

# Power up your transformation.



Product Manager

**EXFO**

We are  
the global  
**network test,**  
**data** and  
**analytics**  
experts.

**No.1**

in optical portable  
test solutions

**90%+**

of leading service  
providers choose us

**30+**

years of leadership

**Awards**

for market share and  
product strategy leadership

**LIGHTWAVE**  
INNOVATION  
AWARDS

**Leading  
Lights  
AWARDS**

**FROST &  
SULLIVAN**

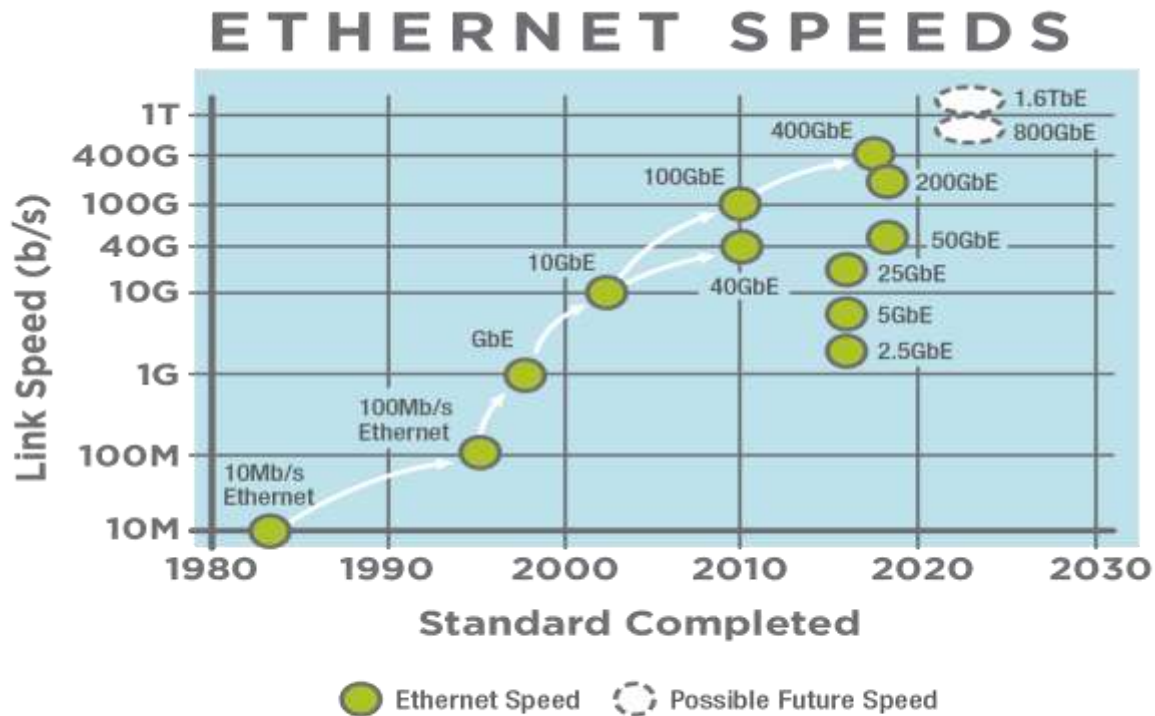
# Market & Challenges



## Multiple applications driving optical network growth



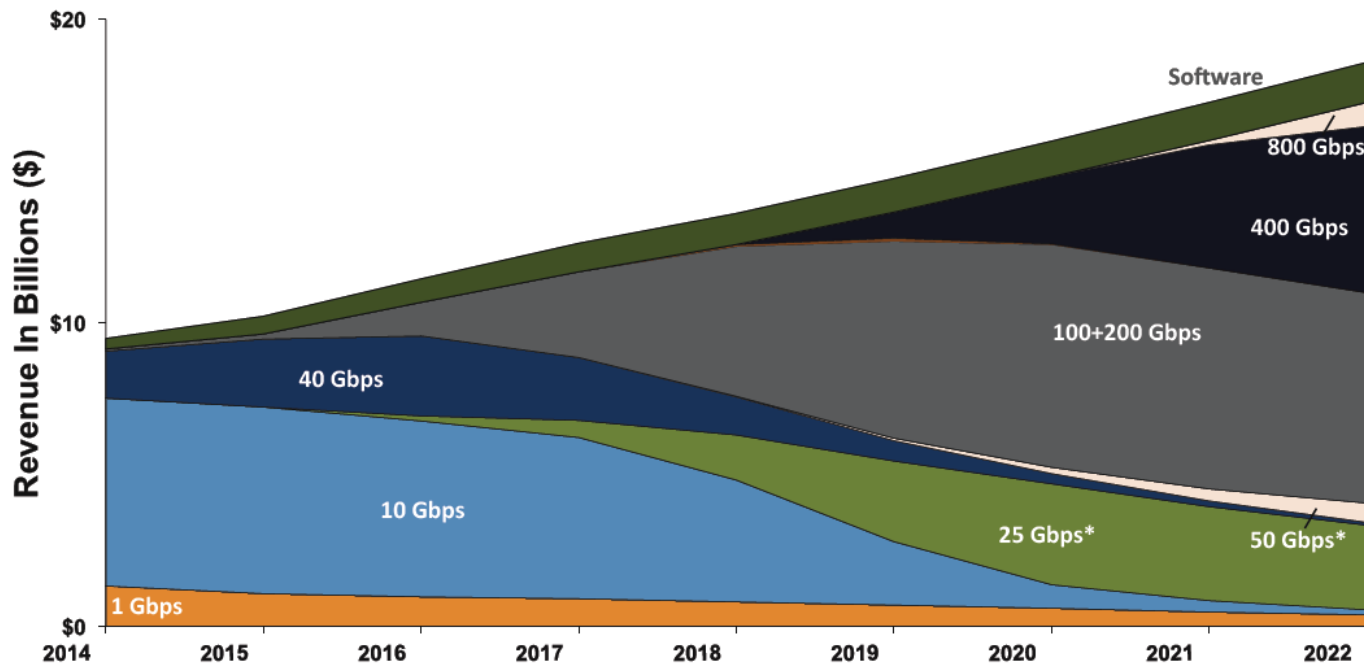
# Interface evolution



# High speed potential

## Market Potential by Speed

Data Center Ethernet Switch Revenue (\$Bn)

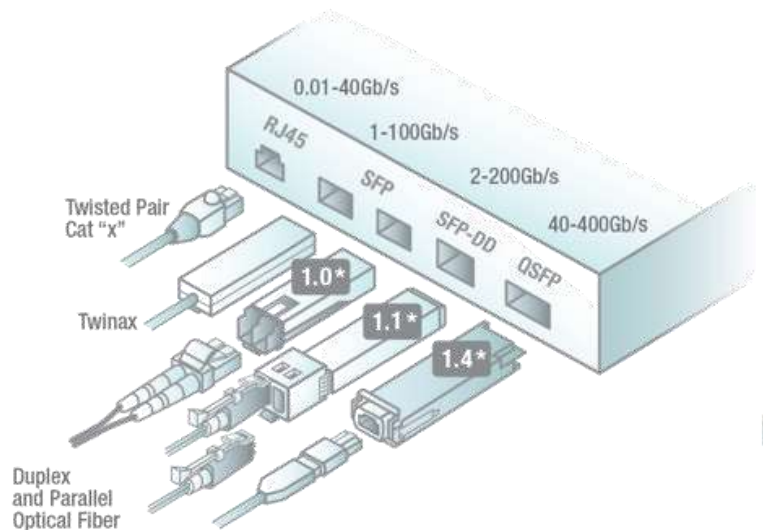


Source: 650 Group December 2017 Long Term Ethernet Switch forecast

\*Shows discrete 25G or 50G ports only. A significant portion of 25/50GE server ports are expected to connect via QSFP-100G break out to 100 GE switch ports at the large Cloud Service Providers.

