



Information Society  
Technologies



## **Results from the FP5-IST optical networking projects**

*presented at "TERENA Networking Conference 2003  
and CARNet Users' Conference 2003"  
19 - 22 May 2003, Zagreb, Croatia*

*by Didier Colle*

Email: [optimist@intec.rug.ac.be](mailto:optimist@intec.rug.ac.be)  
<http://www.ist-optimist.org>



OPTIMIST

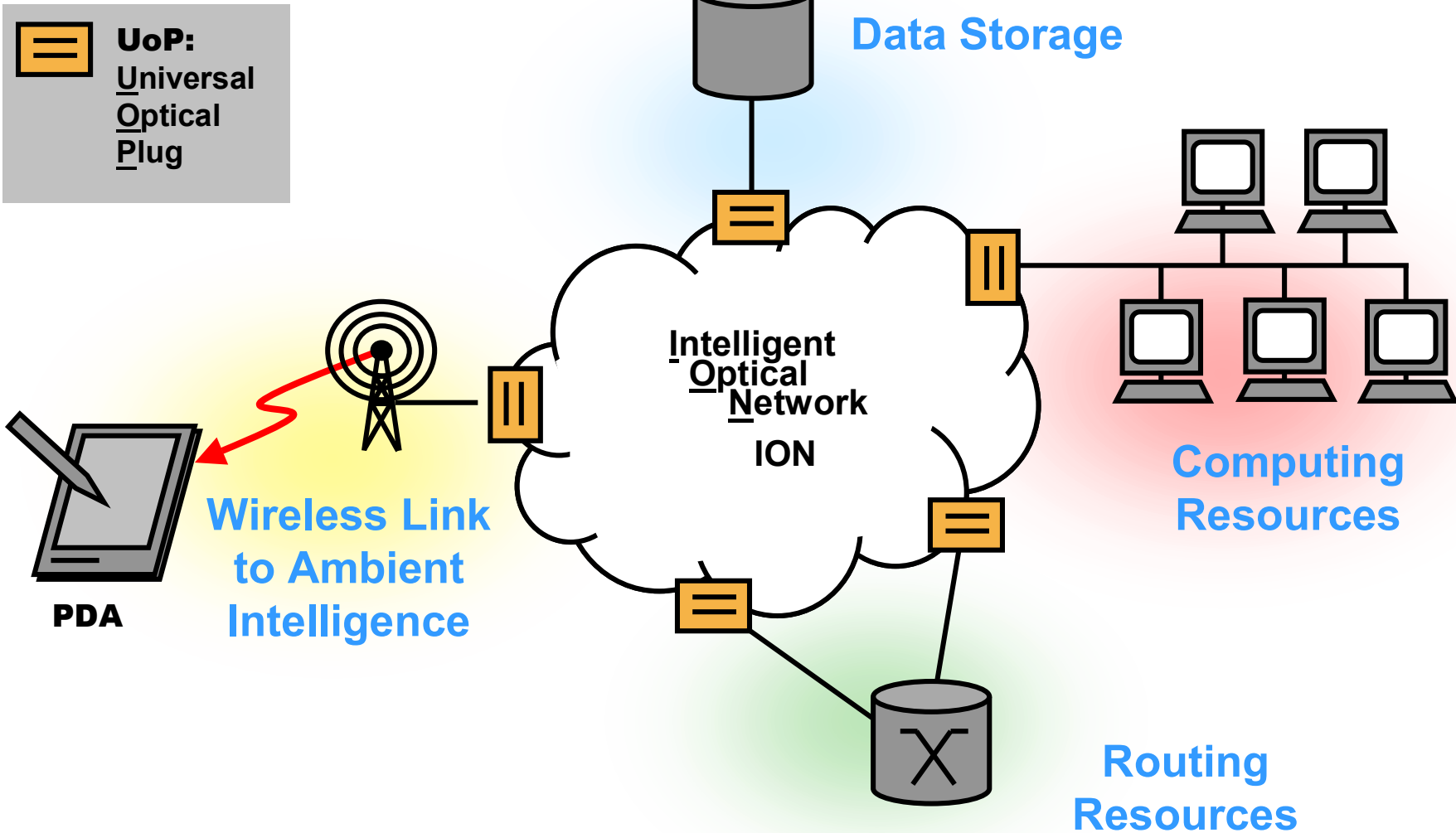
# IST-FP5 OPTIMIST Thematic Network

- **IST OPTIMIST: Optical Technologies in Motion for the IST Programme**
- **Thematic network project funded under the FP5 Programme**
- **Clustering optical projects working on:**
  - ⇒ advanced photonic networking technologies
  - ⇒ advanced photonic (sub)systems
  - ⇒ advanced photonic components and materials
- **Information exchange / dissemination of results / workshops / roadmap activity / website**



