# ITU-T Kaleidoscope 2009
# Innovations for Digital Inclusion

# OPTICAL TRANSPORT NETWORKS: FROM ALL-OPTICAL TO DIGITAL

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# Outlines

- Traditional DWDM based on OTN (Optical Transport Network) ITU-T G.872;
- IPoDWDM;
- ODN (Optical Digital Network);

# Introduction

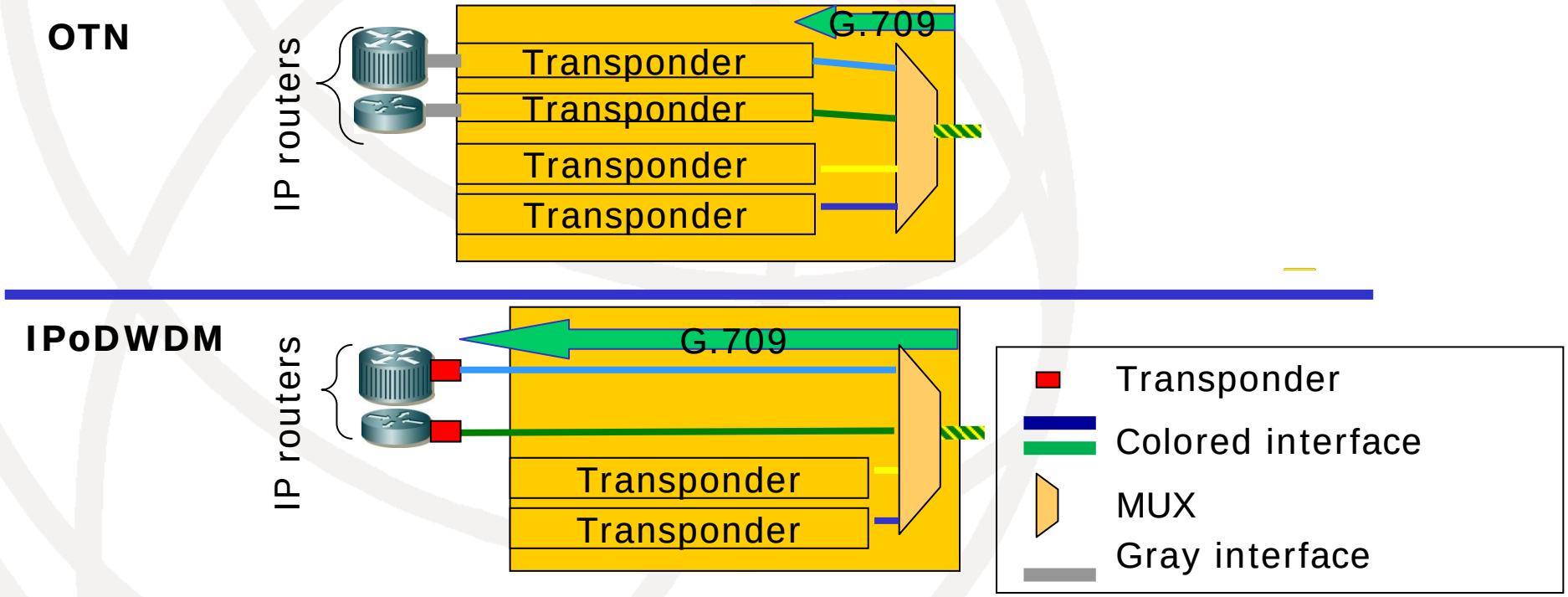
- IP traffic today becomes dominant:
  - New application based on IP (video communication, P2P, etc.);
  - Old application migrate to IP (ex. SS7);
  - IP traffic has overcome capacity of currently used wavelength 10Gb/s;
- Today trend/evolution is:
  - Eliminate SDH/SONET layer;
  - Move Transport from Optical to Digital;

# Traditional DWDM as an OTN

- DWDM is a fully optical network which provides transparency:
  - only 1R regeneration (optical amplification-equalization and CD compensation);
  - theoretically the signal can be delivered from every ONE to any other.
- Traditional (OTN) approach becomes hardly realizable for big network;

