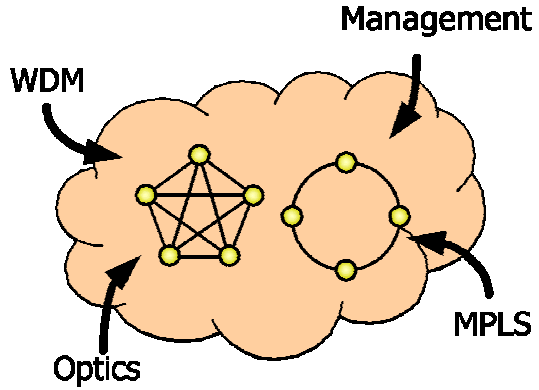
Optical Packet Switching

the technology and its potential role in future communication networks



Results from IST project d a v i d

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What is the next generation photonic network?
(different targets different timescales)

- Extension to current SDH/SONET network with LCAS, ASON, GMPLS, GFP, etc. ?
- Bitrate and protocol transparent optical datapath with electrical control and management ?
- All-optical network with optical control, information processing and routing ?

Why do we need the next generation optical network ?

- for cost reduction reasons (cost reduction potential seems larger for optics than for electronics)
- to increase network efficiency and utilisation
- for resource savings preserving network reliability and availability
- for better network control for fast and efficient configuration of connections (reduction of manual interventions)
- to increase network flexibility and responsiveness to dynamic traffic demands/changes
- because an optical network is in line with a simplified core structure with more complex and intelligent flow handling at the edges (which was the original idea of the MPLS concept)

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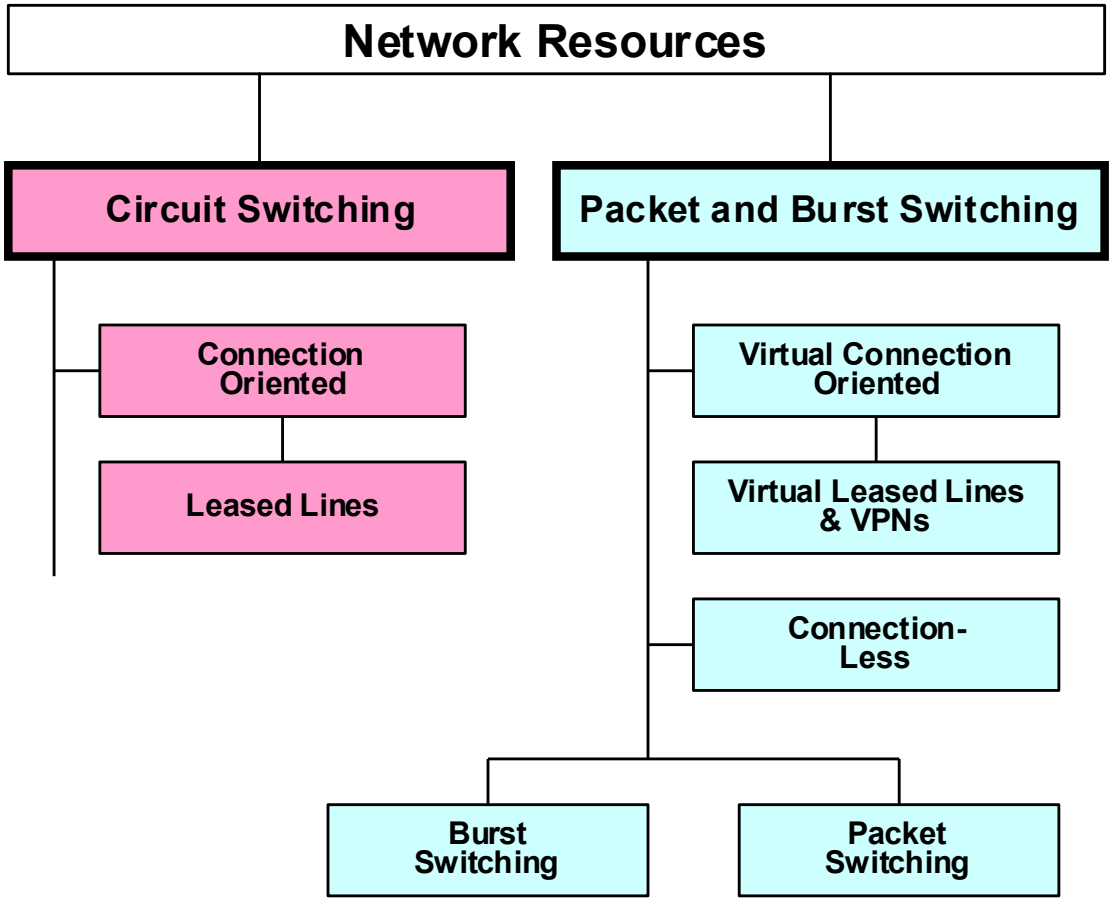
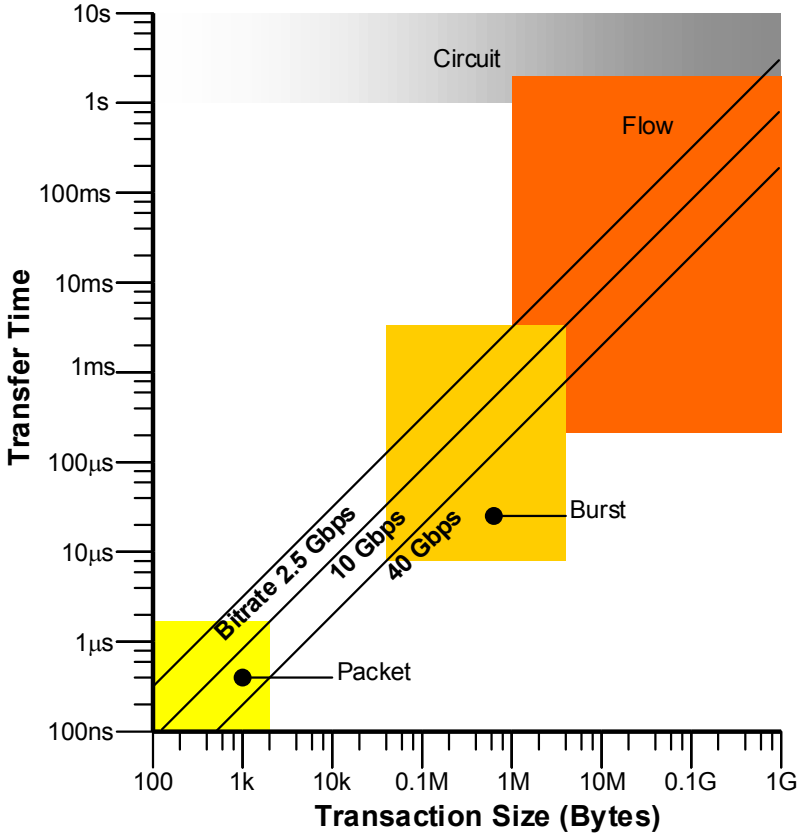
Technological challenges

