

OTN Networks and related testing

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BDM
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Design

Deployment

Service Assurance

EXFO

EXPERTISE REACHING OUT

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Why OTN



1

OTN OH supports OAM&P capabilities similar to SONET/SDH for simplified network commissioning, provisioning and troubleshooting purposes through its supported alarms, errors and TTI trace messages

2

OTN payload is bit, timing and protocol transparent; meaning it can carry any client signal regardless of its line-rate (1.25G, 2.5G, 10G, 40G, 100G), clock (Synchronous, Asynchronous) and protocol (SONET/SDH, Ethernet, FC, etc.)

3

The FEC improves the BER when used for error correction; leading to a coding gain of 6.2 dB for systems with an operating BER of 10-15. This gain allows for running higher rates over existing facilities, longer span lengths, more DWDM channels and relaxed physical layer parameters

4

OTN is an integrated transport solution (versus point-to-point DWDM) specially when combined with ROADM capability for network scalability, Control Plane for traffic signaling and routing and ODU0/ODUFlex for traffic grooming and bandwidth management

5

OTN is the transport technology of choice for transporting next-generation 40GE and 100GE services

ROADM – WSS - Complex Network Elements

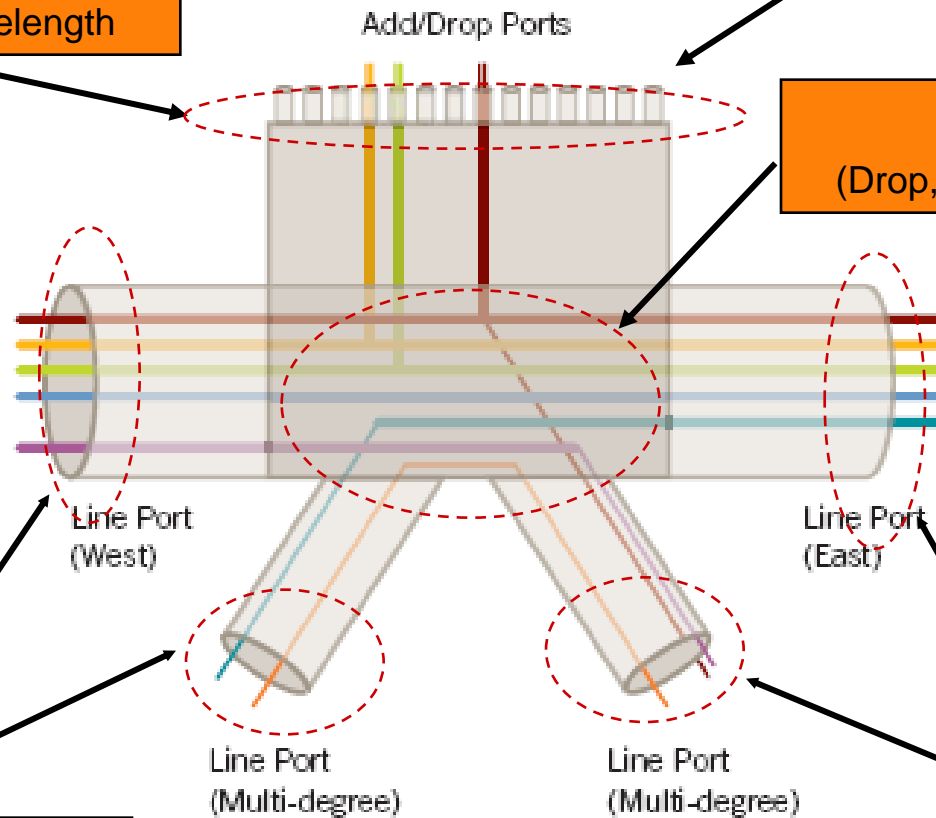
Acronyms:

- ROADM – Reconfigurable Optical Add /Drop Multiplexer
- WSS Wavelength selective Switch

Tunable Output wavelength

Service cards (Ethernet, 10GbE, OTN, FC)