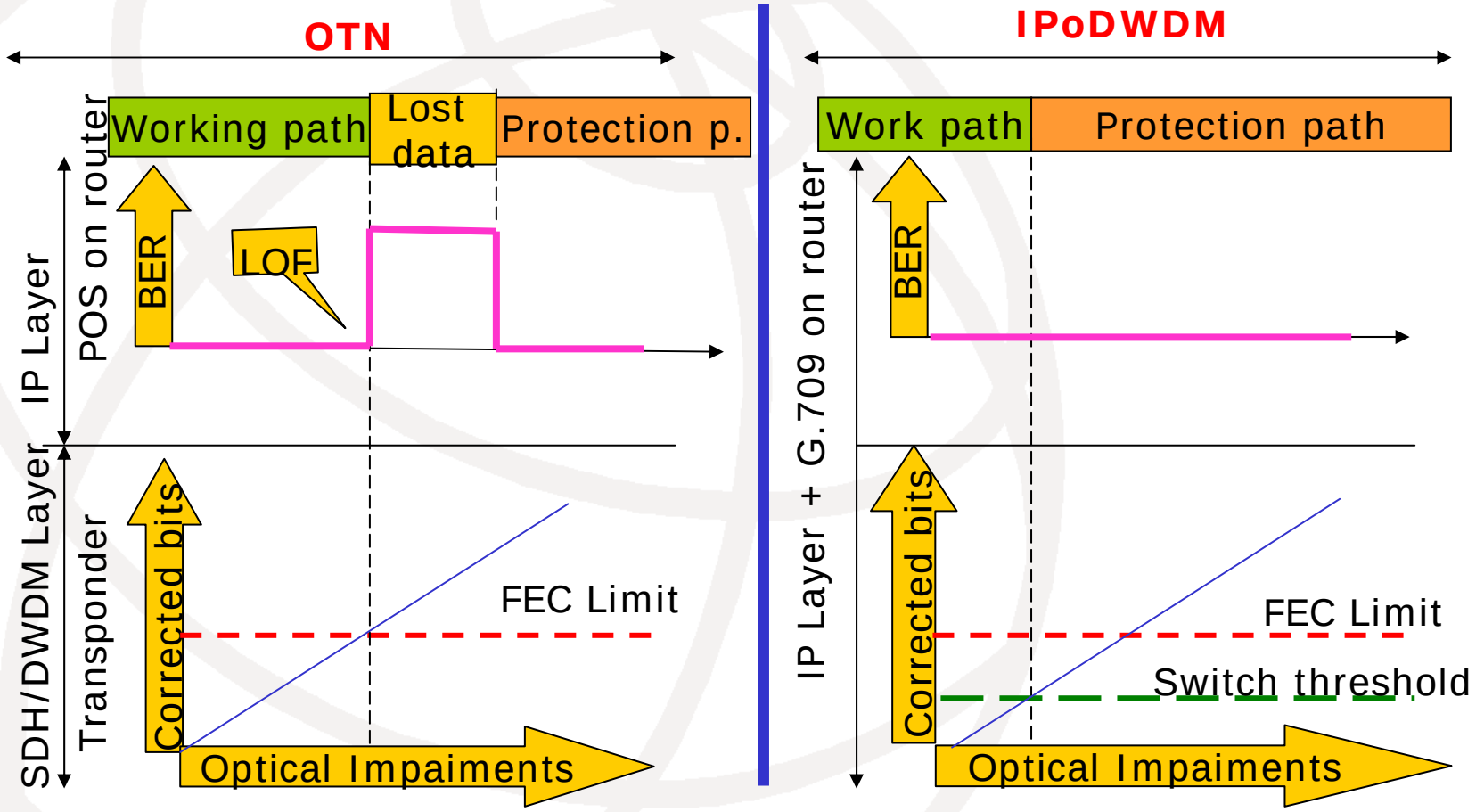
# IPoDWDM Approach

- Insert IP traffic into DWDM without mapping into SDH frame;
- Integration of DWDM transponders directly into IP switch/router.