# Emerging 100G / 400G high speed interfaces

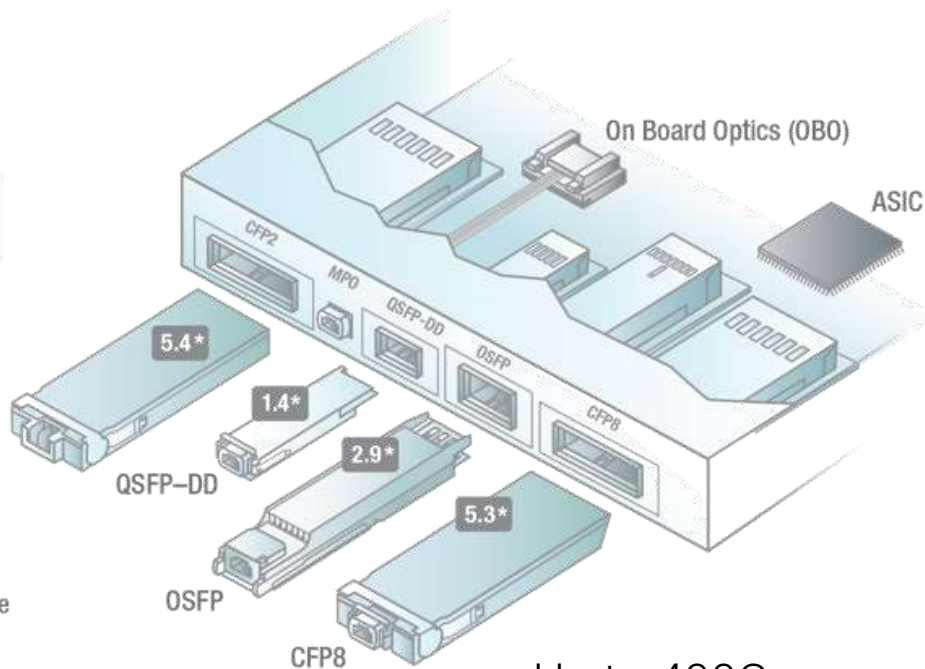
## 1-4 Lane Interfaces



\*Square inches of top surface of the module

Up to 100G

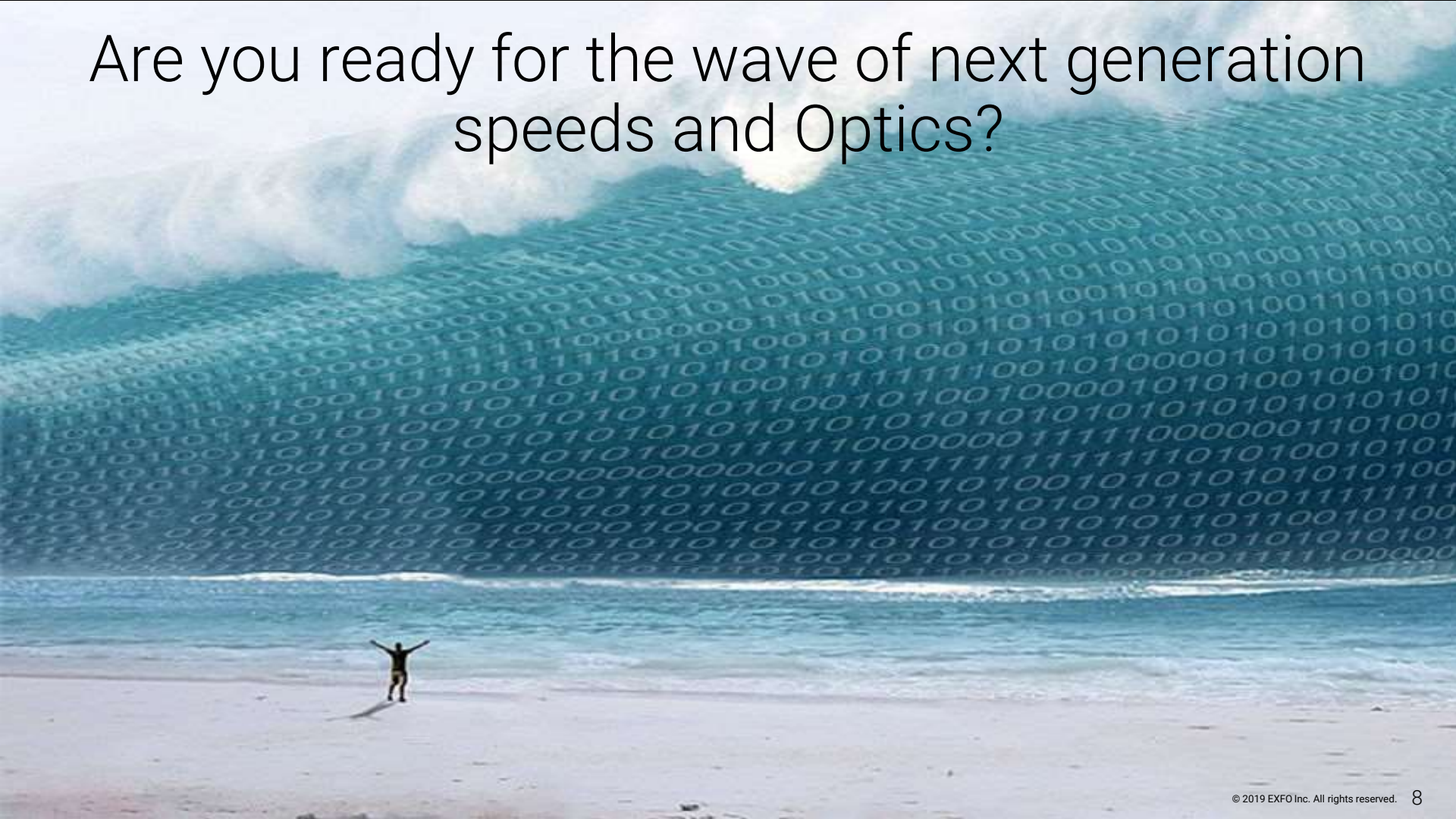
## 4-16 Lane Interfaces



Up to 400G



# Are you ready for the wave of next generation speeds and Optics?



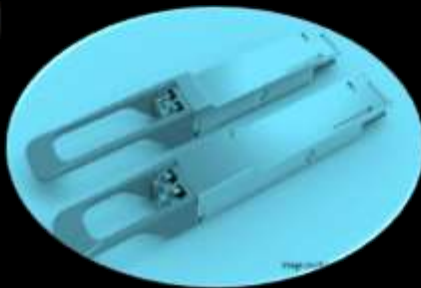


# 400G The next frontier

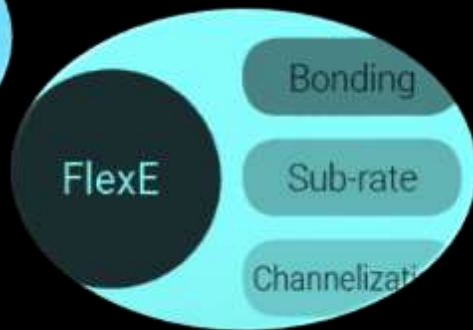
# 400G ecosystem



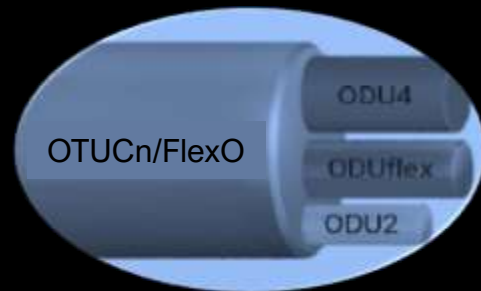
Higher bandwidth



Interfaces



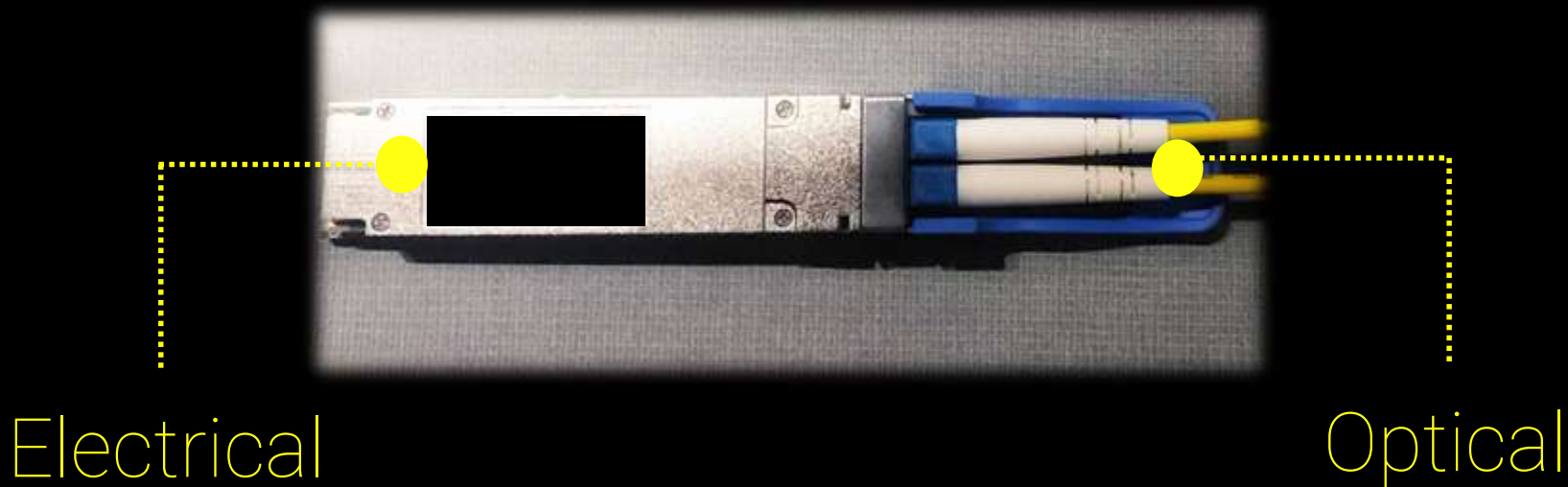
Flexible rates



Adaptable  
