



SEEFIRE
Optical technologies:
XENPAK, XFP and DWDM

www.seefire.org

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SEEFIRE

South-East Europe Fibre Infrastructure
for Research and Education

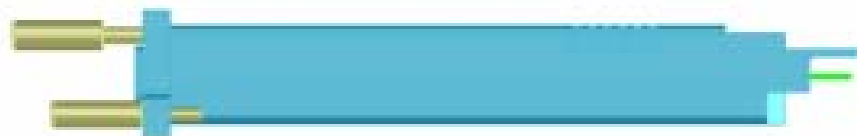
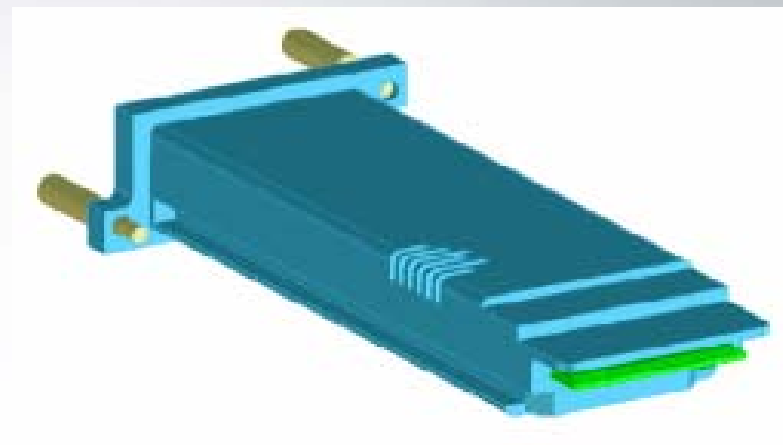
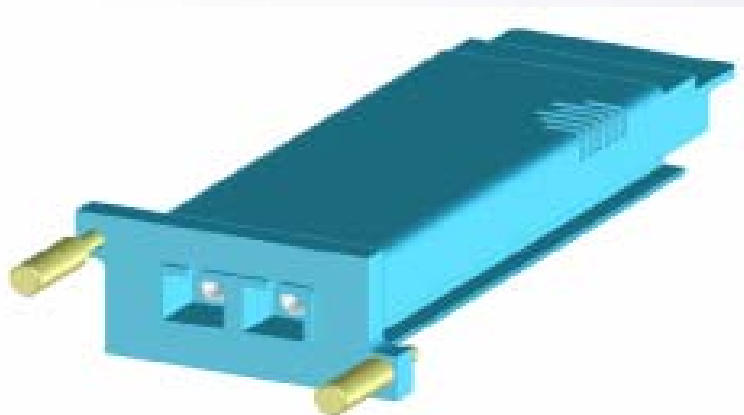
- **MultiSource Agreement (MSA) Group:**
 - March, 2001 – open to any organization
 - Initiators: **Agilent Technologies + Agere Systems**
 - Members > 20
 - IEEE 802.3ae conform 10GE module definition
 - Result: “standard”, interchangeable 10GE interface
- **MSA covers:**
 - XENPAK spec. for all PHY media defined by IEEE 802.3ae
 - Physical dimensions
 - Electrical interface (70-pin) and signal spec.
 - Optical connector specification (SC)

<http://www.xenpak.org>



- **Available XENPAK types:**
 - 10GBase-CX4: copper → 15-20m
 - 4x Infiniband connector (no RJ-45)
 - 10GBase-LX4: MMF/SMF @ 1310nm → 300m/10km
 - WWDMM (Wide-Wave Division Multiplexing)
 - 1x10G multiplexed into 4 wavelengths (4x laser)
 - 10GBase-SR: MMF @ 850nm → 26-300m
 - 10GBase-LR: G.652 SMF @ 1310nm → 10km
 - 10GBase-ER: G.652 SMF @ 1550nm → 40km
- **WAN interfaces: SW, LW, EW**
 - For OC-192/STM-64 compatibility