# IPoDWDM intelligence

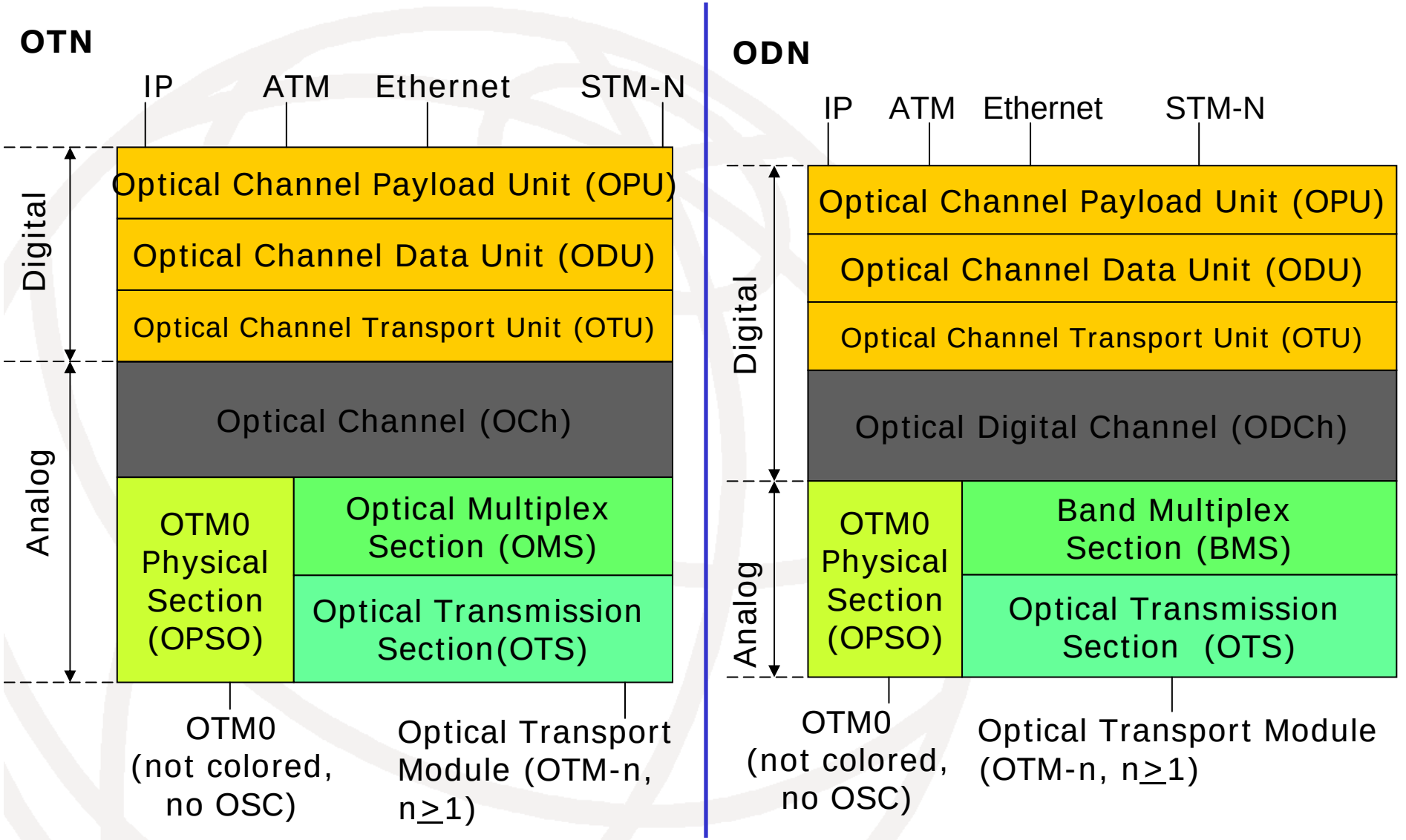
## Preemptive traffic protection becomes possible



# Optical Digital Network Approach

- The philosophy of ODN is based on O-E-O conversion whenever it is possible.
  - OTN manipulate analogical wavelengths;
  - ODN manipulate digital “bits”.