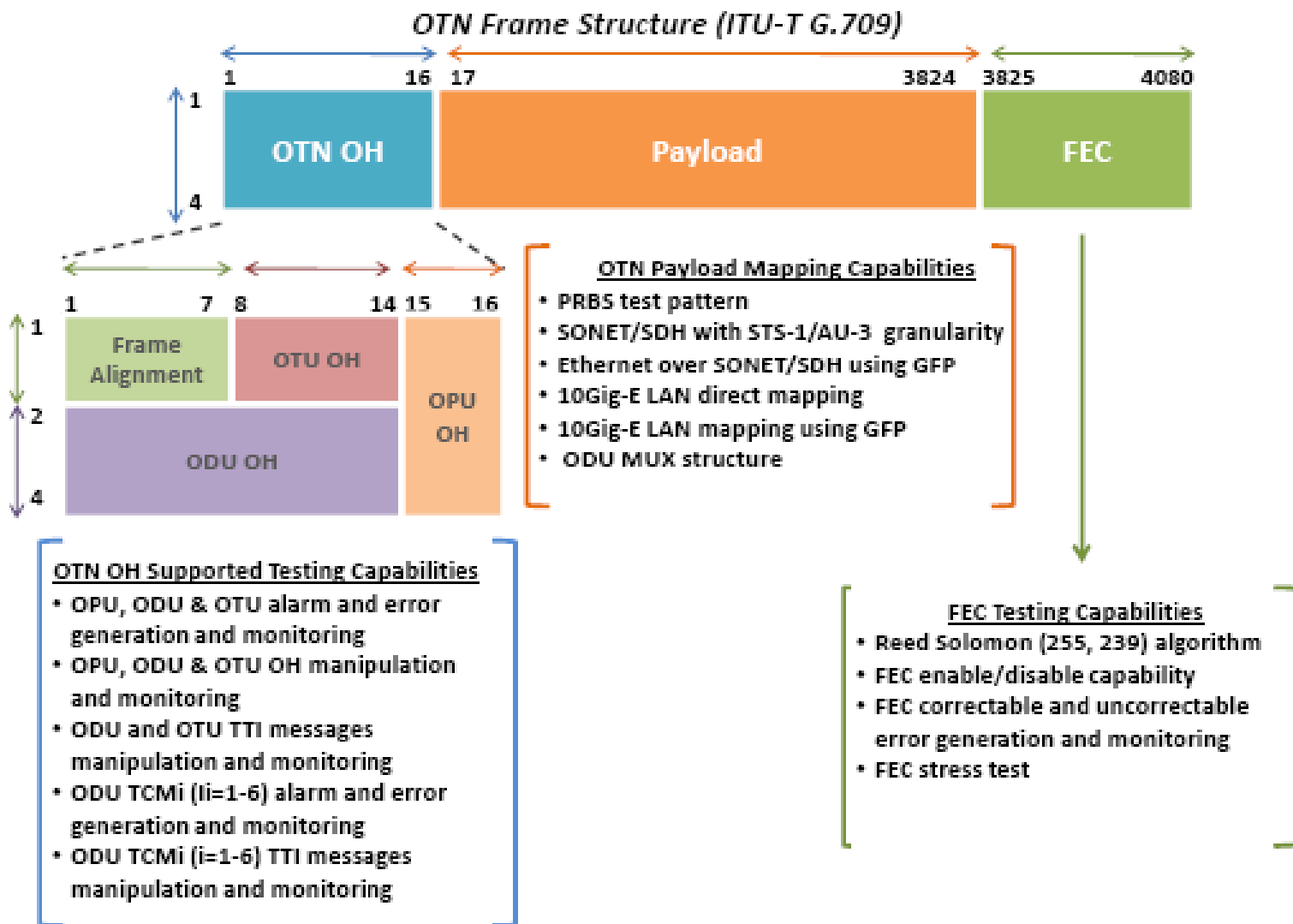
Optical Switch
(Drop, Insert, Pass-Through)