- **Physical layout:** *source – MSA agreement*



- **MultiSource Agreement (MSA) Group:**

- XFP = 10G Small Form Factor Pluggable Module
- March, 2002 – <http://www.xfpmsa.org>
- Low cost solution
- Protocol unaware 10G module definition:
 - 10GE
 - 10G Fiber Channel
 - OC-192/STM-64 + ITU G.709 OTN
- Small (min. 16x on a 19" router card)
 - Market driver: high port density
- Lower power cons. and heat emission
- Multi rate: 9.95 Gbps - 11.09 Gbps



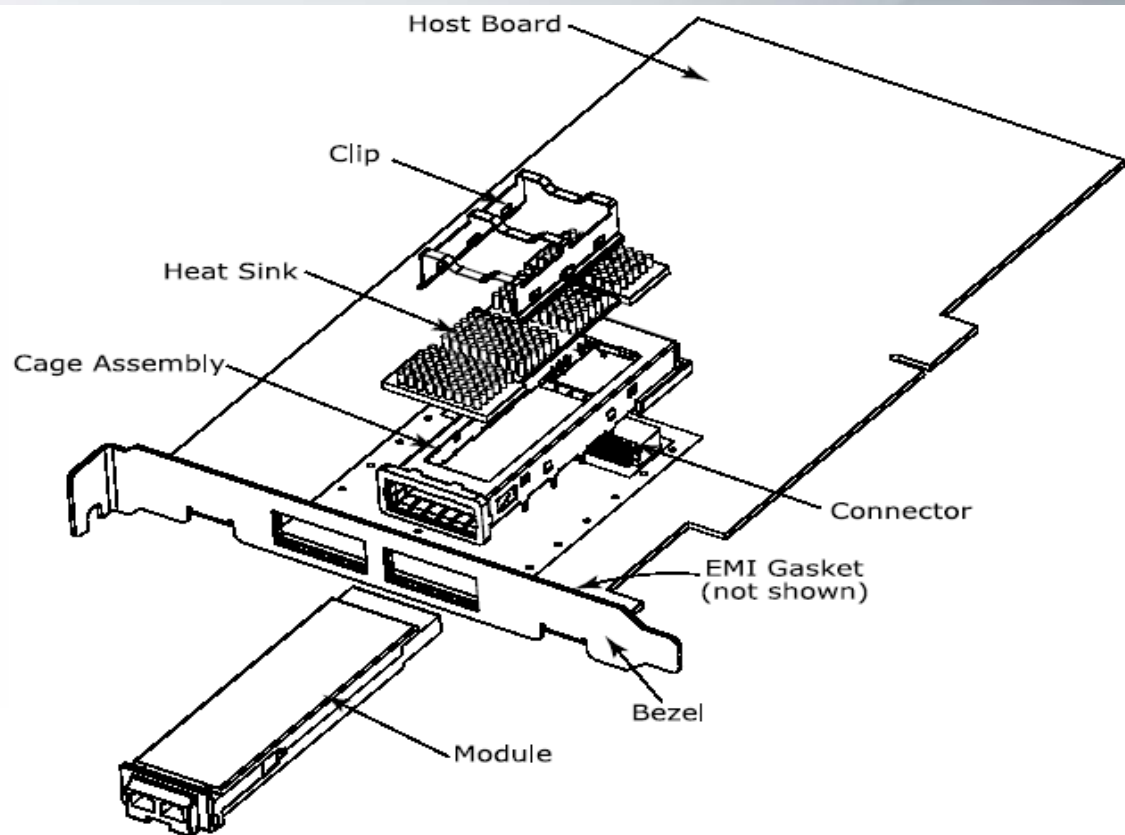
- **Available XFP types:**

- 10GBase-SR, LR, ER @ 10.31Gbps
- 10GBase-SW, LW, EW
- 10G FC @ 10.52Gbps
- OC-192/STM-64 @ 9.95Gbps
- Lower datarates:
 - 1000Base-SX, LX
 - 1G FC: MMF/SMF (1-2x)
 - OC-48