OPTIMIST

# Intelligent Optical Network





OPTIMIST

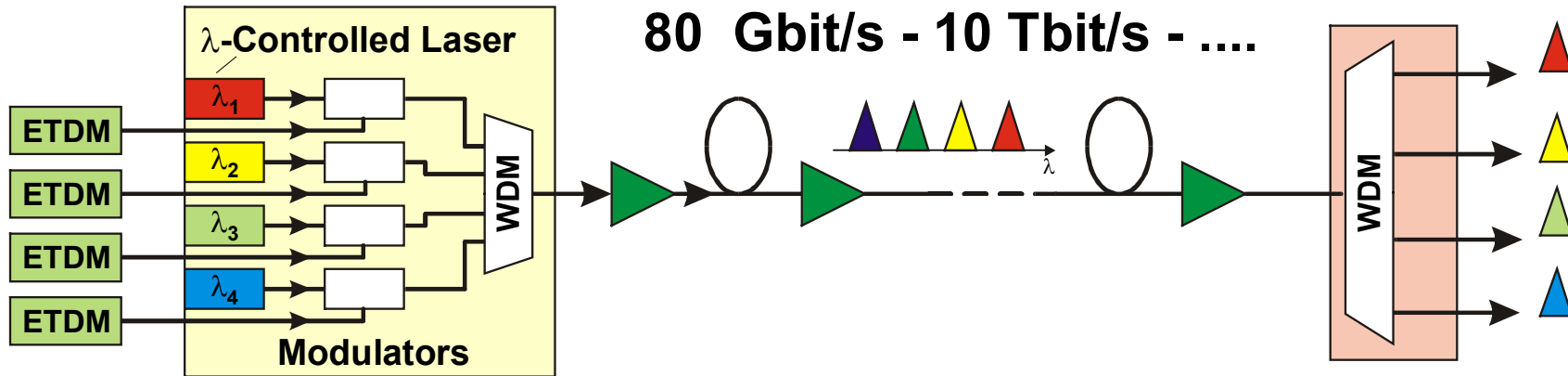
# IST -FP5 High Bitrate Projects



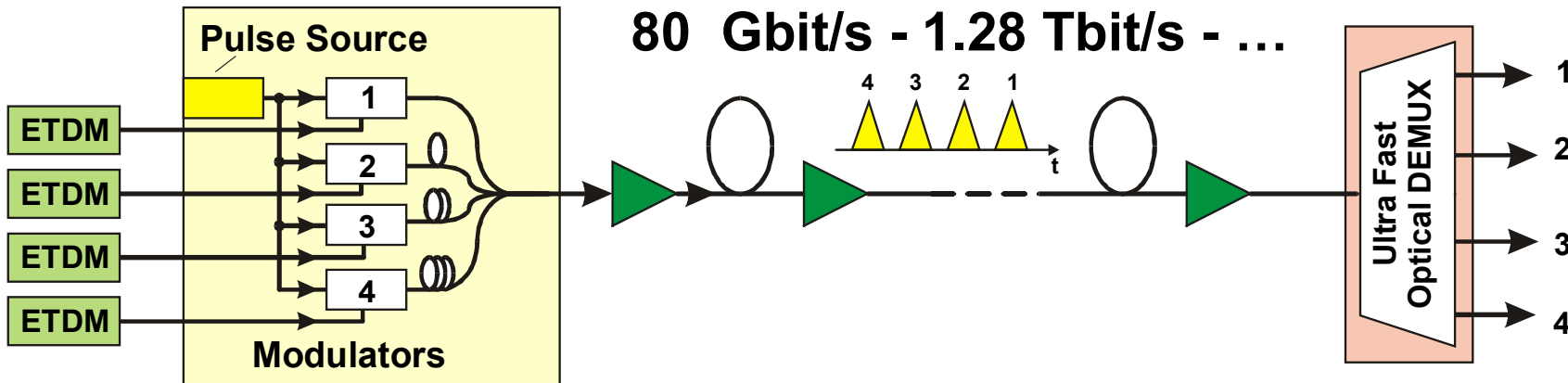
OPTIMIST

# OTDM and WDM Transmission

## Scheme of a WDM Transmission System



## Scheme of an OTDM Transmission System

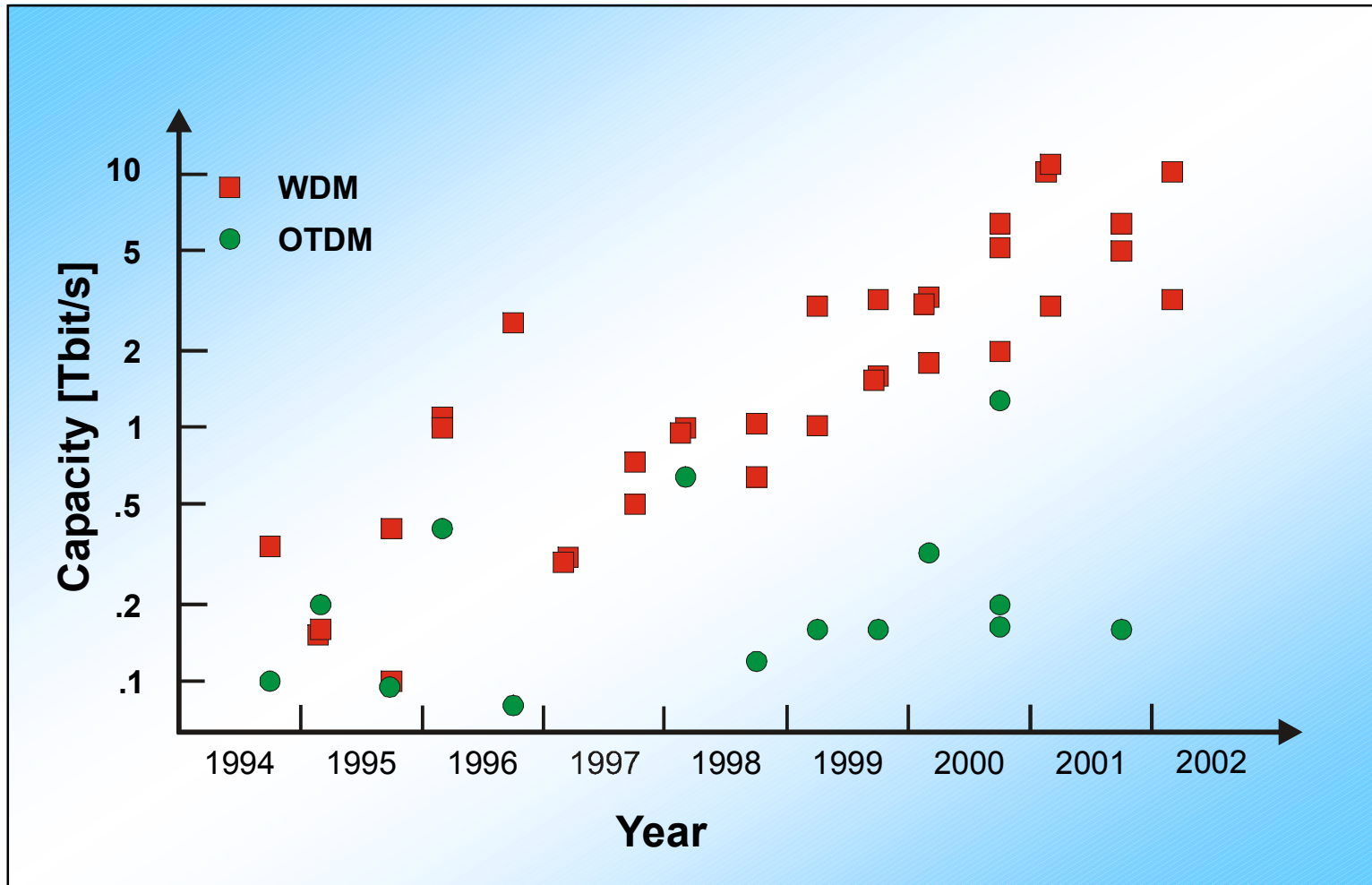


Partly adopted from: Kawanishi, IECE Trans. Comm., Vol.E84-B, (2001), pp. 1135-1141



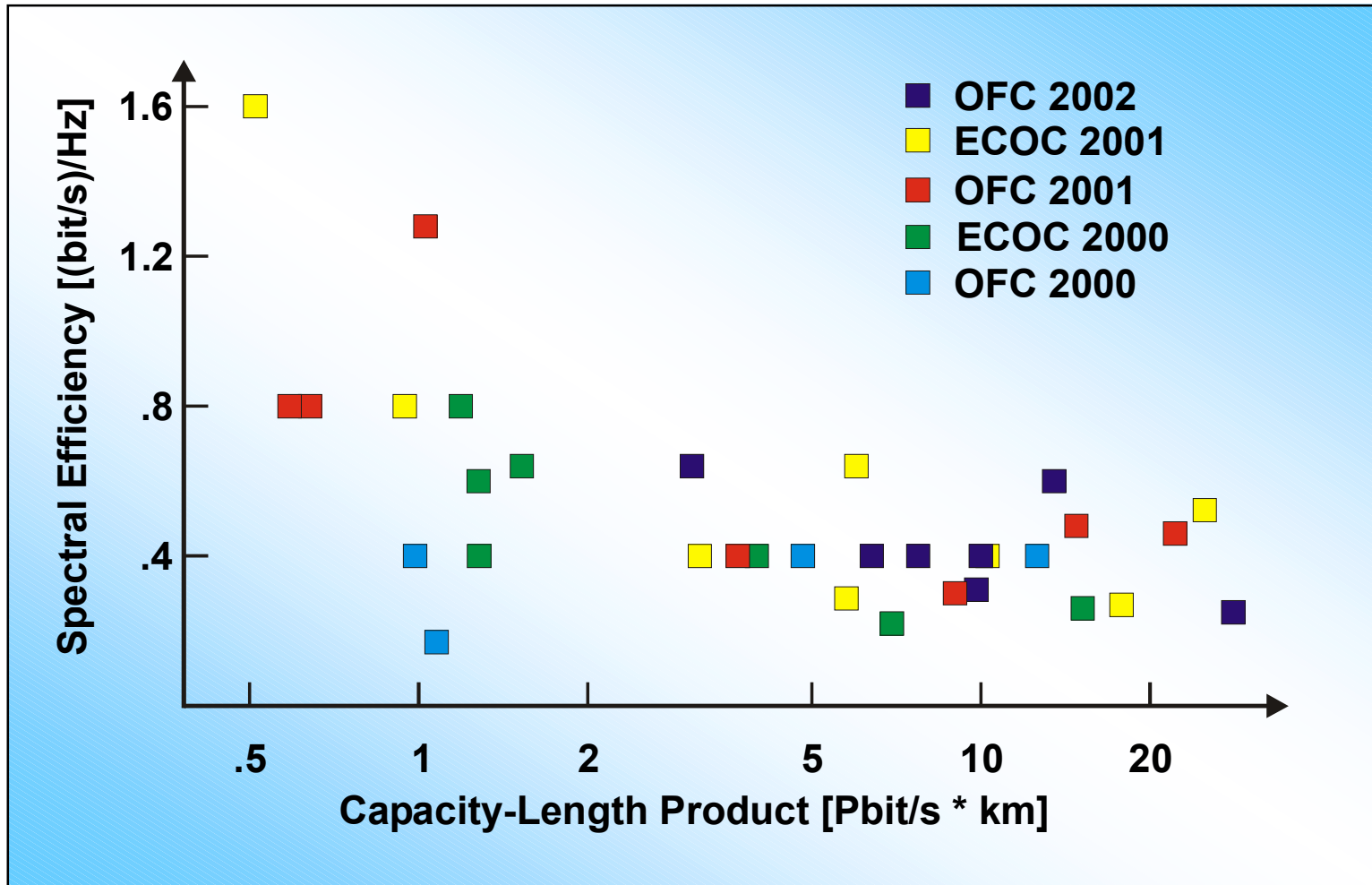
OPTIMIST

# Fibre capacity achievements





# Spectral efficiency achievements





OPTIMIST

# Impairments in ULH networks

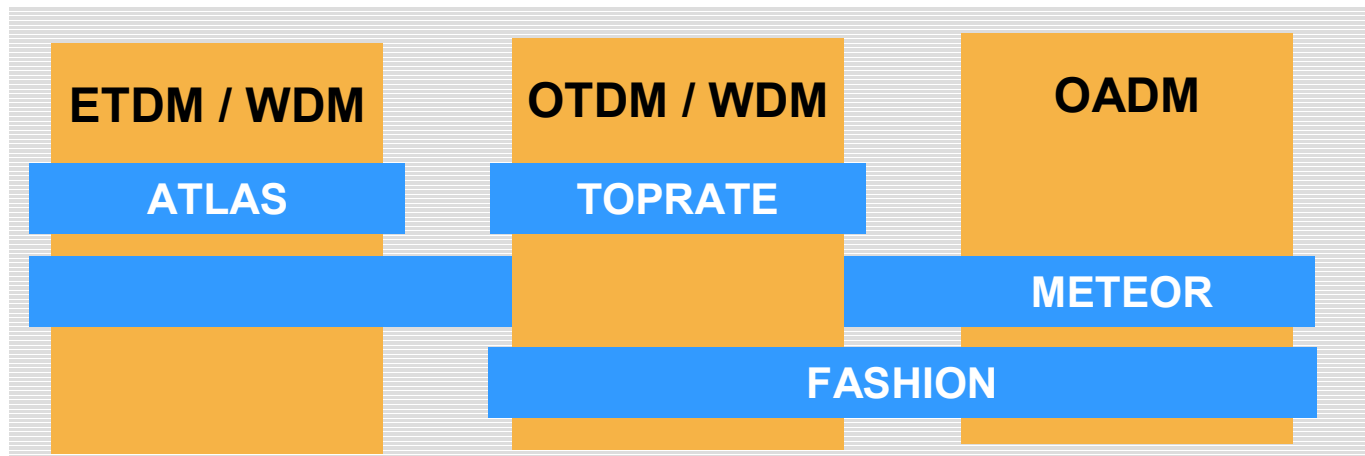
- **Transmission impairments**
  - ⇒ **attenuation**
  - ⇒ **chromatic dispersion and polarization mode dispersion**
  - ⇒ **non-linear Kerr effects (e.g. FWM, XPM) and inelastic scattering effects**
- **Networking impairments**
  - ⇒ **filter concatenation effects**
  - ⇒ **cross talk**
  - ⇒ **power divergence**
  - ⇒ **signal transients**

***Careful design of high speed networks needed***





# High bitrate transmission - IST projects





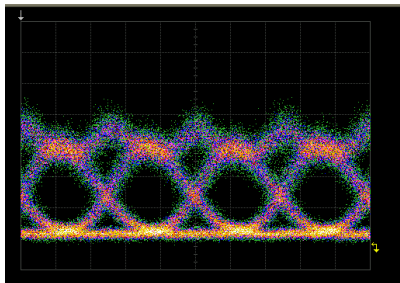
OPTIMIST

# IST ATLAS: Achievements/ Results

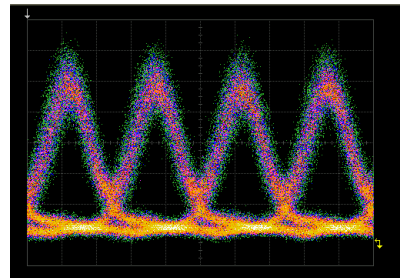
*“All-optical Terabit per second Lambda Shifted transmission”*