technologies

# Transceiver Validation

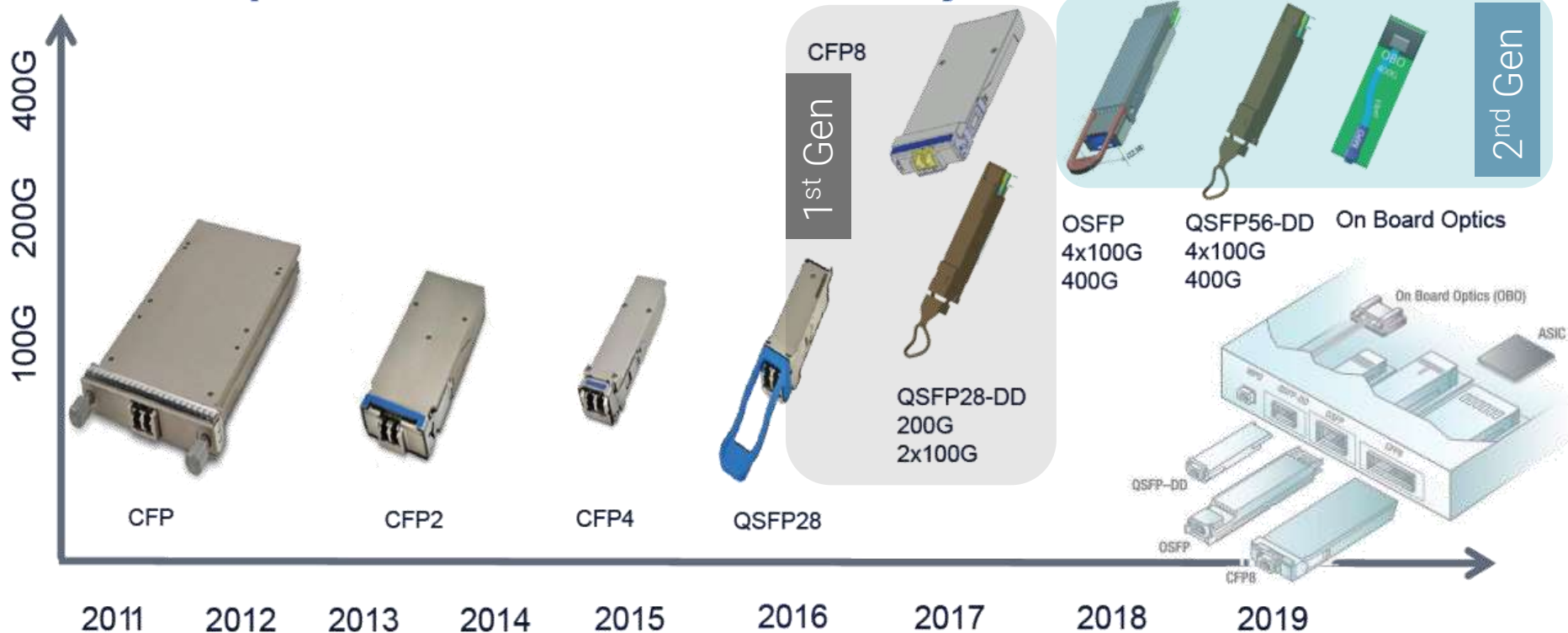
Transceiver roadmap is driven by two main elements:





# 100G to 400G Transceivers - Roadmap

## Router Optics Evolution for 100G and Beyond



# 400G AOC & DAC Cables

One key trend on the 400G market (NEMs, Webscales and Labs) is the use of DAC cables to interconnect Switches/routers in a rack. They are low cost, uses no optics and are multi-formats



QSFP-DD

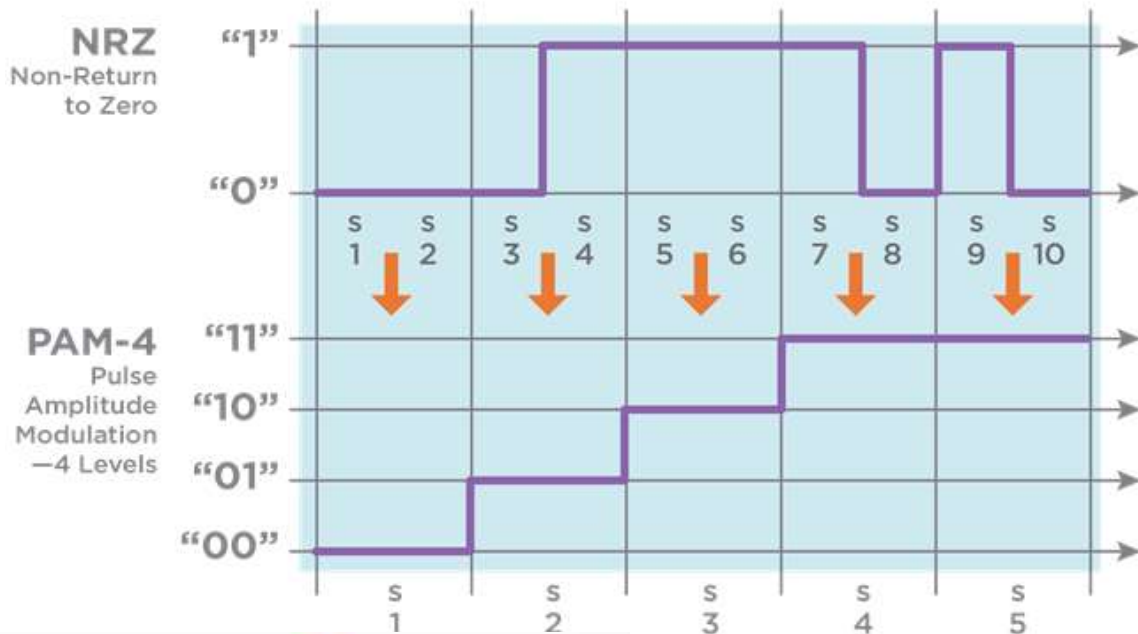
OSFP



# NRZ versus PAM4

New modulation schemes allow transporting more data in the same transceiver form factors