DWDM & Optical Line Amplifier

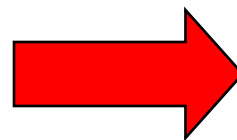
DWDM & Optical Line Amplifier

OTN Stack



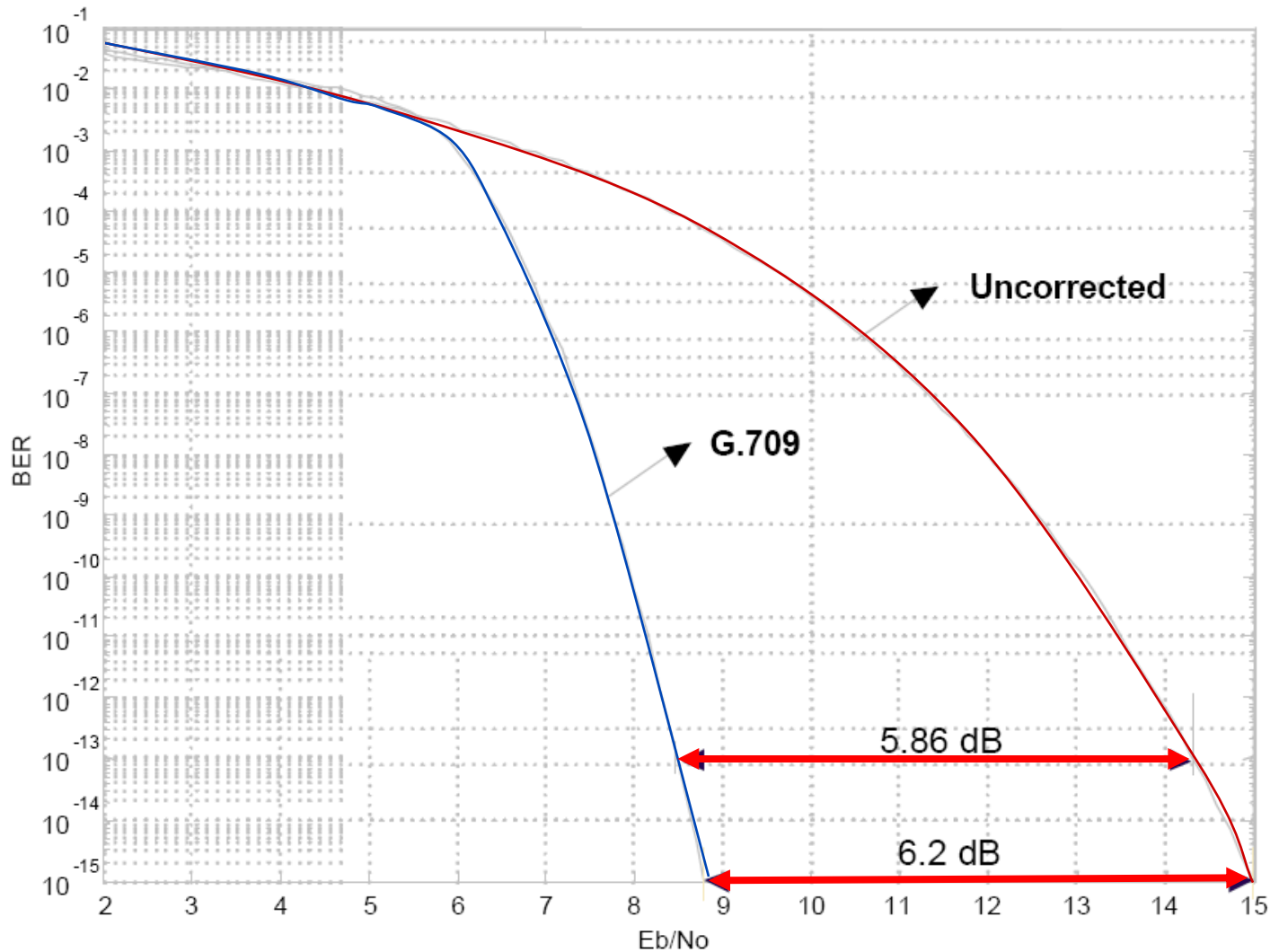
Basic Idea of Forward Error Correction – FEC

1	4	7	0	3	15
2	0	6	9	2	19
5	3	7	2	1	18
8	2	6	9	8	33
1	4	3	4	7	19
2	0	2	7	8	19
<hr/>					
19	13	31	31	29	



1	2	7	0	3	13
2	0	6	9	2	19
5	3	7	2	1	18
8	2	6	6	8	30
1	4	3	4	7	19
2	0	2	7	8	19
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19	11	31	28	29	