- Successful demonstration of 4 x 40 Gbit/s transmission over 500 km G.655

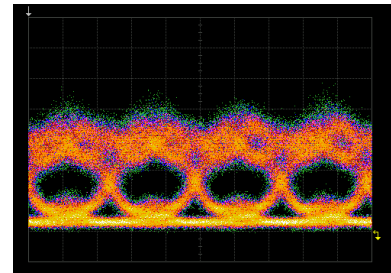
Eye diagrams after 500 km (DM with prechirp map, ch 2 optimized):



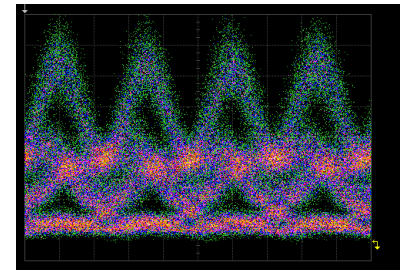
1550.92 nm



1552.52 nm

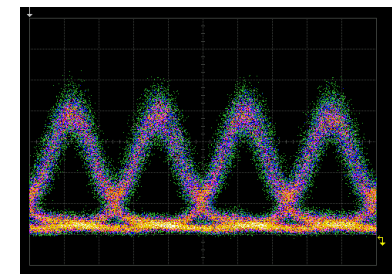
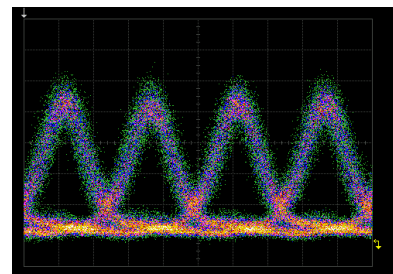
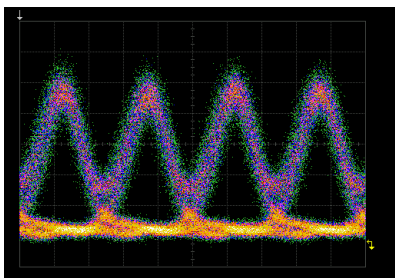


1554.13 nm



1555.73 nm

Eye diagrams after per channel dedicated postcompensation :



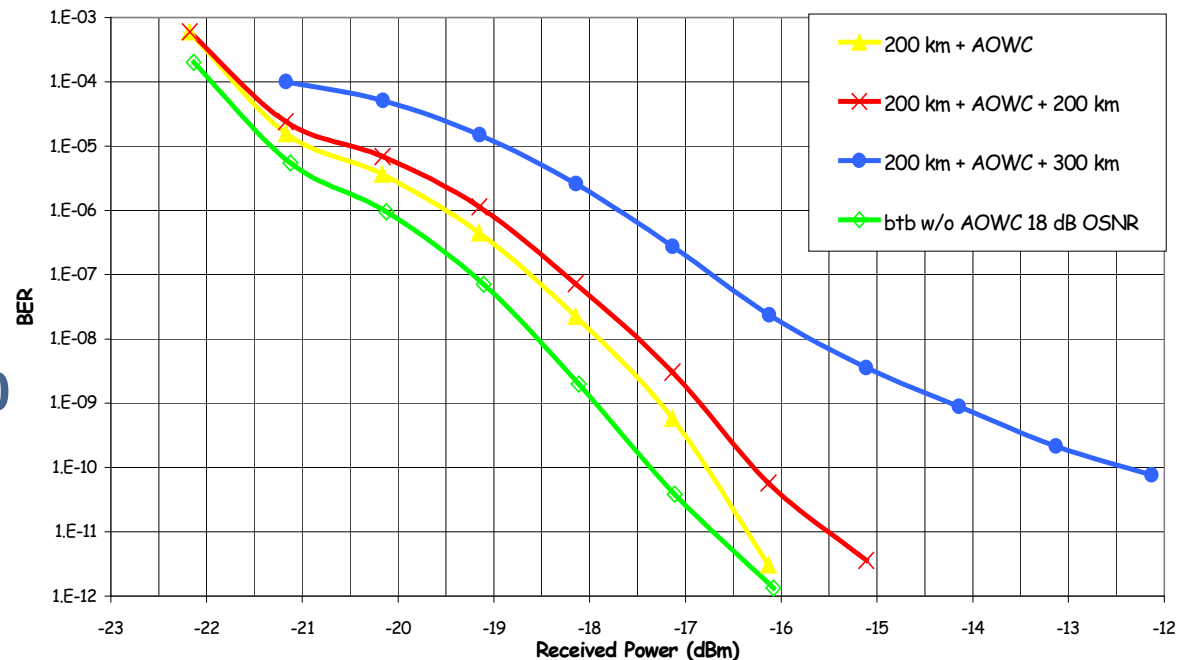


OPTIMIST

# IST ATLAS: Achievements/ Results

- All optical wavelength conversion in-line demonstrated with SOA and PPLN devices.
- Allows for free-blocking routing

Wavelength conversion with SOA: conversion after 200 km and further propagation for other 300 km (G.655 fibre)

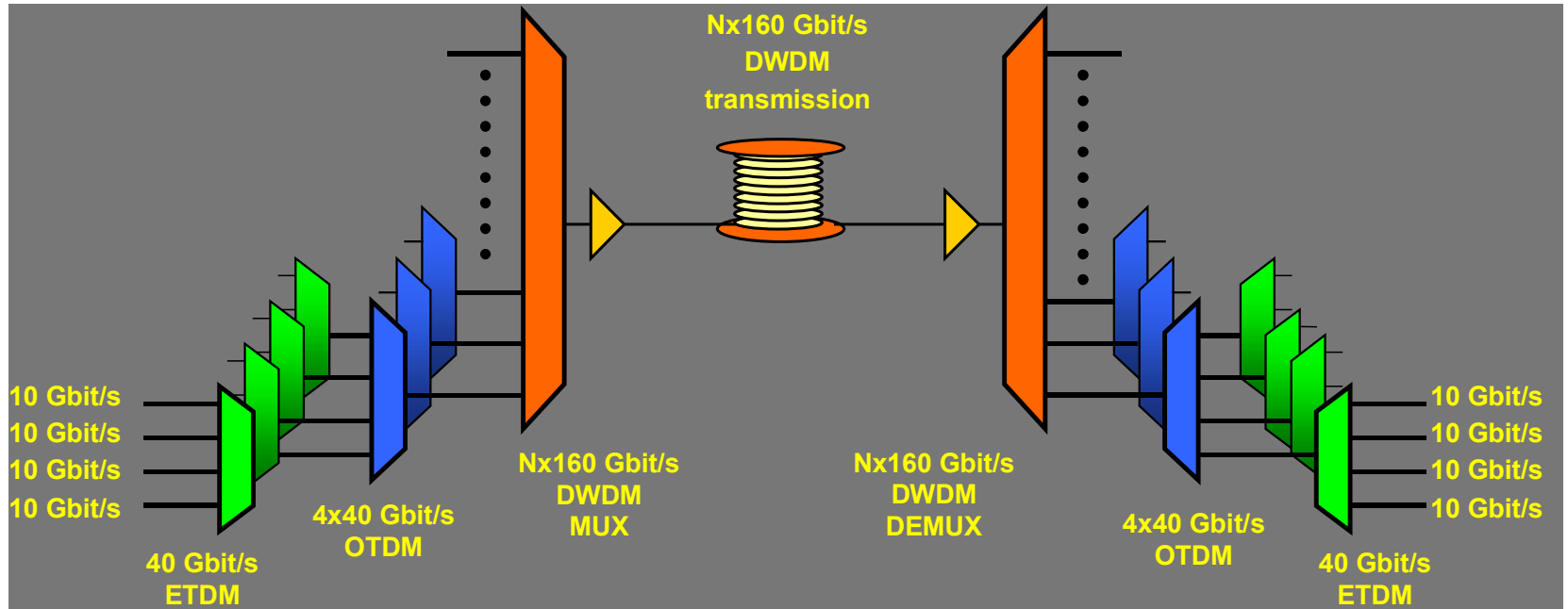




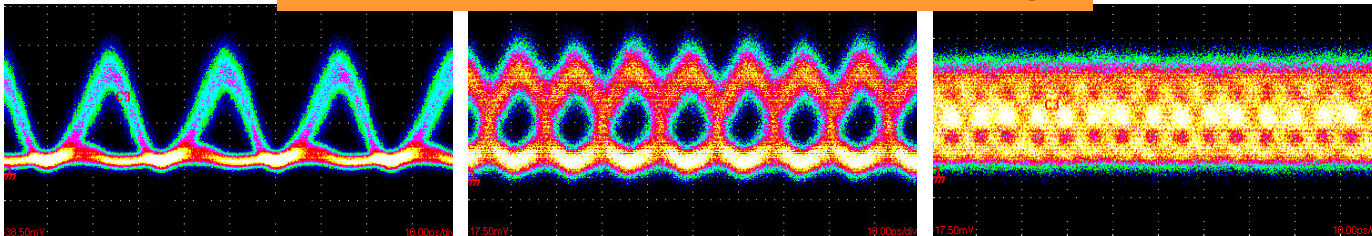
OPTIMIST

# IST TOPRATE

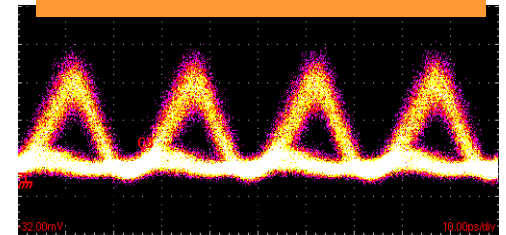
*“Terabit/s Optical Transmission Systems based on Ultra-high Channel Bitrate”*