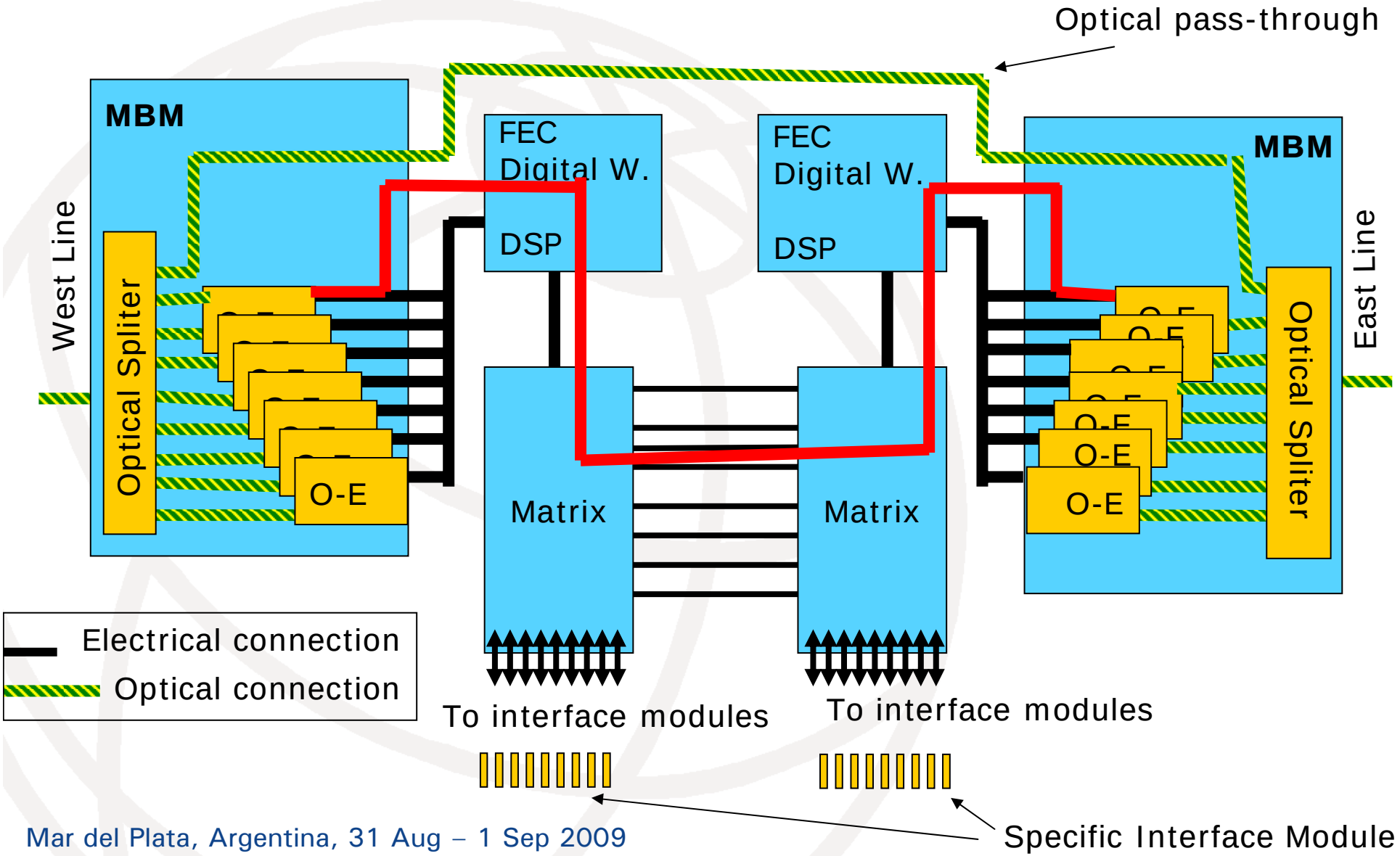
# Network Layers: OTN vs ODN



# ODN advantages

- Each OADM site implements 3R regeneration:
  - the signal is cleaned up from noise and others distortion;
  - It becomes possible to implement higher number of Channels -160 (C band, spacing 25 GHz);
- The network lose transparency.

