shorter amplifier spacing?
- But certainly, initiating research and early discussions on performance tradeoffs across the eco system are key

Beyond 100G

The OIF is a great place to collaborate on these challenges because of its membership at all levels of the eco system!



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