**TX: 4x40 Gbit/s OTDM multiplexing**



**RX: Clock recovery  
160:40 Gbit/s demux**





OPTIMIST

# IST TOPRATE: Achievements/ Results

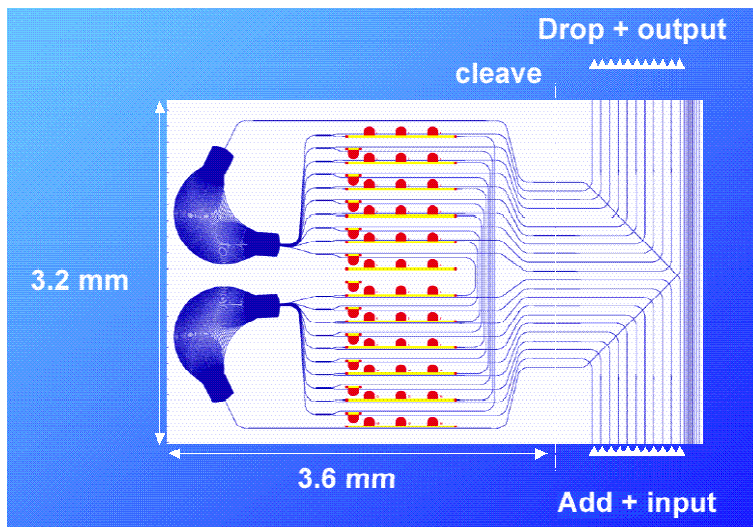
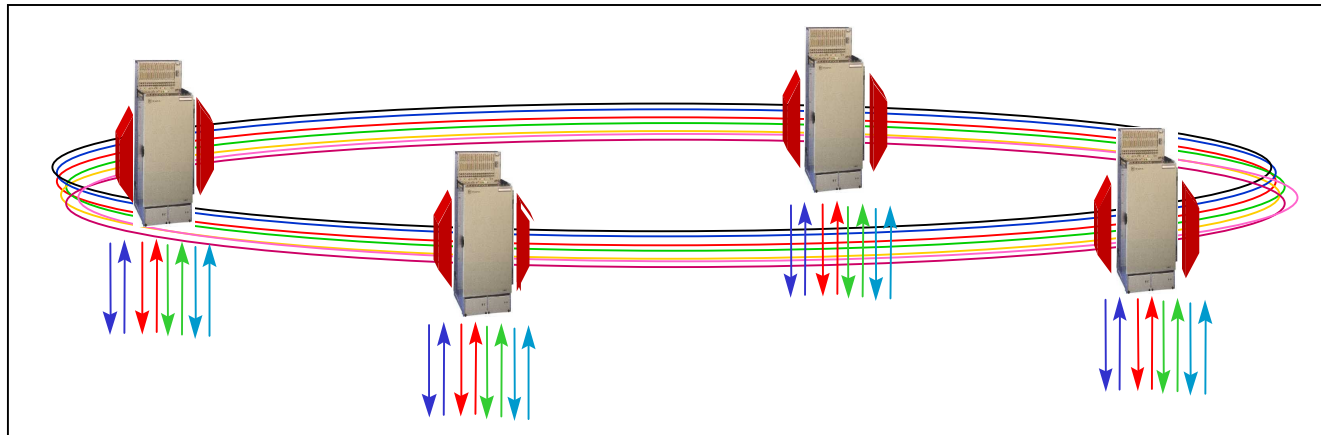
- **Optical Time Division Multiplexing (OTDM) technology**
  - ⇒ to the next bitrate hierarchy of 160 Gbit/s and beyond
  - ⇒ full use of 40 Gbit/s ETDM technology
- **Dense Wavelength Division Multiplexing (DWDM)**
  - ⇒ Nx160 Gbit/s DWDM / use of AWG demultiplexers
- **Fibre transmission**
  - ⇒ Dispersion management optimization
  - ⇒ 160 Gbit/s single channel transmission over 2x100 km
  - ⇒ 4x160 Gbit/s DWDM transmission over 3x80 km
- **Many novel techniques investigated / used for**
  - ⇒ PMD compensation: tunable planar devices (PLC)
  - ⇒ electronic 40Gbit/s eye-monitoring
  - ⇒ optical demultiplexing: novel photonic crystal fibre
  - ⇒ optical clock recovery: 40 GHz optical clock operated in 160 Gbit/s receiver



OPTIMIST

# IST METEOR

## “Metropolitan Terabit Optical Ring”



- High speed (40Gbit/s per channel)
- WDM (up to 40 channels)
- Networking (nodes with add-drop functionality)

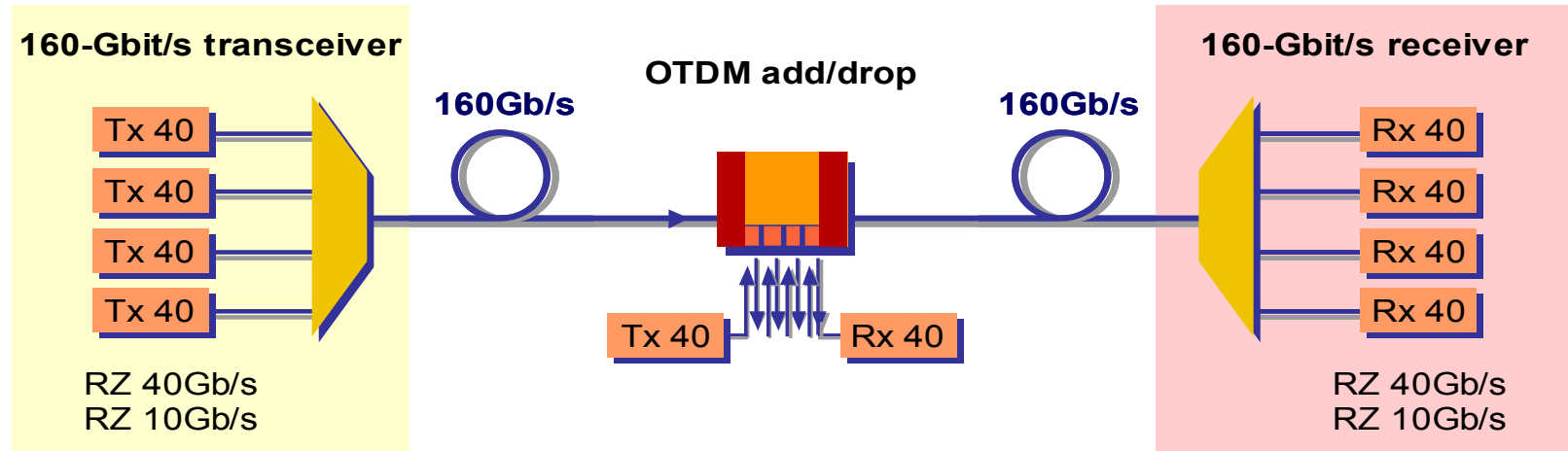
Mask layout active OADM



OPTIMIST

# IST FASHION

## “UltraFast Switching in High-Speed OTDM Networks”



- Transmission of 160 Gb/s OTDM data (16x10 Gb/s and 4x40 Gb/s) over 500 km of fiber to demonstrate the usability in ultra high speed core networks
- Adding to and dropping 10 Gb/s and 40 Gb/s data from a 160 Gb/s OTDM data stream to demonstrate the flexibility of OTDM technology for usage in flexible optical networks
- 160 Gb/s OTDM field trial over installed fibers to study the influence of environmental conditions



OPTIMIST

---

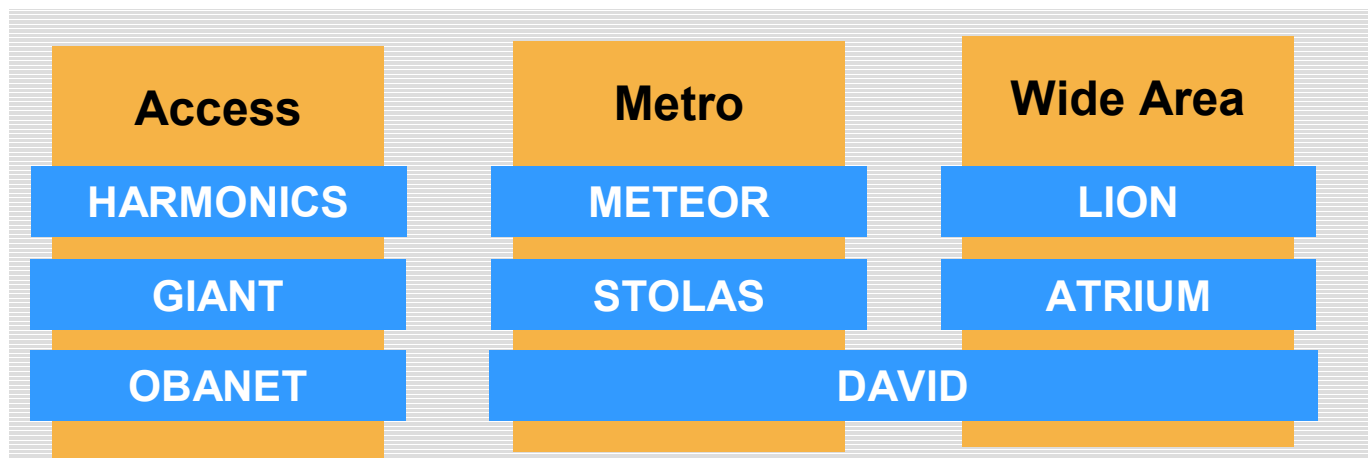
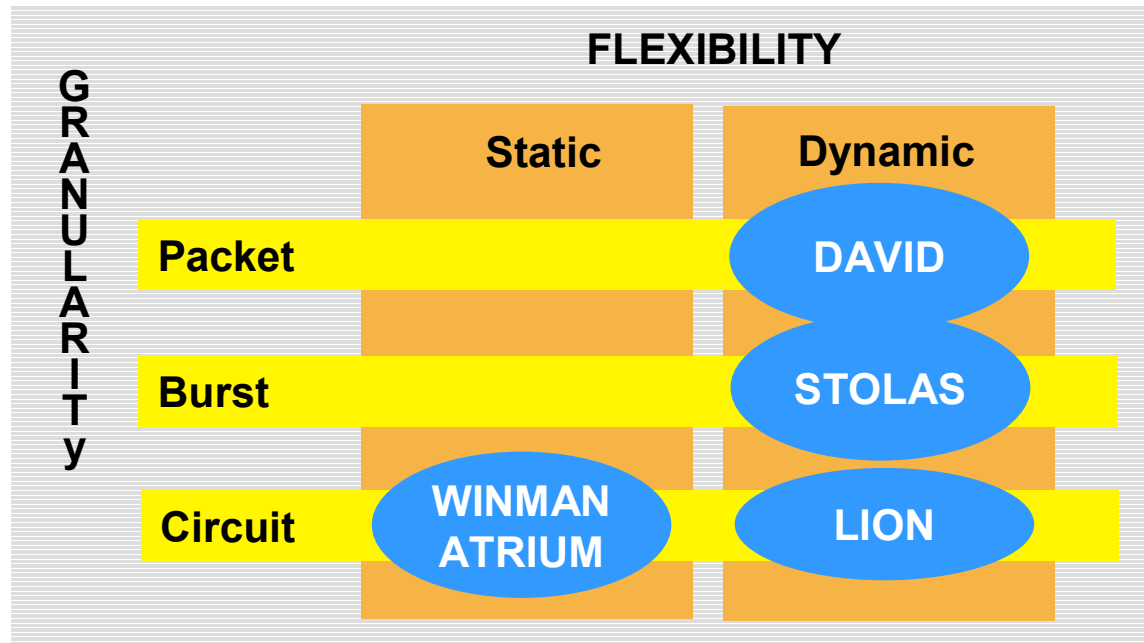
# **IST -FP5 Optical Networking Projects**





