

# Net!Works

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## SUCCESS STORIES

# OPTICAL COMMUNICATIONS



Networked  
Society

## EUROPEAN RESEARCH & INNOVATION IN TELECOMMUNICATIONS



## AN INTERNATIONAL SUCCESS BOLSTERED BY EU-FUNDED RESEARCH

**Hardly visible to end-users, 90% of all digital information is transported over optical networks. Fibre-optic communication is the backbone of the information society today. It will become even more important in the future.**



From ground breaking discoveries, such as optical fibres and EDFAs over products such as WDM systems and OXCs to global standards such as SDH, OTN and ASON, Europe has been at the forefront of optical communications R&D for nearly 50 years. The EU Framework Programme played a pivotal role in developing several generations of optical networks over the last 25 years.

7 of the top 20 network operators are headquartered in Europe. 6 of the 20 largest optical equipment manufacturers have major R&D centres in Europe and represent more than 30% of the global equipment market. Two of the top 3 component manufacturers have operations in Europe. Over a hundred SMEs' and universities deliver complementary innovation on network, system, or component levels. According to a recent Photonics21 study, optical technologies leverage a telecommunication infrastructure market of 350 Billion € and impact more than 700,000 jobs in Europe.

By 2020, at least a 10-fold increase in fibre capacity and Tb/s per wavelength will be required. Fibre communication will move closer to the user and will become a critical infrastructure in datacentre, private, home, vehicle and sensor networks. Based on its strength and expertise, Europe is well positioned to respond to these challenges, if it continues to invest!

**MANY ARCHITECTURES, CONCEPTS AND TECHNOLOGIES HAD THEIR ORIGINS IN COLLABORATIVE RESEARCH PROJECTS, CO-FUNDED BY THE EUROPEAN UNION.**

The investment of Framework Programme funds in optical communications has created a network of experts from industry and academia, provided education and has contributed directly and indirectly to the creation of over a hundred thousand jobs in Europe for highly-skilled knowledge workers. The collaborative approach of the projects allowed consensus building on central topics such as the optical network evolution and network control. The results, disseminated in publications and standard contributions, formed a solid foundation for the product roadmaps of participating system/component manufacturers and enabled network operators to develop their technology introduction strategies ahead of time.

1990

1995

2000

2005

2010

2015

2020

### WDM CAPACITY

2.5 Gb/s  
1 x 2.5G

20 Gb/s  
8x 2.5G

800 Gb/s  
80 x 10G  
8x 2.5G

3.2 Tb/s  
80 x 40G

10 Tb/s  
96 x 100G

25 Tb/s  
M x 400G

100 Tb/s  
N x 1000G

### NETWORK ARCHITECTURE

No WDM  
Point-to-point

200 GHz WDM  
Fixed OADM rings

50 GHz DWDM  
ROADM rings

200 GHz WDM  
Fixed OADM rings

50 GHz DWDM  
Multi-degree (MD)  
ROADM mesh

Flexible Grid  
DWDM  
Colour-/  
directionless  
MD-ROADM  
mesh

Flexible Grid  
DWDM  
Contentionless  
MD-ROADM  
mesh

### STANDARDS

SDH

WDM  
TMN

NG-SDH, OTNv1  
ASON

OTNv2  
GMPLS

OTNv3  
PCE

OTNv4  
Multi-layer PCE

OTNv5

### FP PROJECT CONTRIBUTIONS (METRO/CORE)

**MWTN:**  
WDM network  
demonstrator

**HIGHWAY,  
MIDAS, SPEED,  
UPGRADE,  
ESTHER:**  
40Gb/s  
transmission

**PHOTON,  
WOTAN,  
BLISS, OPEN:**  
Wavelength-  
routed networks  
at 10Gb/s

**MEPHISTO,  
DEMON, PLATO,  
MOON, METON:**  
Optical transport  
network  
management

**TOPRATE,  
FASHION:**  
Early >100Gb/s  
realisations

**METEOR:**  
40Gb/s ring  
networks

**LION, WINMAN,  
DAVID:**  
Multi-layer/  
domain  
management  
& contro

**e-Photon/ONe+:**  
DSP techniques,  
coherent detection

**NOBEL I/II:**  
Metro & core  
evolution  
scenarios and their  
experimentation,  
GMPLS  
interoperability,  
reference  
networks,  
DP-QPSK  
transmission

**PHOSPHORUS,  
MUPBED:**  
GMPLS-controlled  
research  
infrastructures

**BONE, TRIUMPH:**  
100G technologies;  
optical burst  
switching

**STRONGEST:**  
Optical & packet  
integration,  
multi-domain/layer  
PCE,fl exgrid &  
>100G networks

**DICONET:**  
physical  
constraints in  
modelling and  
routing; reference  
networks

**GEYSERS, ONE:**  
IT & networking  
convergence