OTN: Forward Error Correction – FEC Reed-



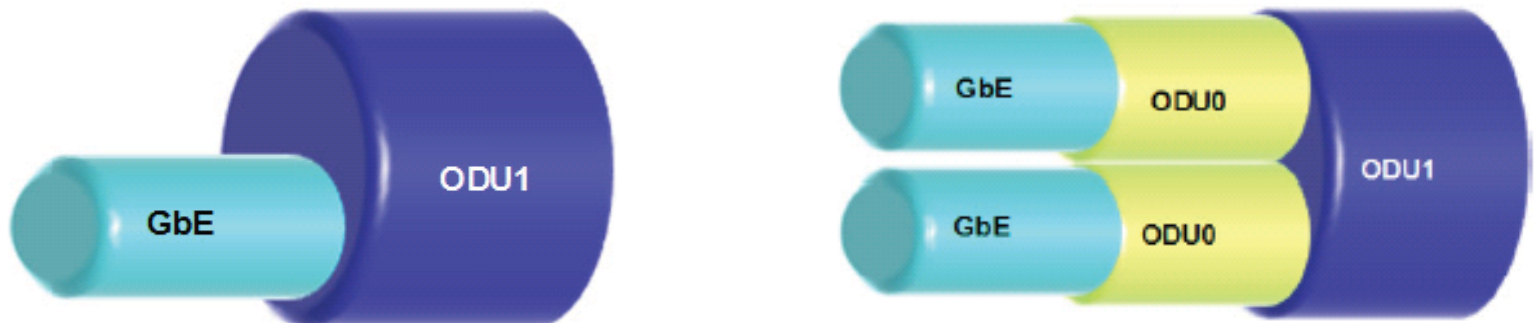
OTN Rates

OTN Interface	Line Rate	Corresponding service	Supported Product
ODU0	1.244 Gbps	Gig-E OC-3/STM-1	<i>Future Development</i>
OTU1	2.666 Gbps	OC-48/STM-16	FTB/IQS-8120/NG/NGE FTB/IQS-8130/NG/NGE
OTU2	10.709 Gbps	OC-192/STM-64 10Gig-E LAN (using GFP-F)	FTB/IQS-8130/NG/NGE
OTU1e	11.0491 Gbps (without stuffing bits)	10Gig-E LAN (direct mapping over OTN)	FTB/IQS-8130/NG/NGE
OTU2e	11.0957 Gbps (with stuffing bits)	10Gig-E LAN (direct mapping over OTN)	FTB/IQS-8130/NG/NGE
OTU1f	11.27 Gbps (without stuffing bits)	10G Fibre Channel	FTB/IQS-8130/NG/NGE (March/2010)
OTU2f	11.3 Gbps (with stuffing bits)	10G Fibre Channel	FTB/IQS-8130/NG/NGE (March/2010)
OTU3	43.018 Gbps	OC-768/STM-256 40GE	FTB/IQS-8140 (SONET/SDH) FTB/IQS-85100G (40GE)
OTU3e1	44.57 Gbps	4X ODU2e (uses 2.5G TS; total of 16)	<i>Future Development</i>
OTU3e2	44.58 Gbps	4 x ODU2e (uses 1.25G (ODU0) TS; total of 32)	<i>Future Development</i>
OTU4	111.81 Gbps	100GE	FTB/IQS-85100G