OPTIMIST

# Network Evolution – IST projects

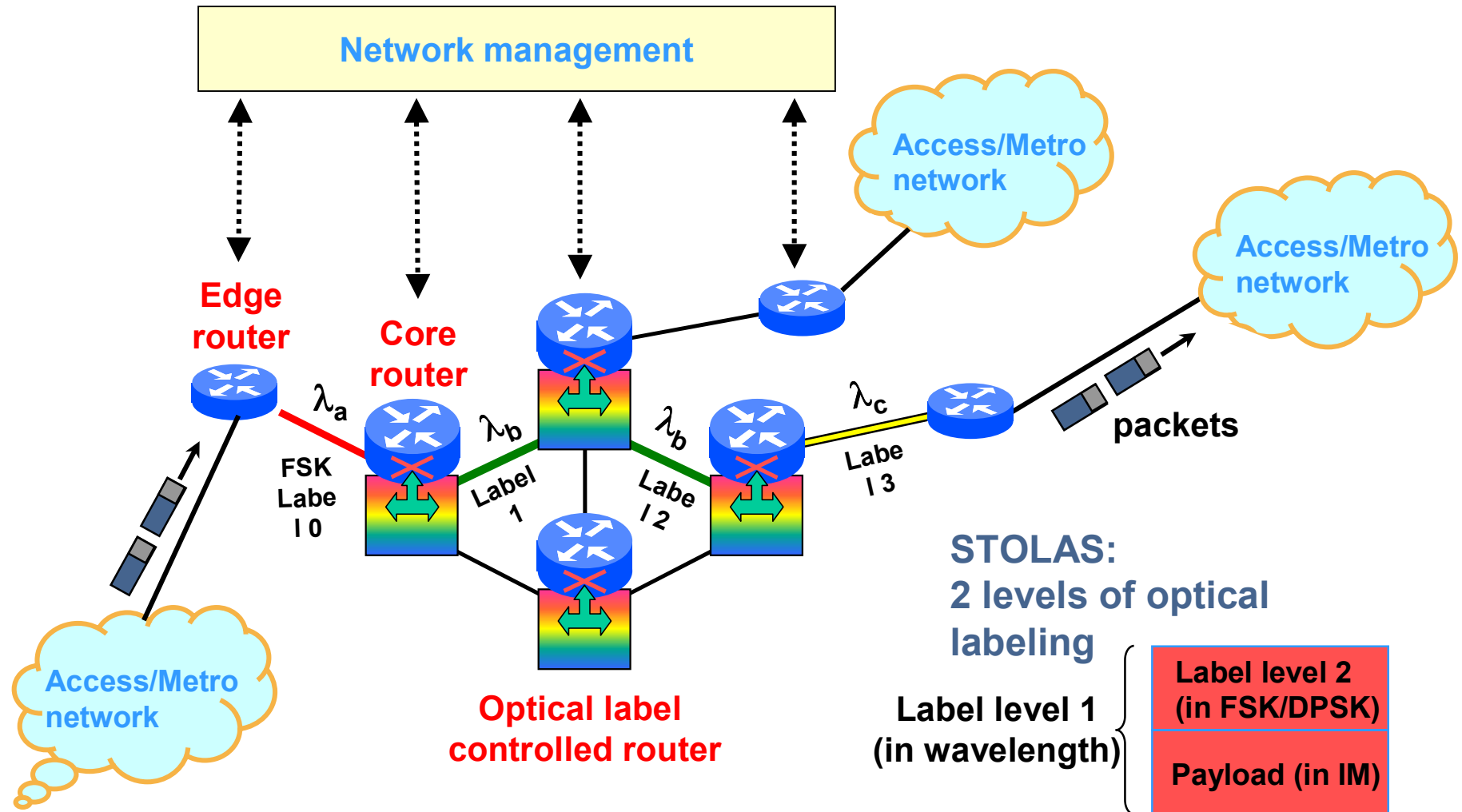




OPTIMIST

# IST STOLAS: Technical Approach

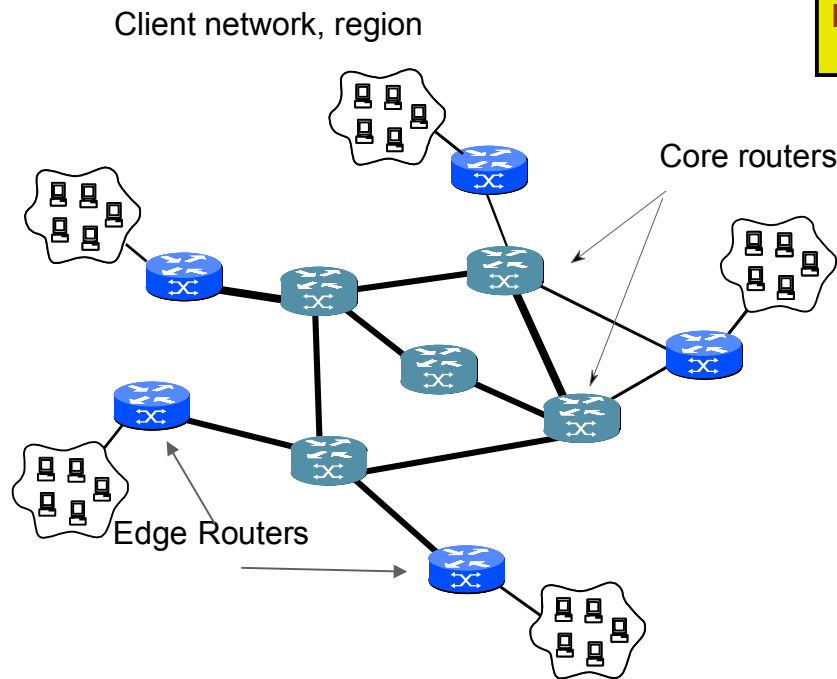
*“Switching Technologies for Optically Labeled Signals”*



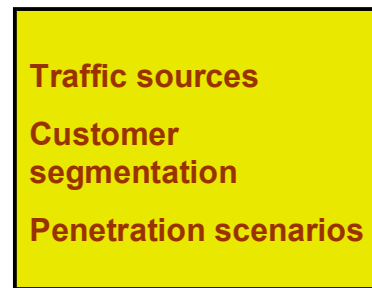


# IST STOLAS: Network simulations & traffic input

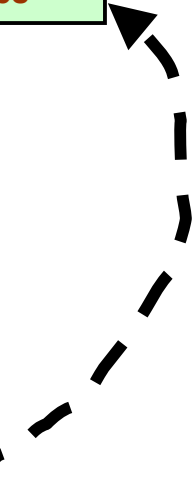
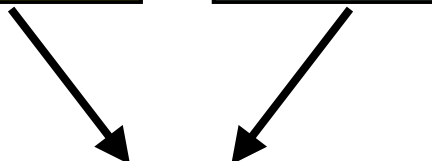
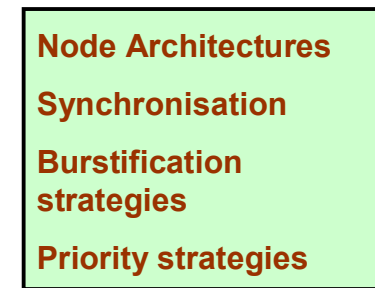
Assume a Full-Service STOLAS network with aggregated traffic inputs. Create a realistic traffic input scenario for this network that may be representative of a typical European region in year 2009. Realistic traffic input created using three generic sources: Voice (Poisson), Data (Pareto), Video (Gamma).