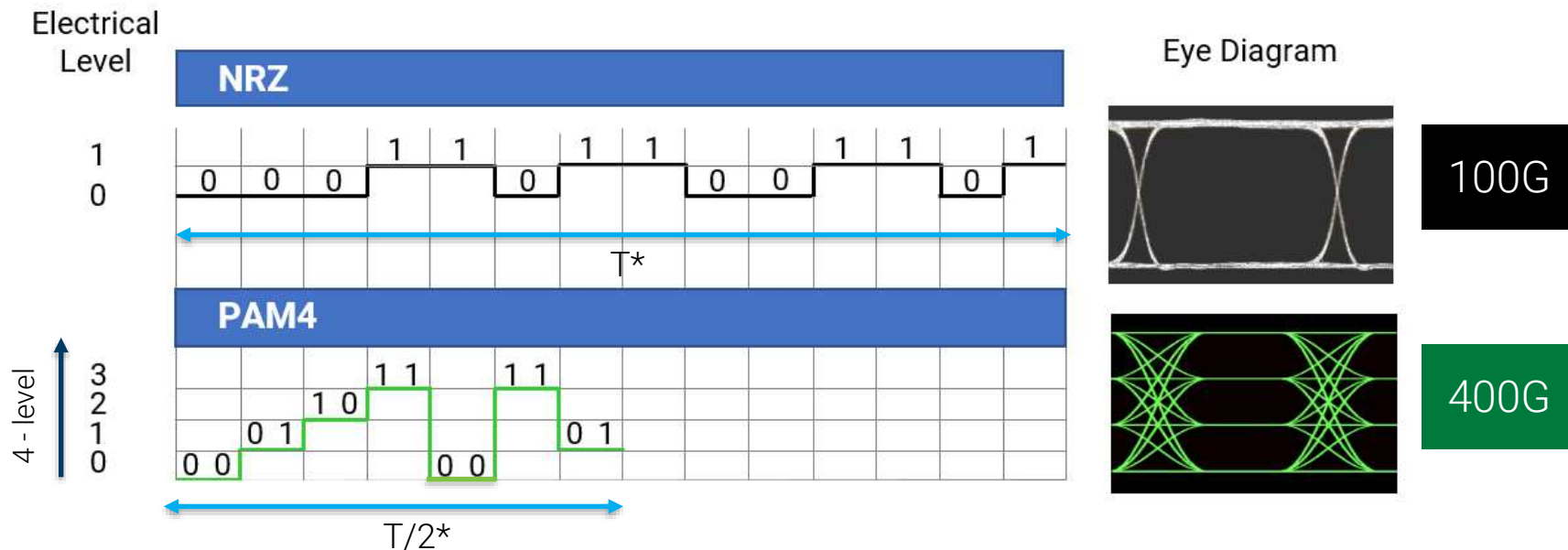
PAM-4 signaling  
delivers twice as  
many bits per  
sample



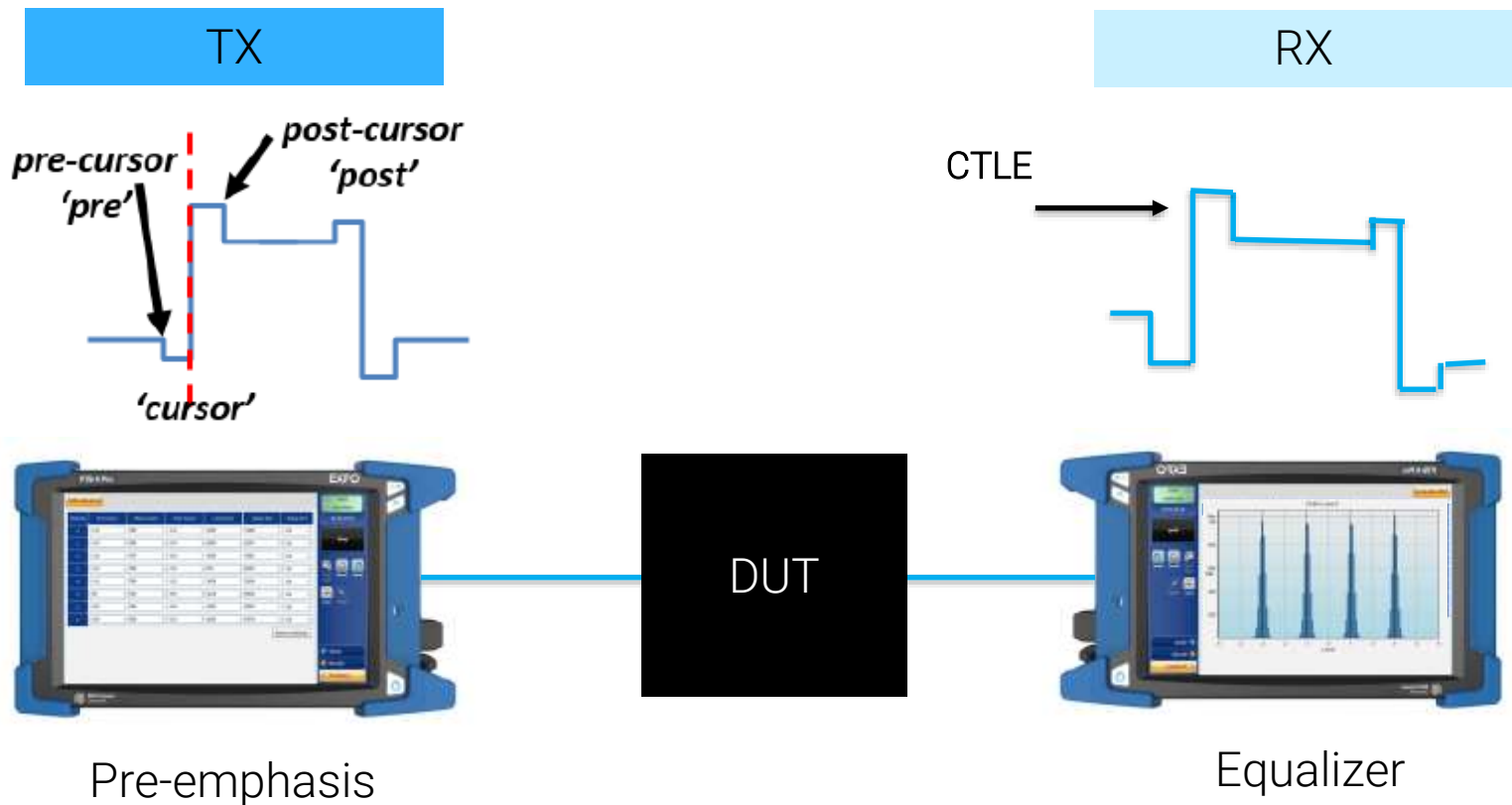


# NRZ vs PAM4

The need to scale the network rates has led to implement PAM4 (Pulsed-Amplitude Modulation). This modulation brings more challenges to the table