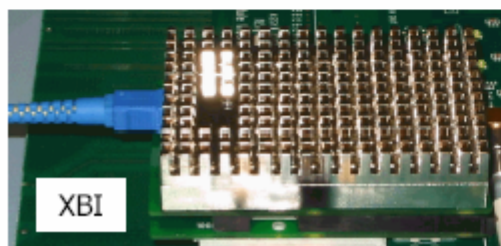
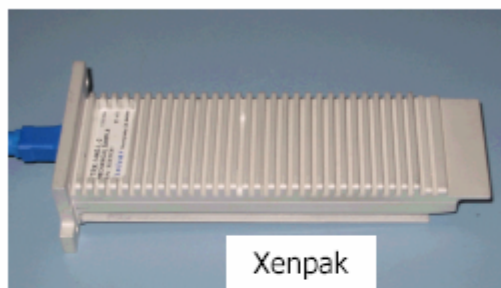
- **Applications:**

- Server network interface cards
- Storage interface, storage arrays, LAN/SAN switch iface

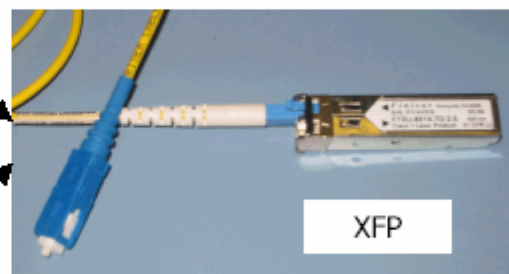
- Physical layout:



Transponder Generation



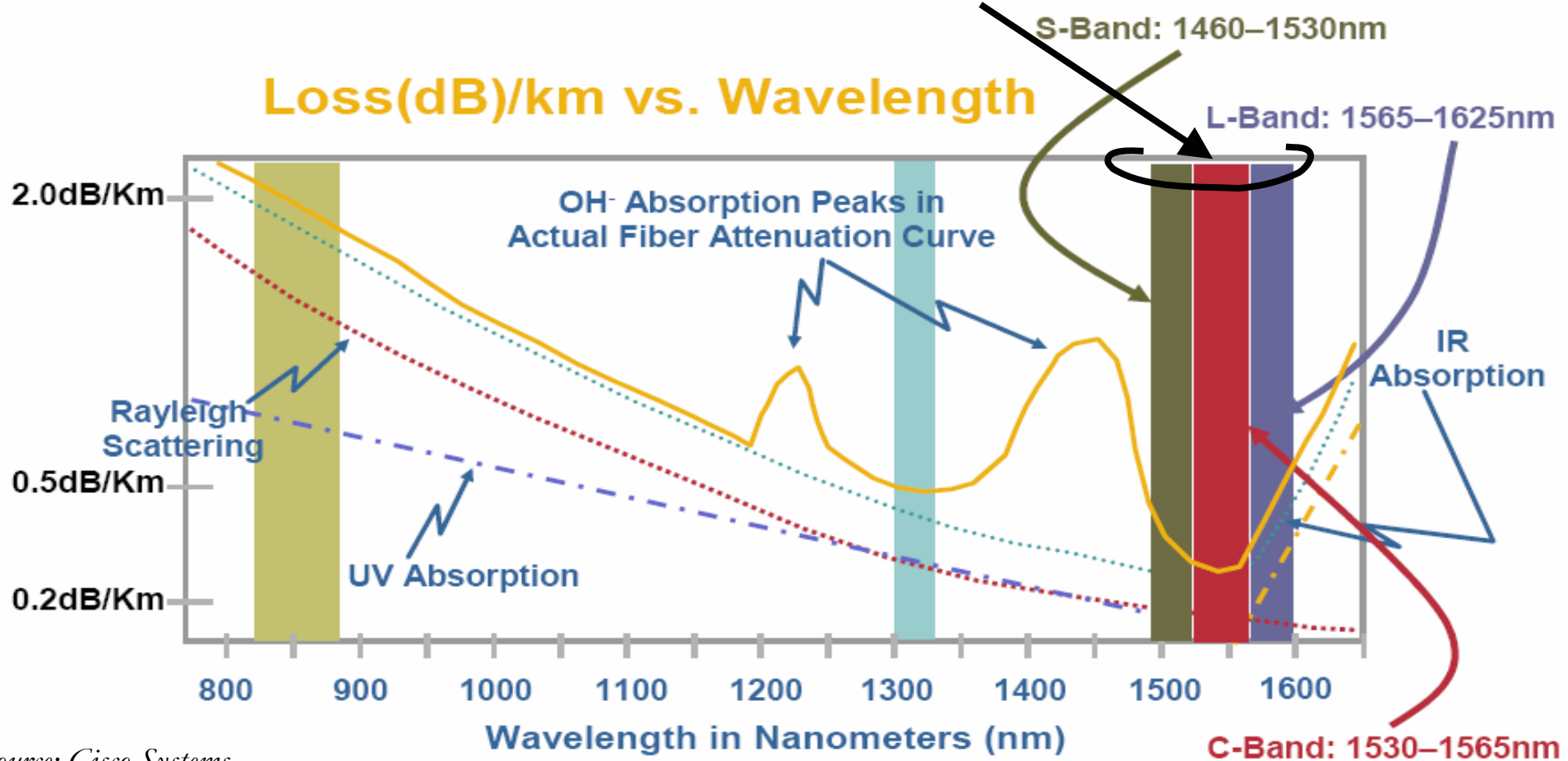
Transceiver Generation



Note that there are SC connectors in each picture to set the relative sizes of these modules!

- **Dense Wavelength Division Multiplexing:**
 - Multiplexing more optical signals into 1 fiber
 - Using different wavelengths (ref. as “lambda”)
 - First deployments: 1998-1999
- **Drivers:**
 - Economic use of fiber
 - Huge aggregated capacity
 - 100G or beyond using one signal not possible today

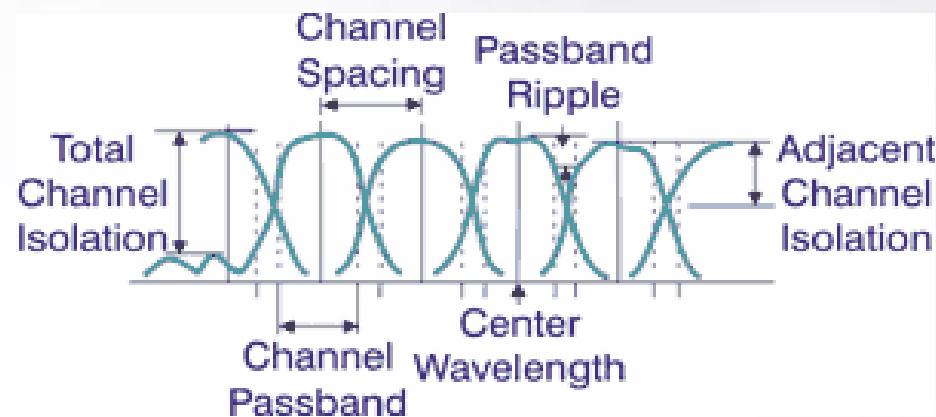
- Fiber transmission bands: DWDM systems
S, L, C bands



Source: Cisco Systems

- **Channel specification:**

- ITU-T G.692/G.694-1 frequency grid
- S, C and L band covered
- 200GHz, **100GHz** and 50GHz are specified by ITU-T
- 100GHz spacing example:
 - 0.8nm/channel
 - 45 channels
 - Approx. 35nm
 - Stable equipment available
 - Can be amplified with a single amp.
- Commonly used: 100GHz spacing + 4, 8 or 16 channels



- **Amplifiers:**

- Signal distortion:

attenuation/modal dispersion/chromatic dispersion



- 3R: Reamplification/Reshaping/Retiming

- Only with OEO today

- **Transponder:**

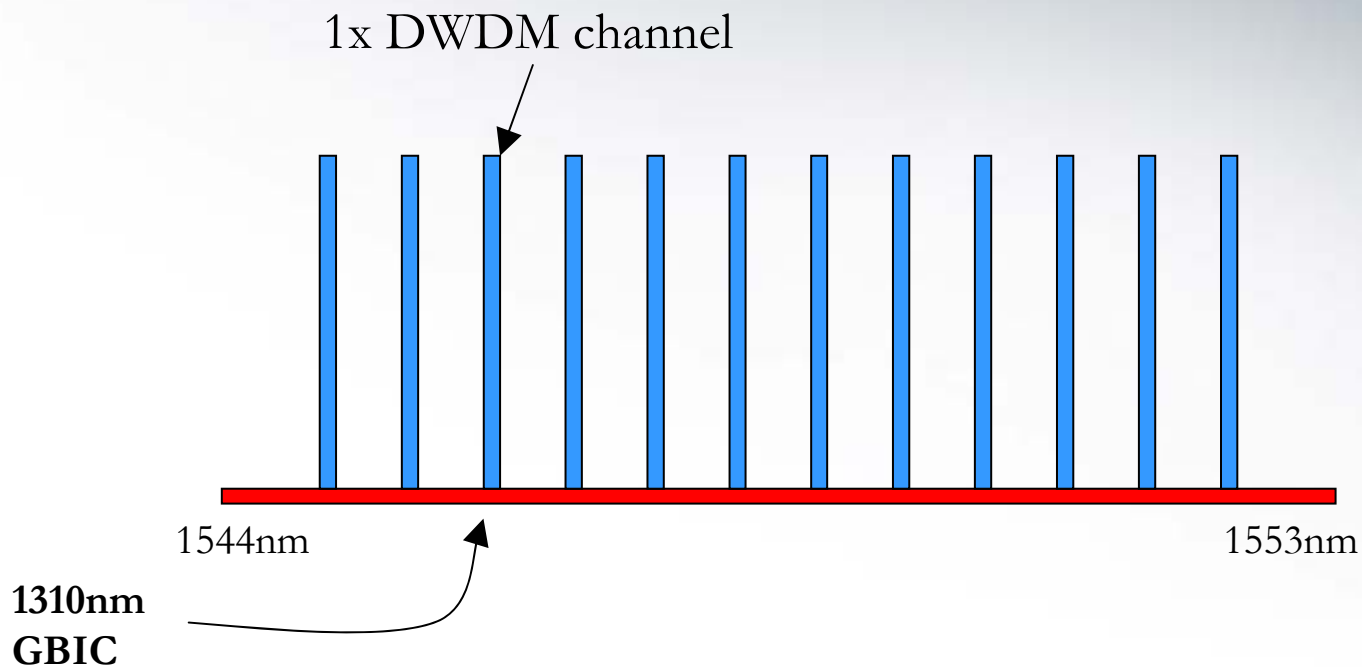
- Wavelength conversion before/after multiplexing/demux.

- Switch/router interfaces use baseband transmission

850nm, 1310nm or 1550nm → conversion needed

- After conversion: signal fits into the ITU channel grid

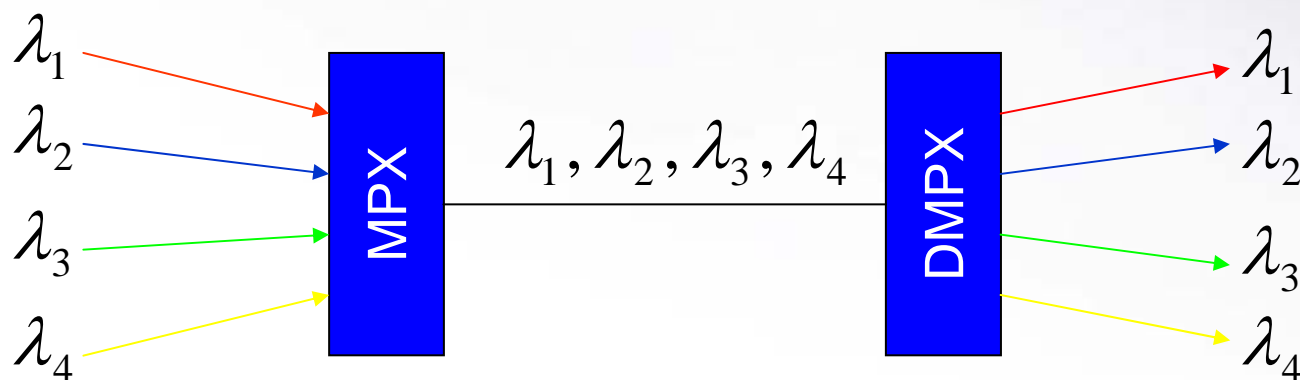
- Transponders contd.:



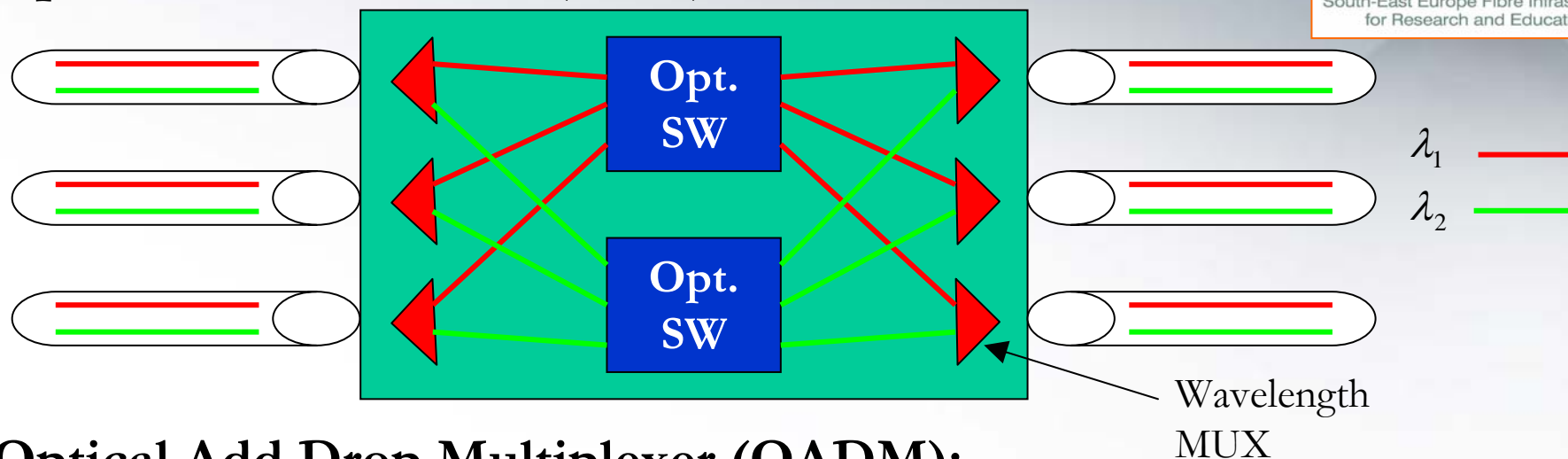
- DWDM “colored” GBICs exist (no transp. needed)

- **Multiplexer/demultiplexer:**

- Multiplex several wavelengths
- Demultiplex several wavelengths

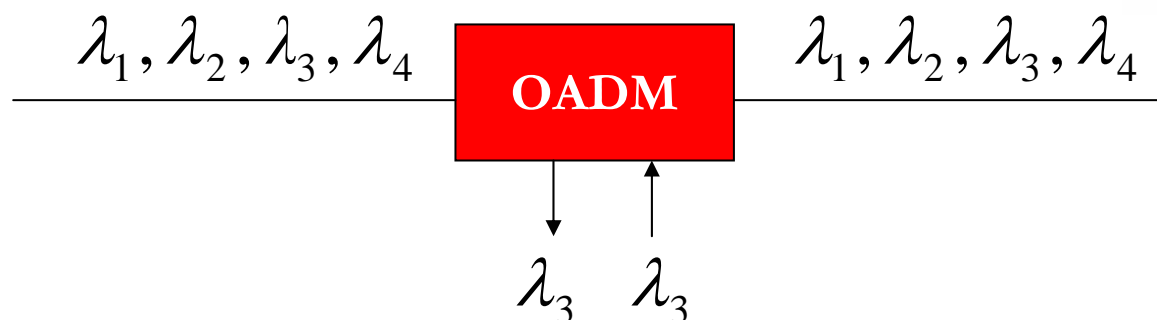


- **Optical Cross Connect (OXC):**



- **Optical Add Drop Multiplexer (OADM):**

- Detach and add a wavelength





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