## Traffic Input



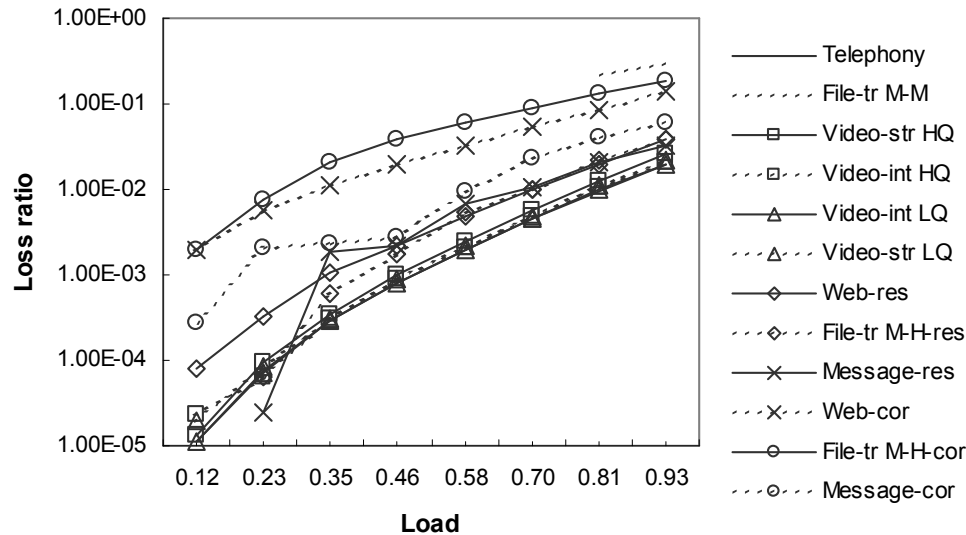
## Architectures



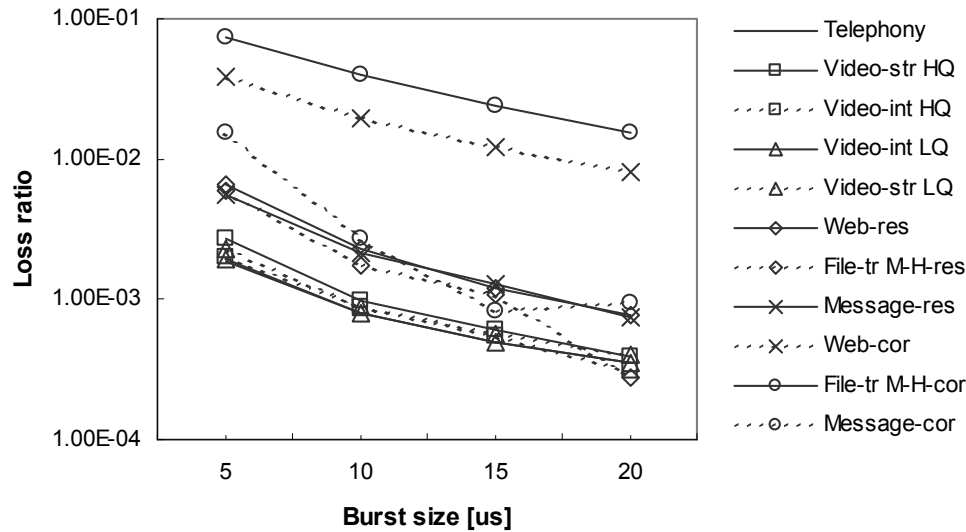


OPTIMIST

# IST STOLAS: Network Simulation Results



**High burstiness application →  
higher loss!**



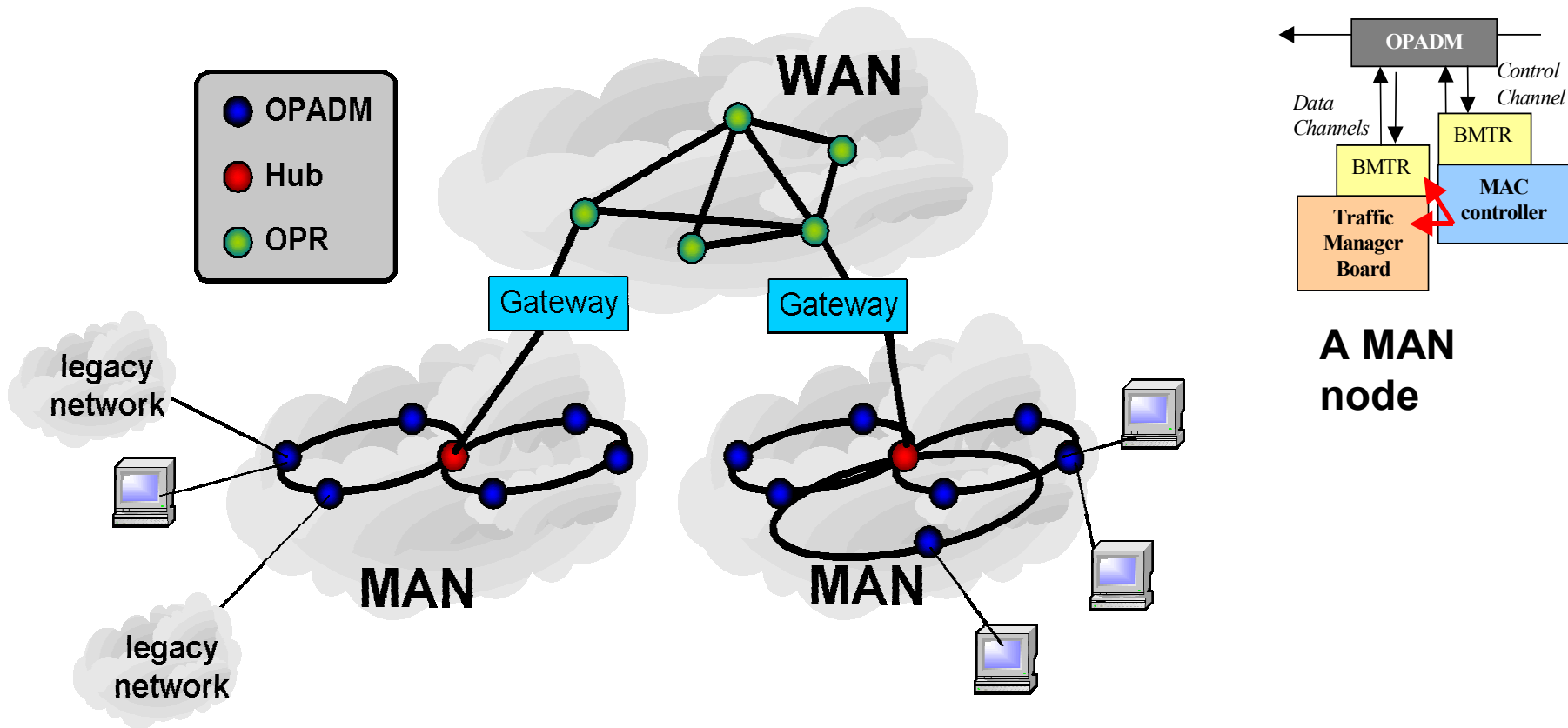
**Decreasing loss with increasing  
burst size**



OPTIMIST

# IST DAVID

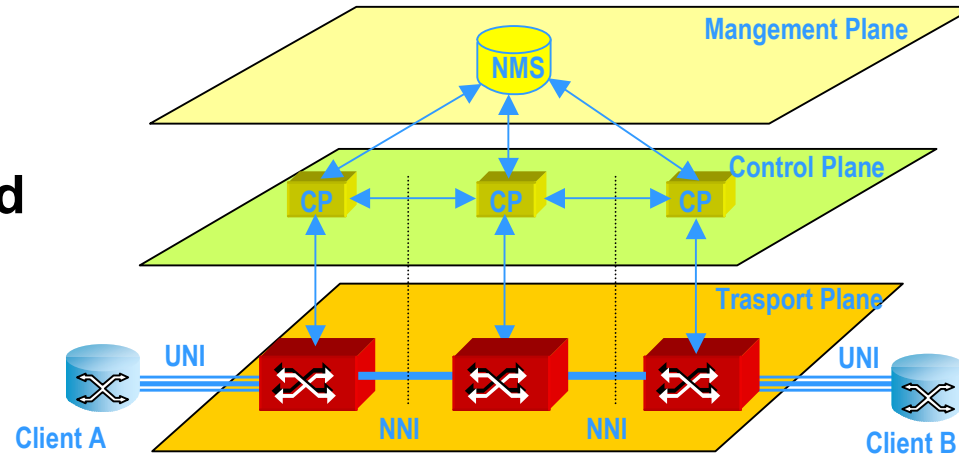
## “Data and voice integration over WDM”





## “Layers Internetworking In Optical Networks”

reference network  
scenario :  
**Automatic Switched  
Optical Networks /  
Generalised-MPLS**



- Traffic/demand model for ASON/ASTN networks
- Definition of guidelines on the optimisation of the transport network evolution (flexible connection provisioning, control plane, management plane, resilience, ...)
- ASON for survivability/ resilience using the ASON flexibility
- Study of ASON dimensioning and dynamic traffic conditions resulting in a joint optimisation planning scheme



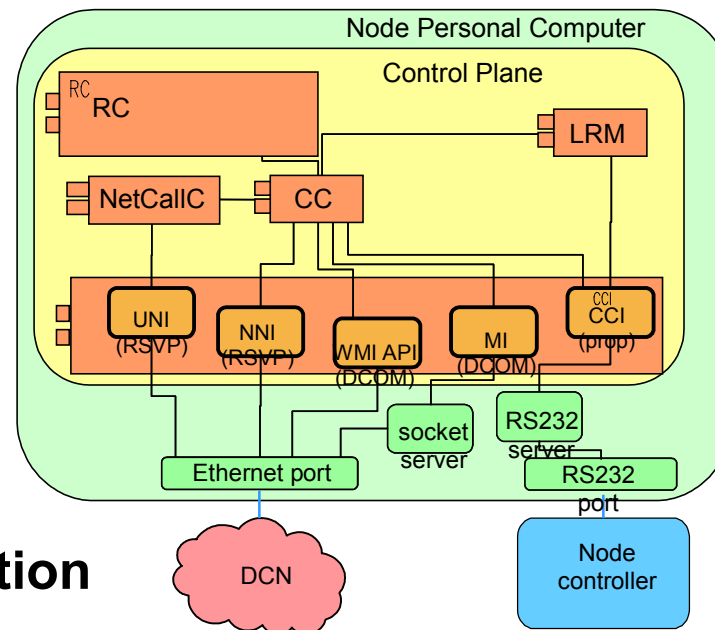
OPTIMIST

# IST LION: Achievements/ Results

- **Interfaces and OAM**

- ⇒ **Functional architecture of a control plane**
- ⇒ **Comparison with status of standardisation**
- ⇒ **Study of OAM mechanisms and their interworking**