# Electrical Validation - Pre-emphasis & Equalizer



# The road to coherent interfaces



Early coherent line card  
100G



AC100  
100G



CFP-DCO  
100G



CFP2-ACO  
200G




CFP2-DCO  
200G



400ZR  
400G

**Compact, high-capacity module solutions enable reduced network costs**





# Flexible & Adaptable Applications

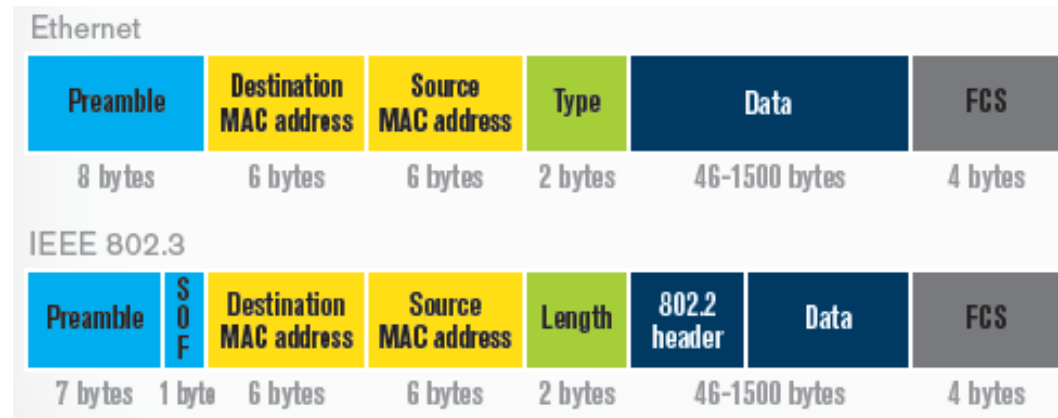
# 200G/400G Ecosystem - IEEE 802.3bs highlights

## Characteristics

- Support a MAC data rate of 200 Gb/s
- Support a MAC data rate of 400 Gb/s
- **Mandatory FEC**
- Preserve minimum and maximum Frame Size
- Provide appropriate support for OTN
- Energy Efficient Ethernet (EEE)
- **FEC Level monitoring**

Ethernet interface	Line rate
400G Ethernet	425 Gbit/s
200G Ethernet	212.5 Gbit/s

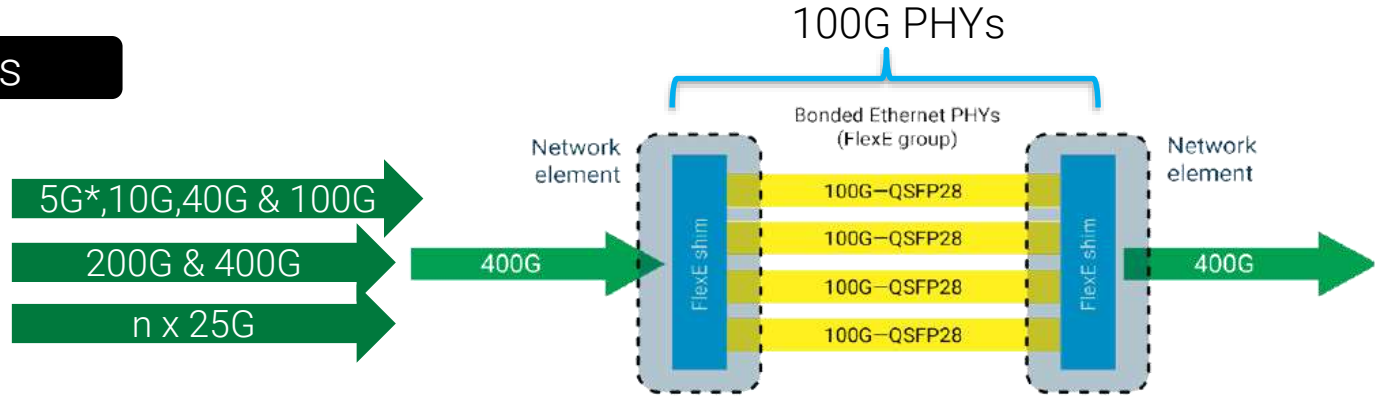
## Ethernet frame format and rates



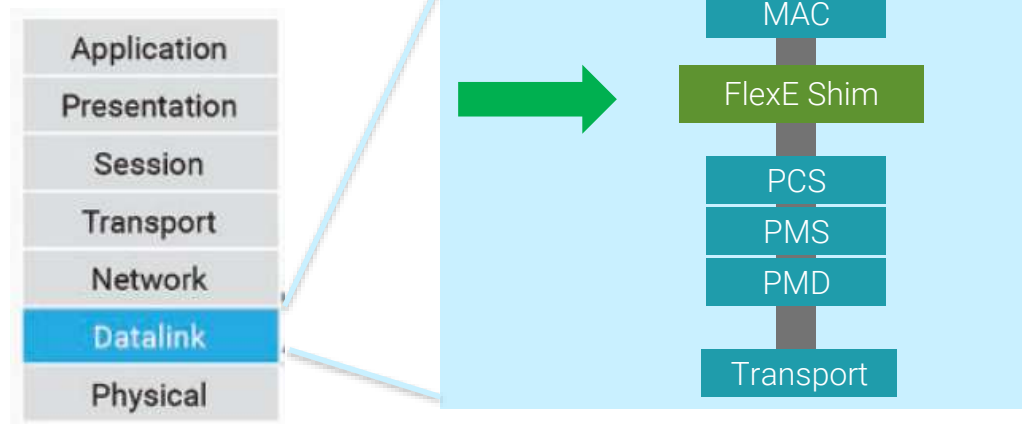
# 400G Ecosystem - Flex Ethernet (FlexE)