# ODADM Description

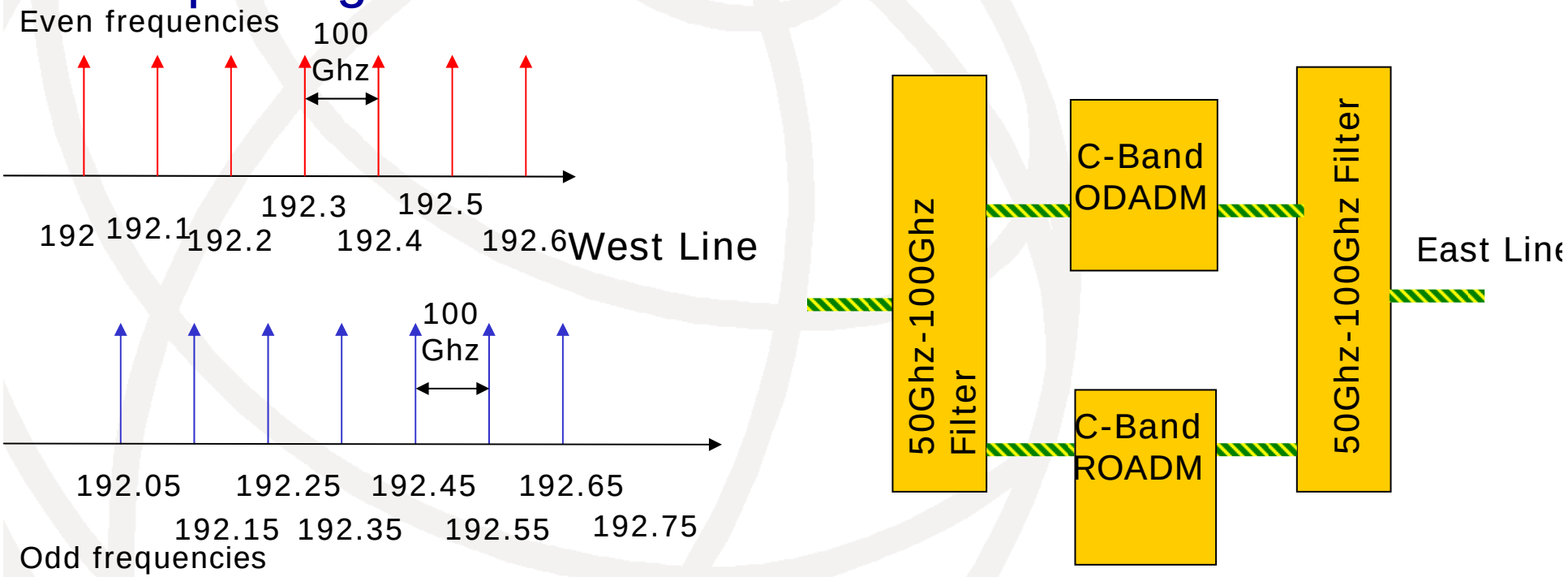


# RECONCILATION BETWEEN THE APPROACHES

- To integrate different approach the existing OTN network must support Alien Wavelets (ITU-T G.698.2)
  - IPoDWDM is easy to integrate into OTN;
  - IPoDWDM is easy to integrate into ODN but not efficiently;
  - ODN can be integrate into OTN using an optical band split filter.

# Example of ODN-OTN integration

- The majority of deployed DWDM networks are equipped with 100GHz lambda spacing while transponders have stability for 50GHz spacing.



# Capacity Evolution

- 10 Gb/s -> 40 Gb/s -> 100 Gb/s
  - CD increases and PMD appears;
- **OTN** and **IPoDWDM**:
  - the limit of 160 channels (L+C band)
- **ODN**:
  - due to E-O-E no dispersion problems.
  - granularity of PIC is inflexible parameter (today either 10 or 40 Gb/s based)