Functional Overview

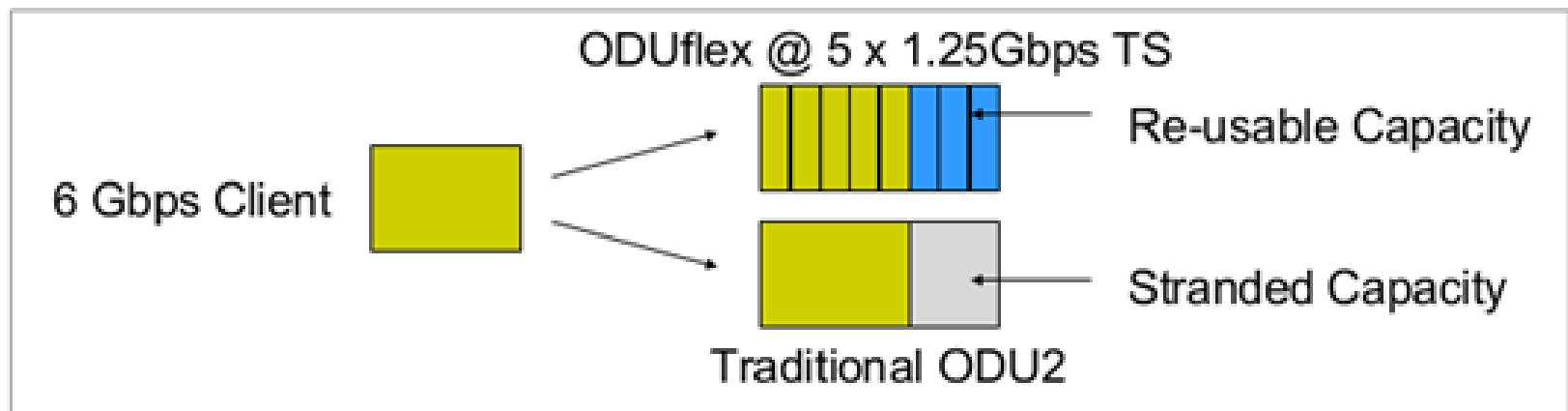
Client Signal mapping

- ODU0 is a new container size that has been introduced to accommodate efficient transport of Gigabit Ethernet (1.25 Gb/s). OTU1 was not efficient for 1GbE signal with a payload rate of 2.48832
- ODU0 is half the size of an ODU1 container i.e = 1.244 160 Gb/s
- Gigabit Ethernet does not directly fit in the ODU0 container, transcoding (provided by GFP-T) is needed to bring the Gigabit Ethernet rate inside OPU0 rate (8B/10B coding)
- ODU0 does not have a physical instance/interface (i.e. there is no OTU0), the signal needs to be multiplexed into a higher layer in order to be transported on the OTN network



ODU FLEX

- ODU FLEX is the new OTN
- Allows for flexible ODU rates for transparent transport of any client signal
- Adapted in 2 ways:
 - For Constant Bit Rate (CBR) client signals
 - Rate = $239/238 \times \text{CBR rate}$
 - For GFP-F mapped packet client signals
 - Rate = $N \times \sim 1.25 \text{Gbit/s (ODU0)}$ with $1 \leq N \leq 80$



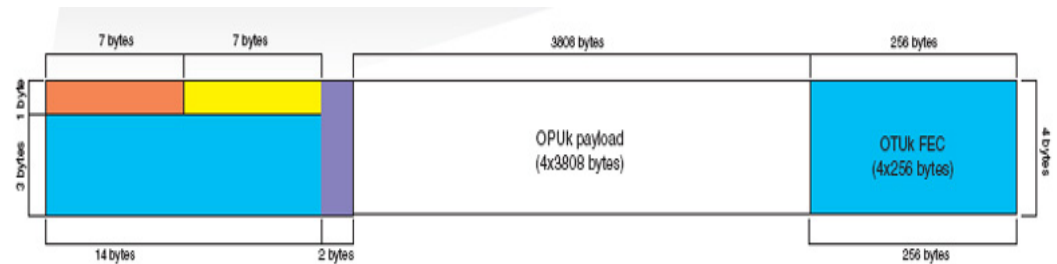
EXFO OTN Support

OTN Capabilities	8120	8120NG	8120NGE	8130	8130NG	8130NGE	8140
OPU, ODU (including TCM) OTU alarms, errors and TTIs generation and monitoring	√	√	√	√	√	√	√
OPU, ODU, OTU OH manipulation and monitoring	√	√	√	√	√	√	√
PRBS pattern in OTN payload	√	√	√	√	√	√	√
SONET/SDH mapping into OTN payload	√	√	√	√	√	√	√
Ethernet over SONET/SDH mapping into OTN payload		√	√		√	√	
10Gig-E LAN direct mapping into OTN payload					√	√	In ODU MUX
10Gig-E LAN mapping into OTN payload using GFP					√	√	In ODU MUX
ODU Mux structure mapping into OTN payload				√	√	√	√
FEC testing	√	√	√	√	√	√	√