## Flex-E Elements

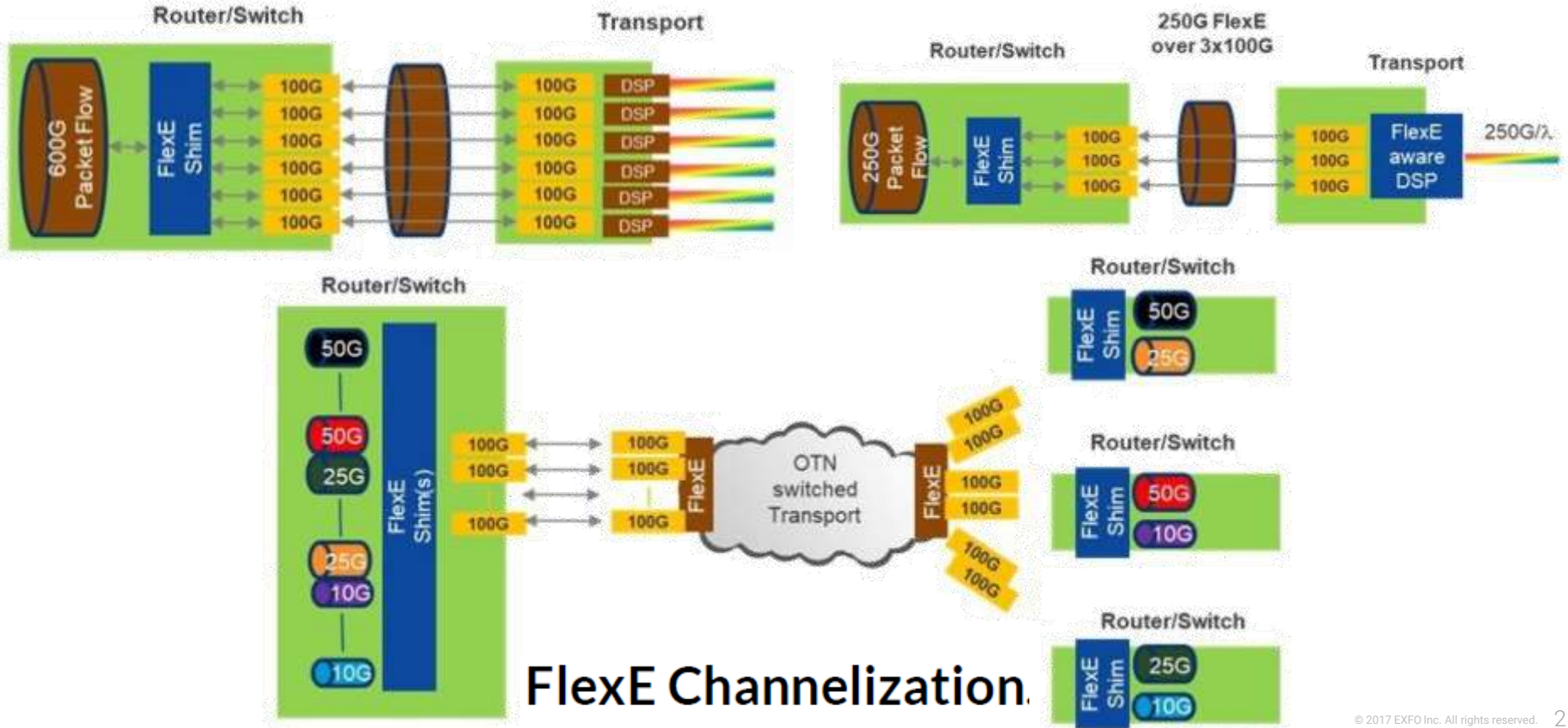
- Clients
- Group
- FlexE Shim

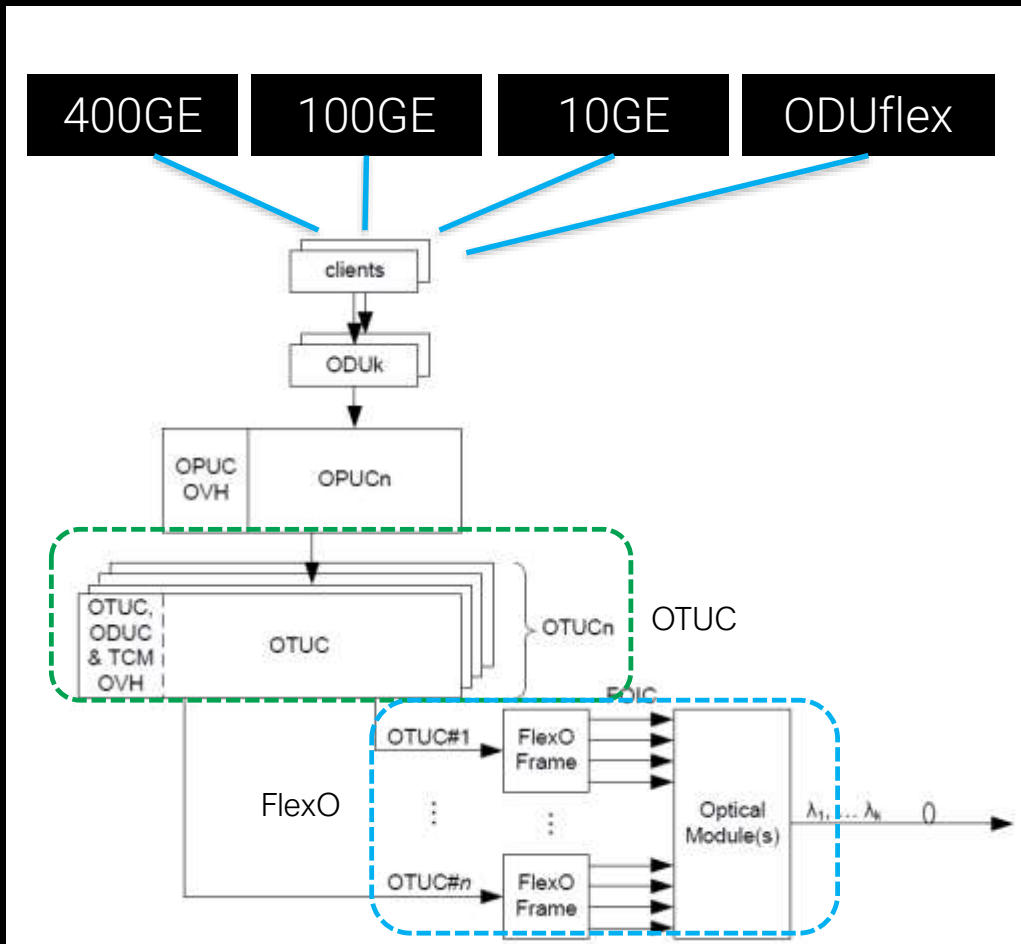


## OSI Model



# Ethernet Next-gen – FlexE





# OTUCn/FlexO

1. OTUCn Manages the configuration of the different clients in the containers.
2. FlexO associates PHYs, for the physical transport
3. The FEC is set on the associated interfaces



# How can we help -- Simplifying your testing





# EXFO Solutions

# Open Transceiver System

The new OTS  
innovative  
technology

Ultimate flexibility and  
upgradability.



# A new way forward — EXFO FTBx-88460 200G/400G



## Description

- **Compact & Portable** 4-slot module with TA
- **200G/400G** framed/unframed Ethernet testing through L4 with EMIX
- **RFC2544** With 10 frame sizes
- Unframed 8/16 lanes test patterns : **PRBS13Q, PRBS31Q, SSPRQ**
- **Pre/Post FEC, RX equalizer, Histogram, Pre-Emphasis, temperature analysis**
- Supported in the **LTB-8 rackmount** platform and the **FTB-4 Pro portable** platform
- **FlexE** full support with Ethernet clients from 5GE to 400GE
- **OTUCn and FlexO** support
- **QSFP-DD (TA4), OSFP (TA4), CFP8 (TA4), QSFP28**
- **iOptics** 100G/400G transceiver validation support including DAC support

## Benefits

- **Most compact 200G/400G** Solution of the industry
- **Field to lab ready**—from the lab rackmount platform to the field portable platform
- **Multi-interfaces** support using TA4
- **200G/400G ecosystem** testing capabilities
- Same **easy of use GUI**
- **800G** Capacity testing