New capacities are being studied by IEEE 802.3ba

**G.698.2** should **standardize** new interfaces

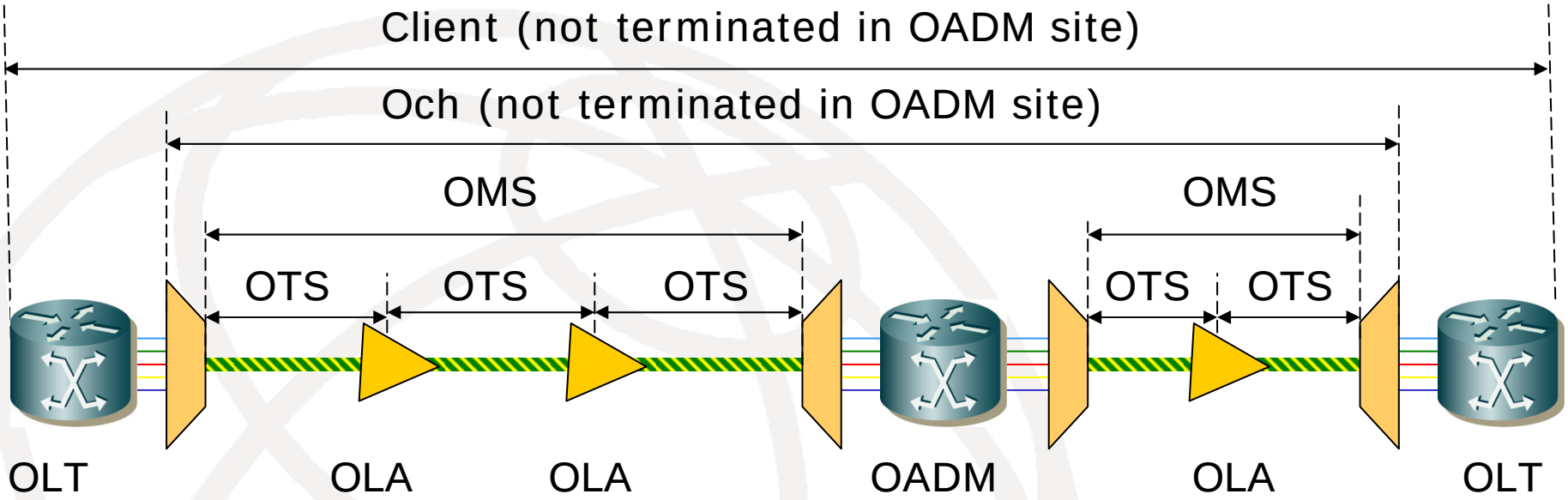
# Conclusions

- OTN, IPoDWDM, ODN approaches analyzed;
- IPoDWDM and ODN are seen as very promissing;
- Examples on integration of both technologies;
- Stimulus for further research and standardization activities;

# Back up

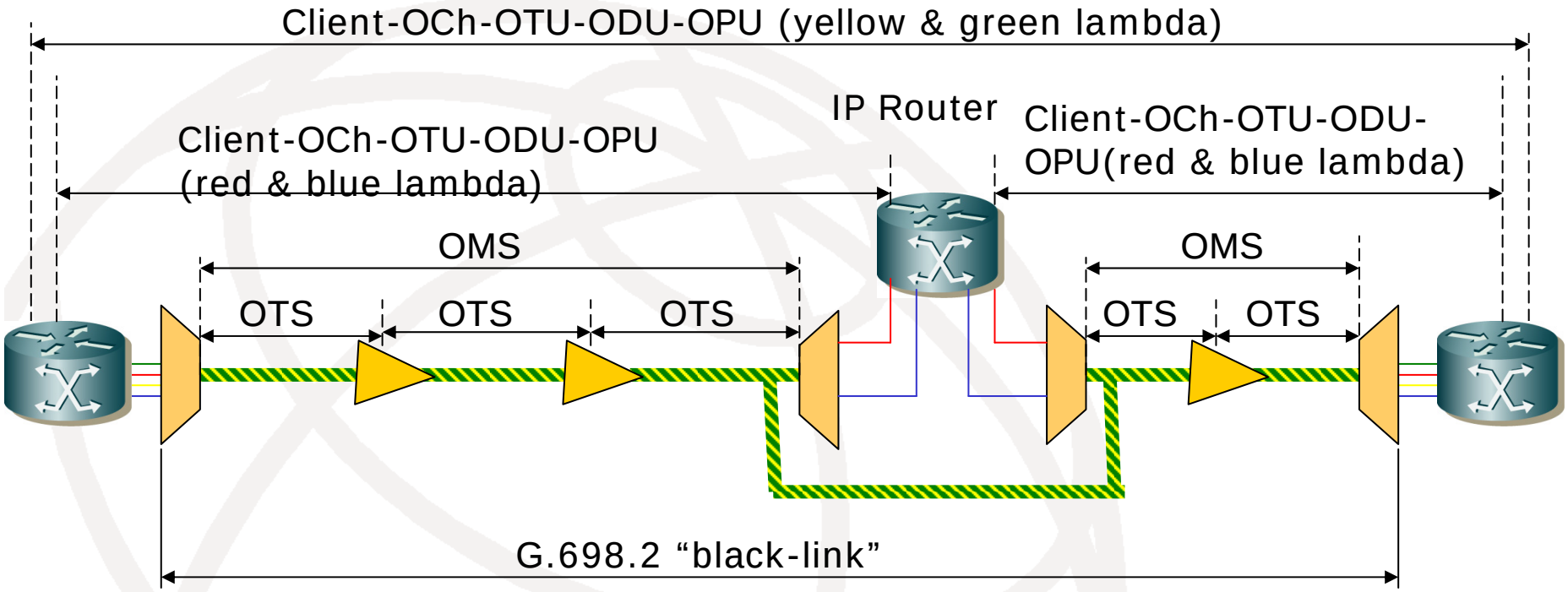
- The following slide are for back up

# OTN Network Elements




- OLT (Optical Line Terminal)
- OADM/ROADM (Optical Add Drop Multiplexer) also Reconfigurable
- OLA (Optical Line Amplifier)
- OXC (Optical Cross-Connect)