OTN Testing



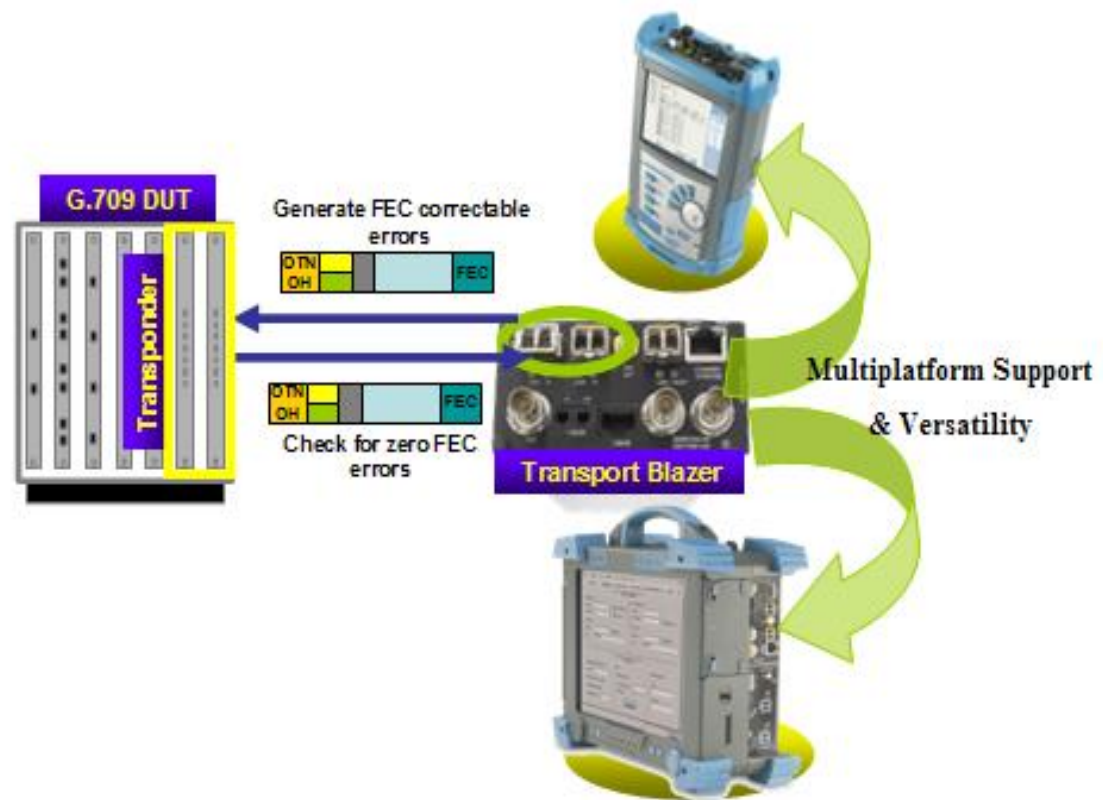
11.8 G!



- At Installation / Commissioning the following measurements are recommended:
 - Support of OTU1, OTU2, OTU1e, OTU2e, OTU1f, OTU2f Bitrates
 - Proper Mapping of SDH Signals (synch. and asynch.)
 - FEC Test (Insertion of correctable and uncorrectable Errors)
 - Error and Alarm Insertion, and Analysis in OTU, ODU (incl. ODU TCM)
 - Path Trace Identification in OTU, ODU
 - Test of Mux/Demux Functionality (ODU1/ODU2)
 - ODU Multiplex Test: Alarm Generation and Analysis
 - APS/SDT
 - RTD

Appropriate FEC Behavior Test

- Using the Transport Blazer generate FEC correctable errors distributed over the FEC portion of the OTN frame
- Verify the error correction capability of the G.709 NE using its FEC.



- Using FEC STRESS option, an advanced FEC test can be performed by distributing correctable errors randomly over the entire OTU frame.
- If the DUT is unable to correct errors, the payload will be affected.

EXFO's FTB-8130NGE

Power Blazer 10Gbps Multi-Service Test Module

Multi-rate SFP Test Port

- 155M, 622M, 2.5G SDH
- OTU1
- 100M/1000M Ethernet
- FC 1G/2G/4G

Ext Referenz-Output für 10G Lab Applications

Add/Drop Port optical

Ethernet optical 100/1000M

10/100/1000M

- Ethernet Add/Drop Port
- Ethernet electrical



10G XFP Test Port

- 10G SDH
- OTU2, OTU1e, OTU2e
- OTU1f, OTU2f
- 10G Ethernet LAN/WAN
- 10G FC

Clock in/out

E1 (Bantam and RJ48C)

E1, E2, E3, E4
STM-0e
STM-1e

Supports today:

- ODUMUX: ODU1 in ODU2
- OTN ThruMode
 - Non-Intrusive
 - Intrusive
- 10GigE LAN in ODU2 with GFP-F

Will support:

- ODU0
- ODUflex
- ODU0 direct in ODU2

Most compact Multi-Service solution in the Market!

High Speed OTN Testing Solutions

43G serial optics – OTU3

- OTN testing at OTU-3
- Including Forward Error Correction (FEC) as per ITU-T G.709
- OTN ThruMode at 43G
- Compatible with: NRZ, Duo-Binary, DPSK, and DQPSK

Will support

- Multi-Stage OTN mapping
 - ODU0-ODU1-ODU2-ODU3
- Direct 32xODU0 in ODU3



112G parallel optics – OTU4

- OTN testing at OTU4
- Including Forward Error Correction (FEC) as per ITU-T G.709
- Based on CFPs (MSA)

Will support

- Multi-Stage OTN mapping
 - ODU0-ODU1-ODU2-ODU3-ODU4
- Direct 80xODU0 in ODU4



Questions?