**Architecture of the Control Plane Implementation**

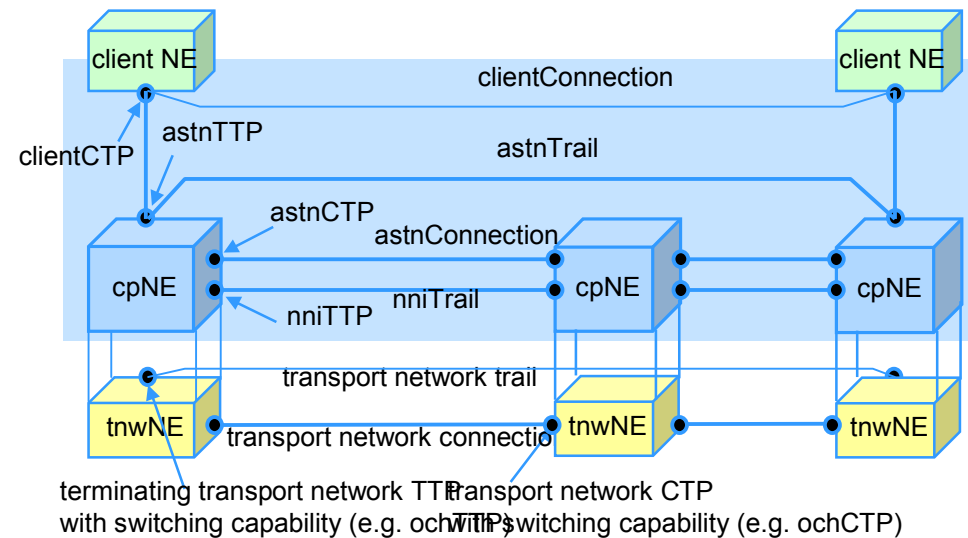




# IST LION: Achievements/ Results

- **Management**

- ⇒ Management concept supporting a smooth migration to ASTN-enabled Transport networks
- ⇒ Management Requirements for ASTNs
- ⇒ Network Level Management Information model
- ⇒ Implementation of two Management Prototypes for the
- ⇒ LION testbed validating the management concept ongoing