# IPoDWDM Network Elements




Optical colored interface

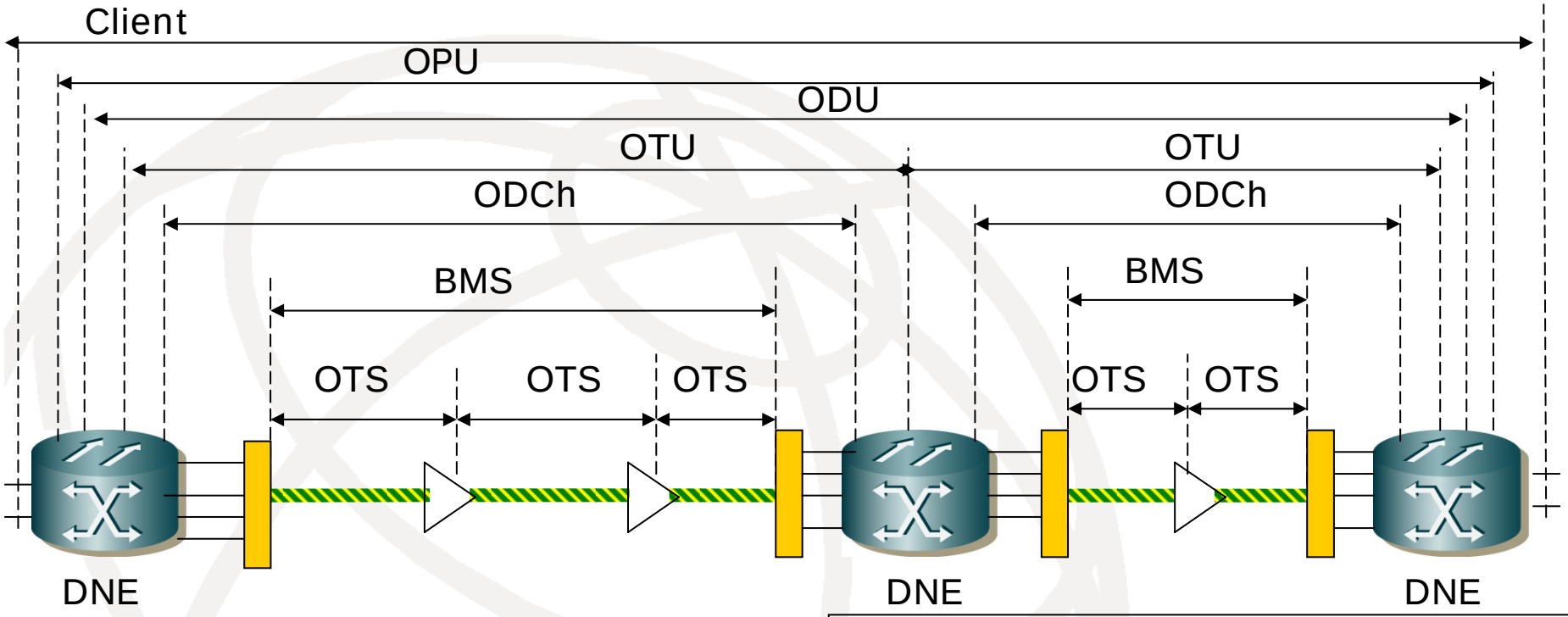
DWDM MUX/DMUX

Optical fibre

Optical Line Amplifier

OPU - Optical Channel Payload Unit
ODU - Optical Channel Data Unit
OTU - Optical Channel Transport Unit
OCh - Optical Channel
OMS - Optical Multiplex Section
ONE - Optical Network Element
OTS - Optical Transmission Section

# ODN Network Elements




Electrical connection

Optical connection

OLA (Optical Line Amplifier)

MBM (Multiplexing Band Module)

OPU - Optical Channel Payload Unit
ODU - Optical Channel Data Unit
OTU - Optical Channel Transport Unit
DNE - Digital Network Element
ODCh - Optical Channel
BMS - Band Multiplex Section
OTS - Optical Transmission Section