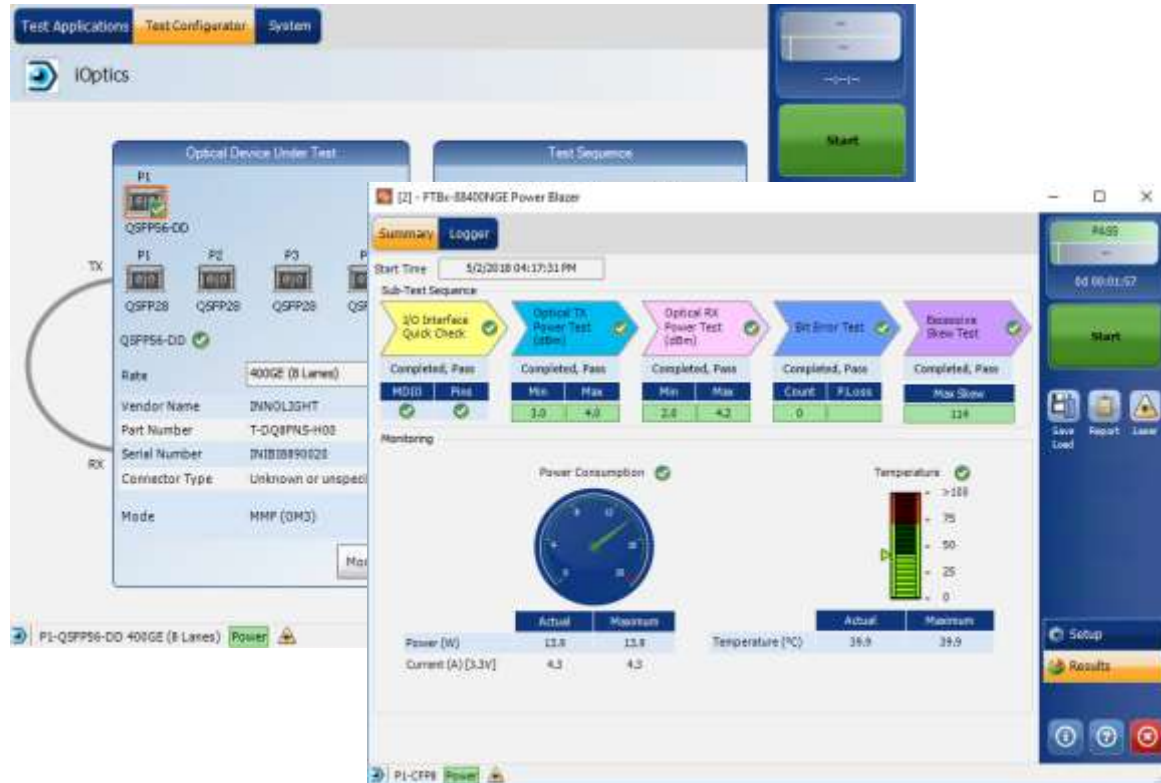


# 400G/200G/100G/50G/10G Transceiver validation

Intelligent test application that quickly validates transceiver key sub-tests.

Supporting 4x QSFP28, AOC/DAC cables, CFP8, QSFP-DD, OSFP and more...

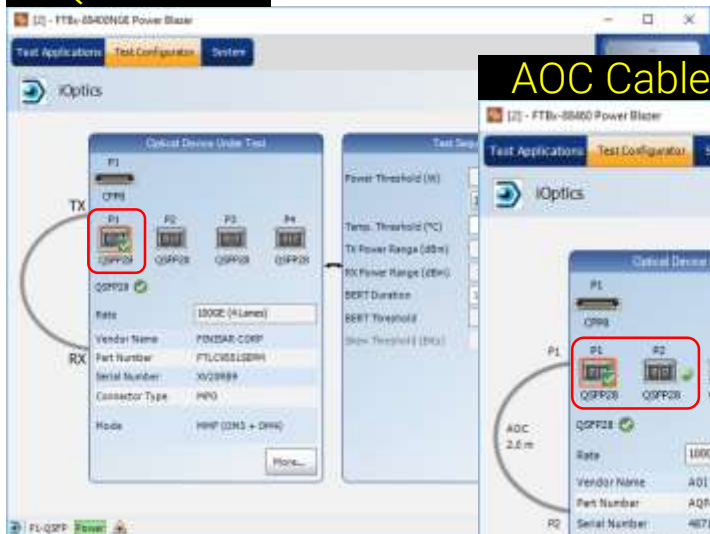
1. Power monitoring
2. MDIO/I2C Quick check
3. Temperature monitoring
4. Optical TX power per lane, monitoring
5. Optical RX power per lane, monitoring
6. Stress test
7. Skew test (high-speed devices)





# Transceiver and Cable validation

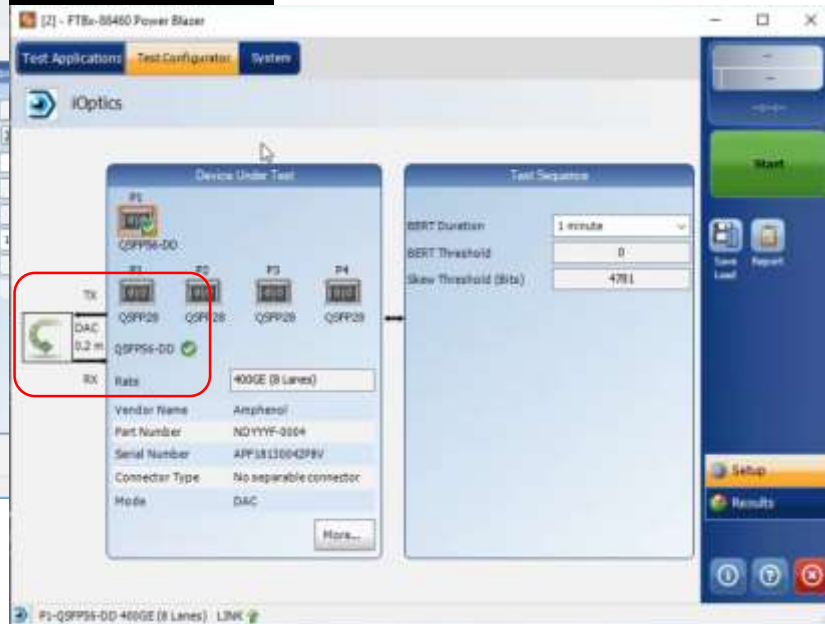
## QSFP-28



## AOC Cable



## DAC Cable



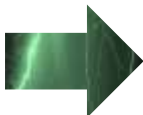
# 200G/400G Ethernet QoS Measurement

As the market moves forward to 400G..

RFC2544



Lab

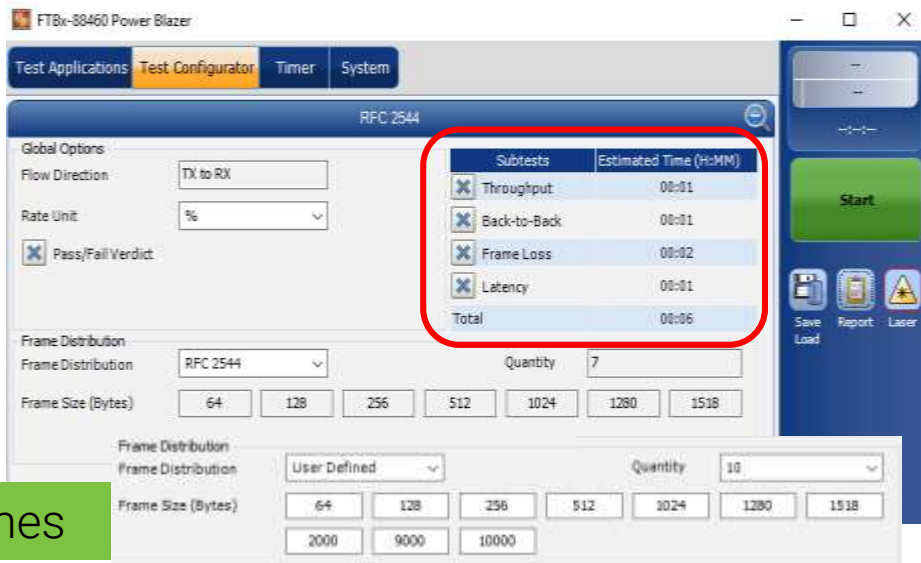


Field

Ethernet QoS measurements is becoming a must :