Objects of the LION information model

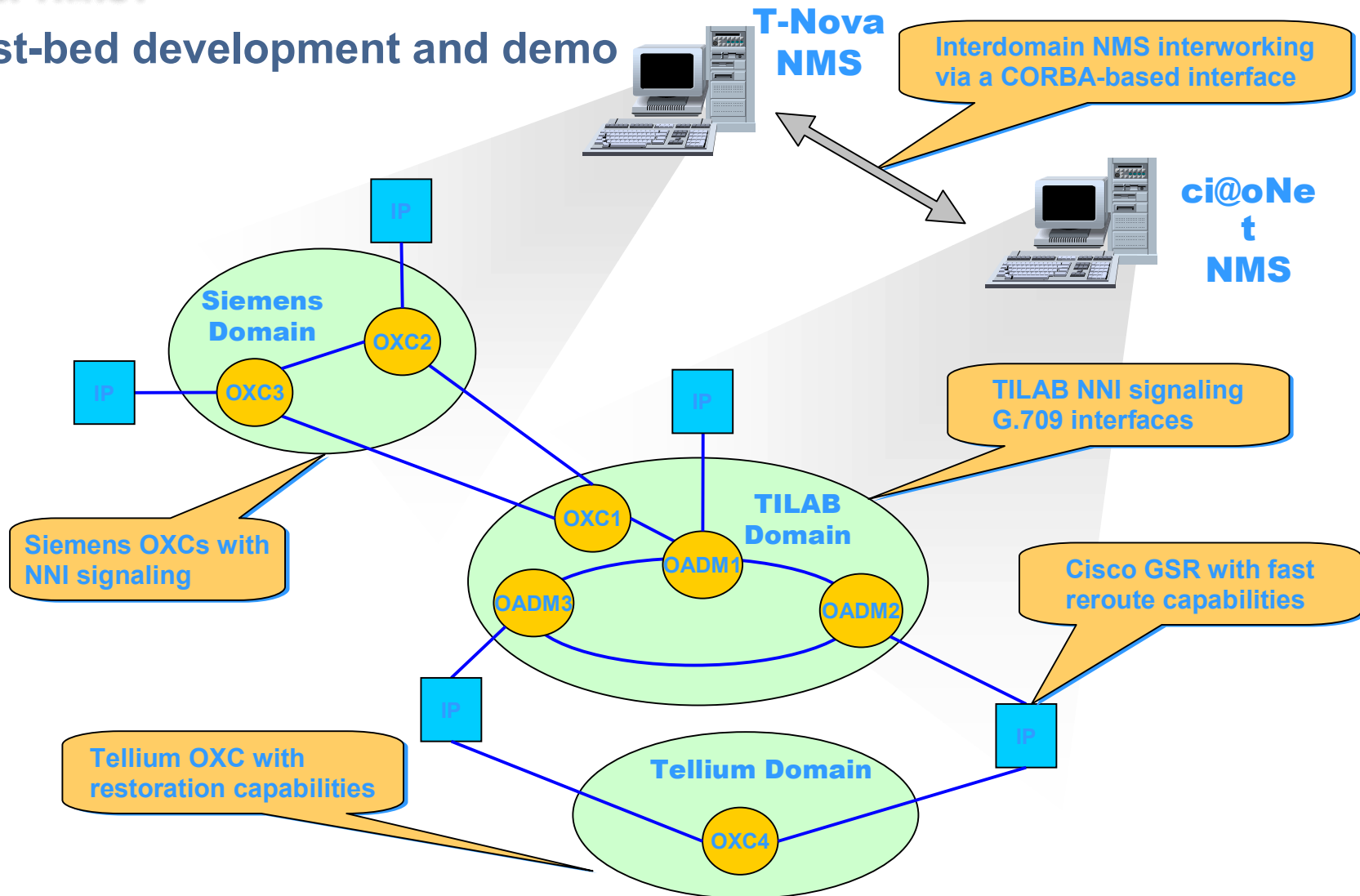




OPTIMIST

# IST LION: Achievements/Results

test-bed development and demo

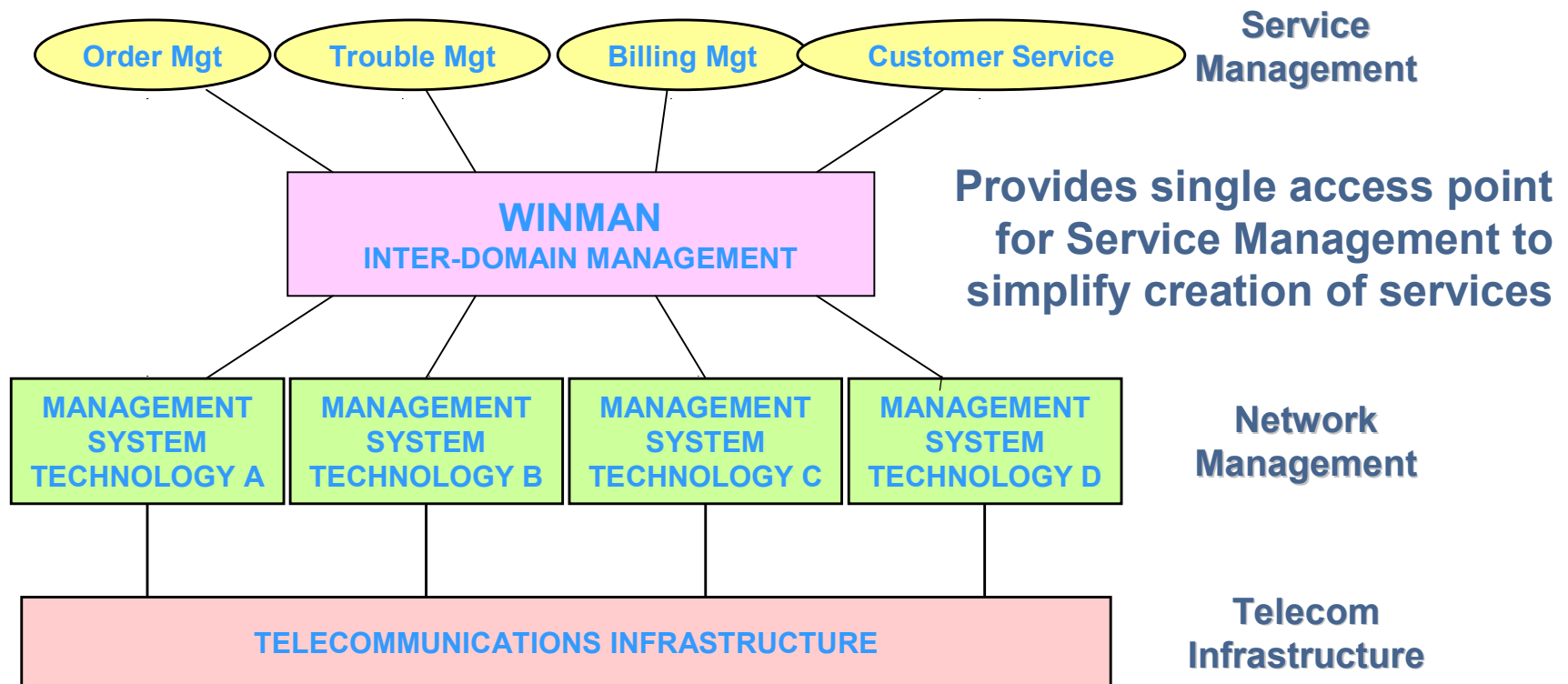




OPTIMIST

# IST WINMAN

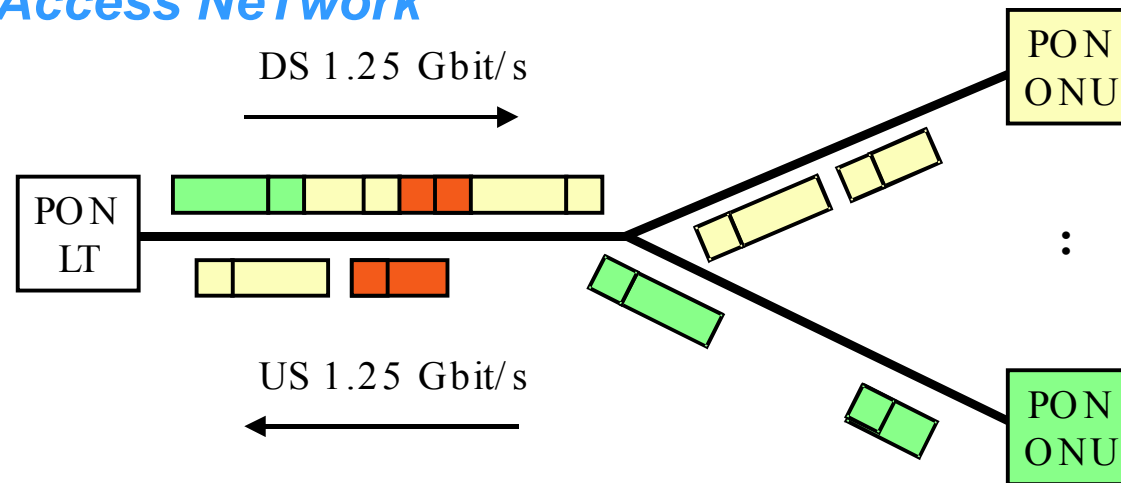
## “WDM and IP Network MANagement”





# IST GIANT

## “GigaPON Access NeTwork”



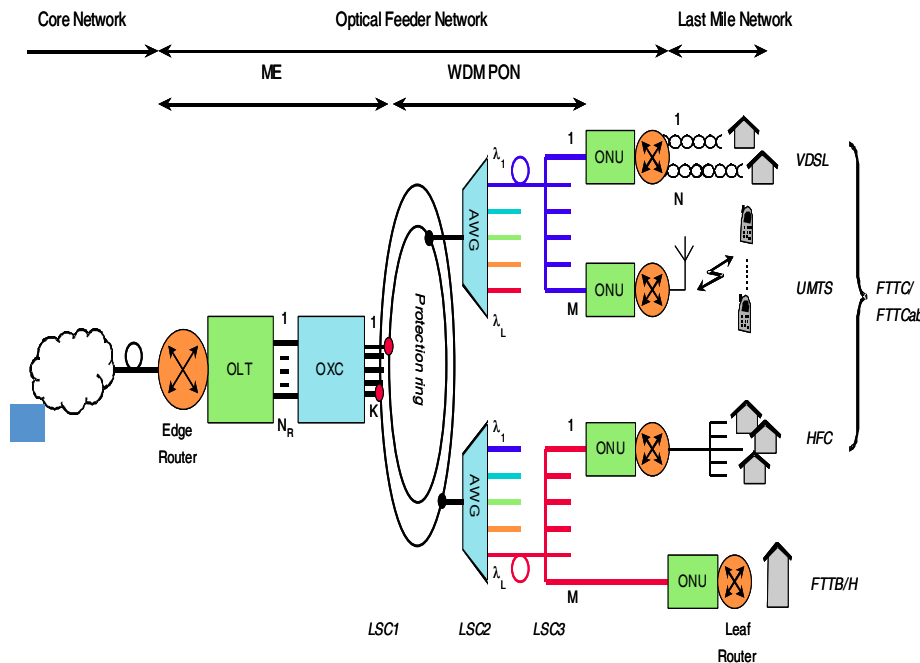
- GigaPON is based on passive optical technology (1.25 GBit/s symmetrical) ; it can be seen as an upgrade for a BPON which is standardised up to 622 Mbit/s.
- The system will be packet oriented with a mixture of real-time and non-real time data in an IP dominated world. A GigaPON system that combines high transmission efficiency with a guaranteed level of QoS clearly represents a competitive opportunity.
- The main technical issues are found in the upstream link, from the user side (ONU) to the network side (LT).



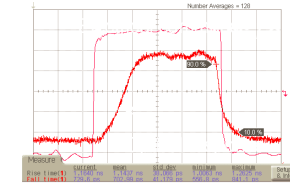
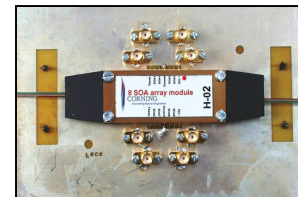
OPTIMIST

# IST HARMONICS

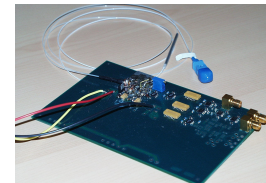
## “Hybrid Access Reconfigurable Multi-wavelength Optical Networks for IP-based Communication Services”



•Novel optical system modules for flexible wavelength-routed access networks were designed and integrated in a lab test.



### Optical Cross Connect

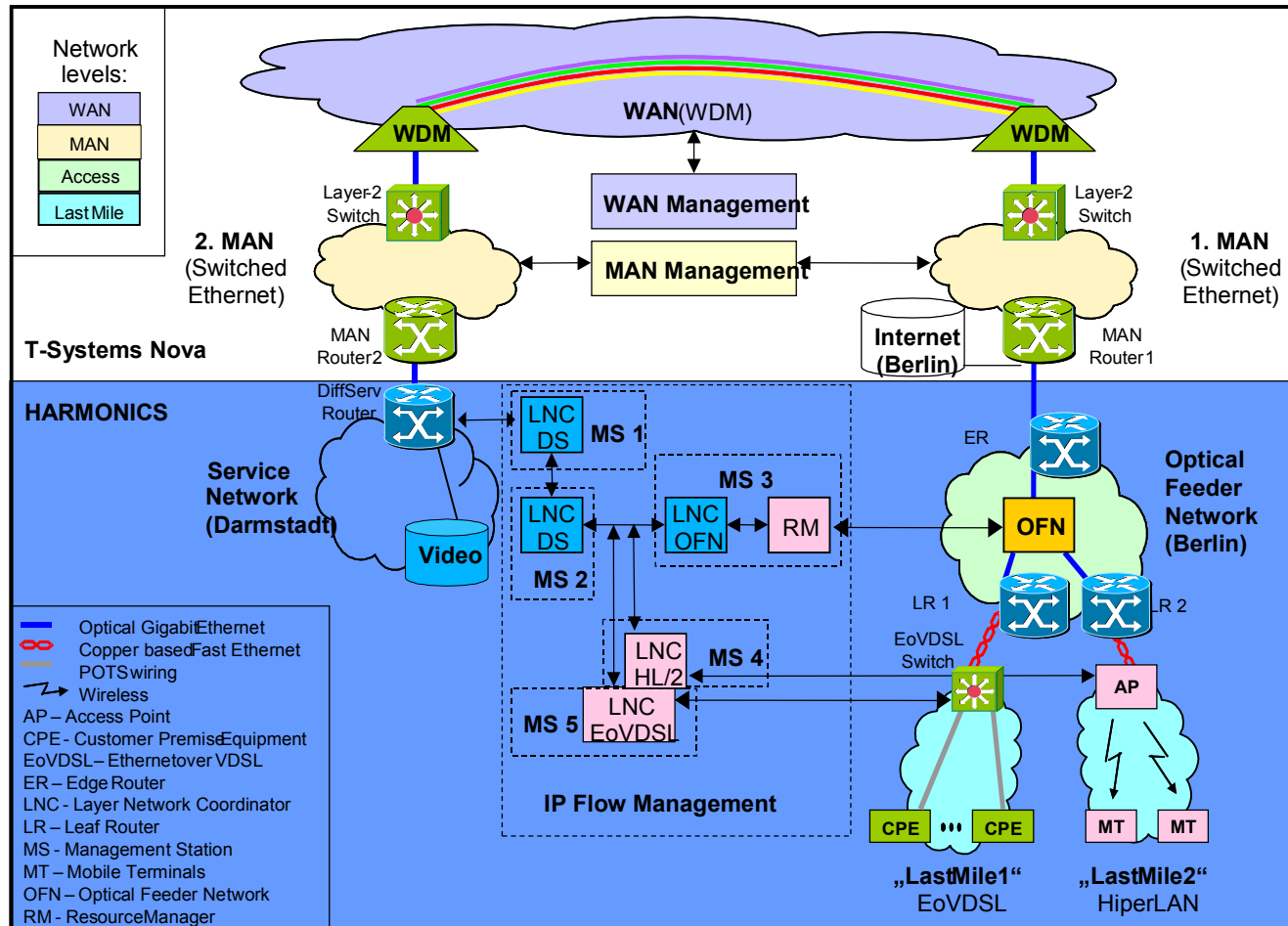


### Burst Mode Receiver

•A management architecture for flow based IP services across core, and multiple access domains has been developed and tested for different QoS.  
 •A novel time-and-wavelength MAC protocol for packet-based access networks has been designed. An implementation in an emulator for real data traffic will be used for the field trial.



# IST HARMONICS



Outline of the HARMONICS field trial running in Berlin (Optical Feeder Network emulation and Last Mile Access) and Darmstadt (Video Server)



OPTIMIST

[www.ist-optimist.org](http://www.ist-optimist.org)



OPTIMIST



**Welcome!**

- ▶ Newsletter
- ▶ News Library
- ▶ Projects
- ▶ Workshops
- ▶ Technology
- ▶ Links
- ▶ About
- ▶ Help
- ▶ Search
- ▶ Admin

info on

- ⊕ projects
- ⊕ workshops
- ⊕ tech trends
- ⊕ FP6
- ⊕ Partner Search



the **OPTIMIST**  
Thematic  
Network

Facilitating  
the concertation  
process in the area  
of Photonics

**Subscribe** to our Quarterly Electronic Newsletter

➤ [optimist@intec.rug.ac.be](mailto:optimist@intec.rug.ac.be)

Website maintained by Intec  
(IMEC-Ghent University)