- ➡ Throughput
- ➡ Latency
- ➡ Frame loss

Includes 10 Frames



# PAM4 Histogram (RX)

Analyzing the electrical eye is a key requirement of the PAM4 analysis

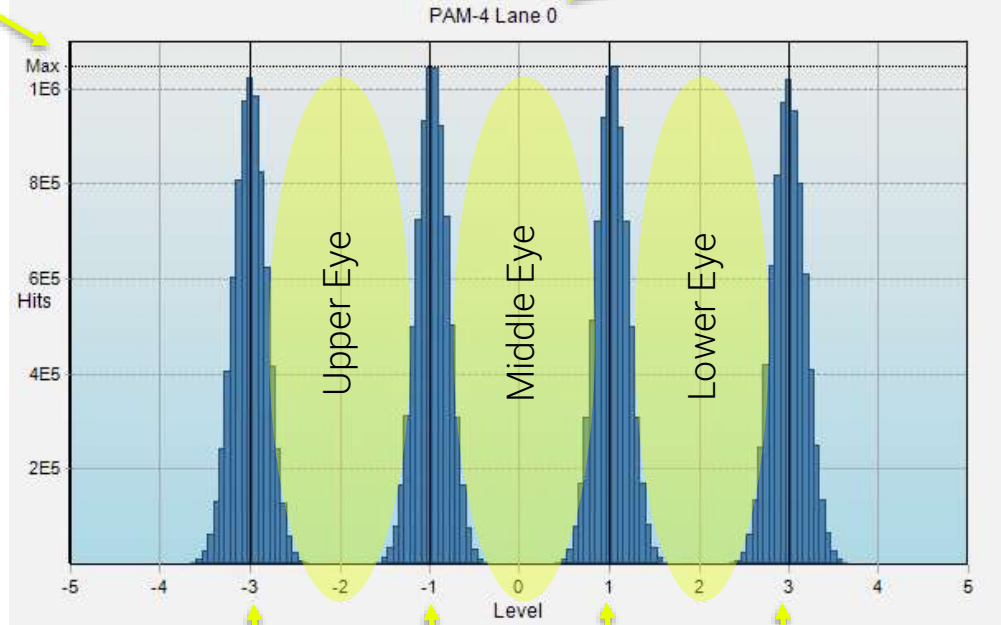
Optimal way to Characterized the received PAM4 signal.

User can see the PAM eyes without an Oscilloscope

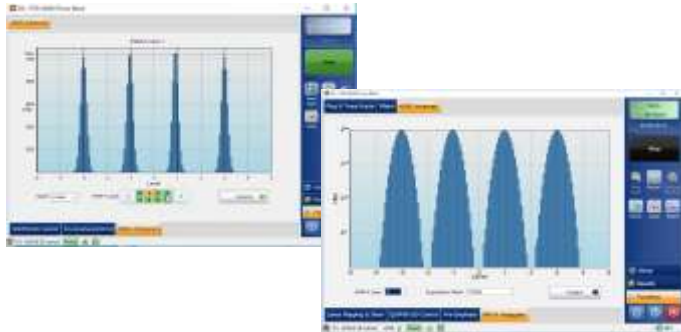
All lanes are scanned and saved on the report

Max

Lane # number



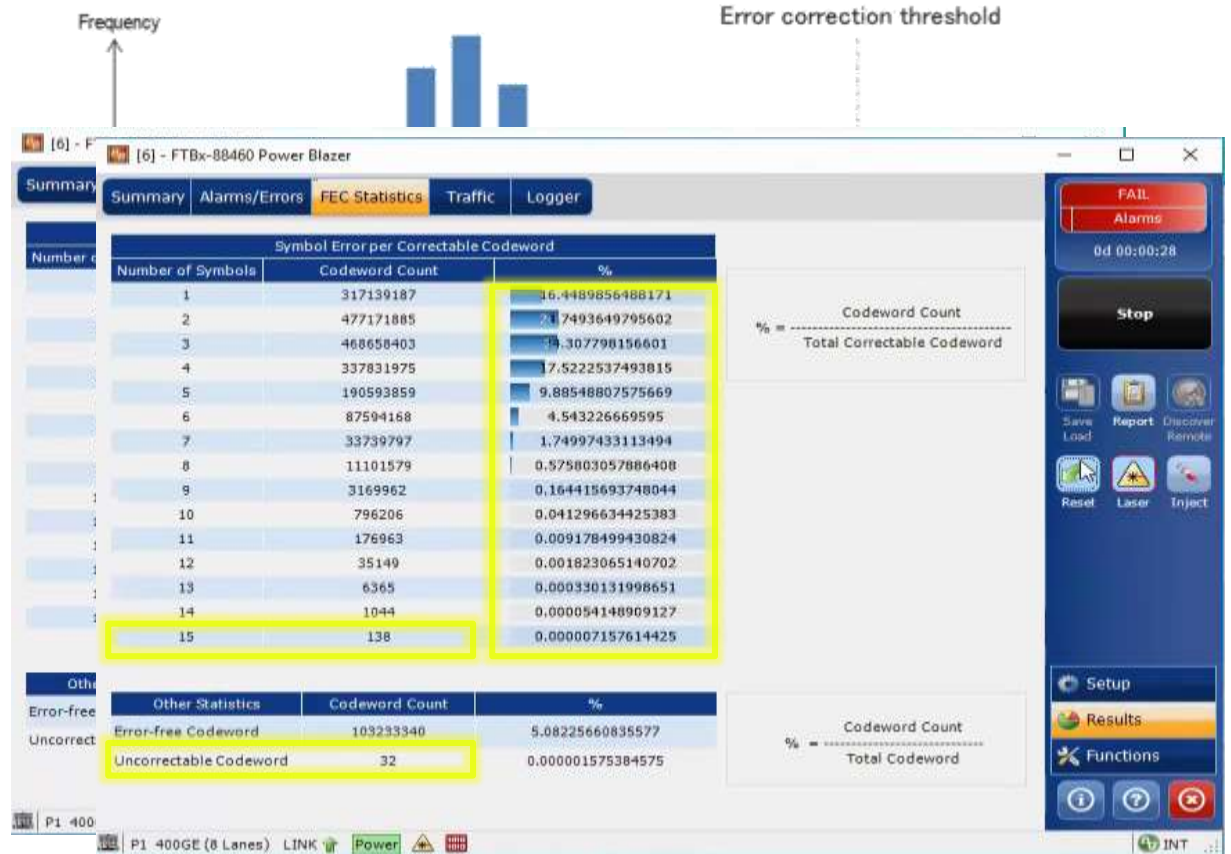
PAM 4 Levels



# 400G testing – FEC Codeword distribution

Customers required a way to validate the FEC

Errors	Seconds	Count	Rate
66B Block	--	--	--
FEC-UNCOR-CW	--	--	--
FEC-COR-CW	--	--	--
FCS	--	--	--
Jabber	--	--	--
Oversize			
Runt	--	--	--
Undersize	--	--	--



# Summary

## 100G

### End-To-End 100G System

- Open Transceiver system
- Comprehensive multi-application support
- Advanced Ethernet and OTN Capabilities
- Dual Port Ethernet testing



## 400G

### 100G/200G/400G Ecosystem

- Open Transceiver System
- Comprehensive client side validation
- Multiple technology support:  
100G/200G/400G, FlexE, OTUCn, FlexC
- QSFP-DD, OSFP, CFP8 Interface
- SFP28/SFP56
- OSFP



## iDptics

### Optical Transceivers

- Now support 400G transceivers
- From simple validation to full characterization
- Quick PASS/FAIL verdicts
- High-speed optics including CFP, CFP2, CFP4, CFP8, QSFP-DD, OSFP, AOC, DAC, QSFP+ and QSFP28
- Low-speed optics including SFP, SFP+, SFP28, XFP





# Questions ? - Demo



Thank you

Smarter  
network  
in sight.™