possible optical connection types



Technological challenges

packets vs. circuits

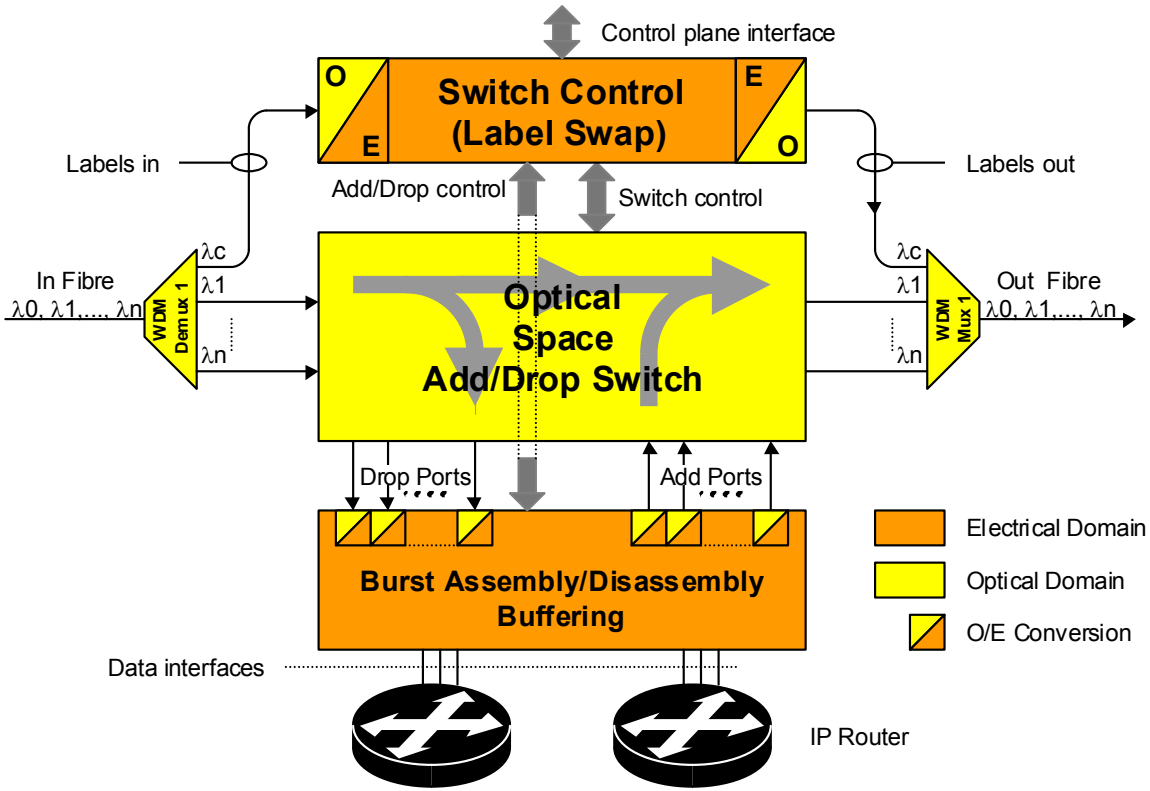


Why packet switching

- Primarily a traffic engineering tool!
- Seen as the final goal for network flexibility, however must be justified
- Packet based operation at application level and transport level should **not be mixed** up!
- Potential new methods for network resilience in packet based networks (path set-up without resource reservation)

Optical Burst and label Switching

potential step towards optical transport plane



- **DAVID** = **D**ata **a**nd **V**oice **I**ntegration over **D**WDM
- A European research project
  - Financially supported by the EU commission
  - IST program
- Goals
  - Develop concepts and technologies for future, optical networks
  - Traffic engineering in packet-over-WDM based networks
  - Control systems for optical networks
- Timeline
  - Start July 2000, end October 2003

DAVID Project partners

- Companies
  - Alcatel, CIT (F)
  - Alcatel, SEL (D)
- Network operators
  - BT (UK)
  - TELENOR (N)
  - TELEFONICA (E)
- Research centers
  - IMEC (B)
  - COM (DK)
- Universities
  - NTUA (G)
  - University of Bologna (I)
  - Politechnica de Torino (I)
  - LRI (F)
  - INT (F)
  - University of Essex (UK)
  - UPC (E)

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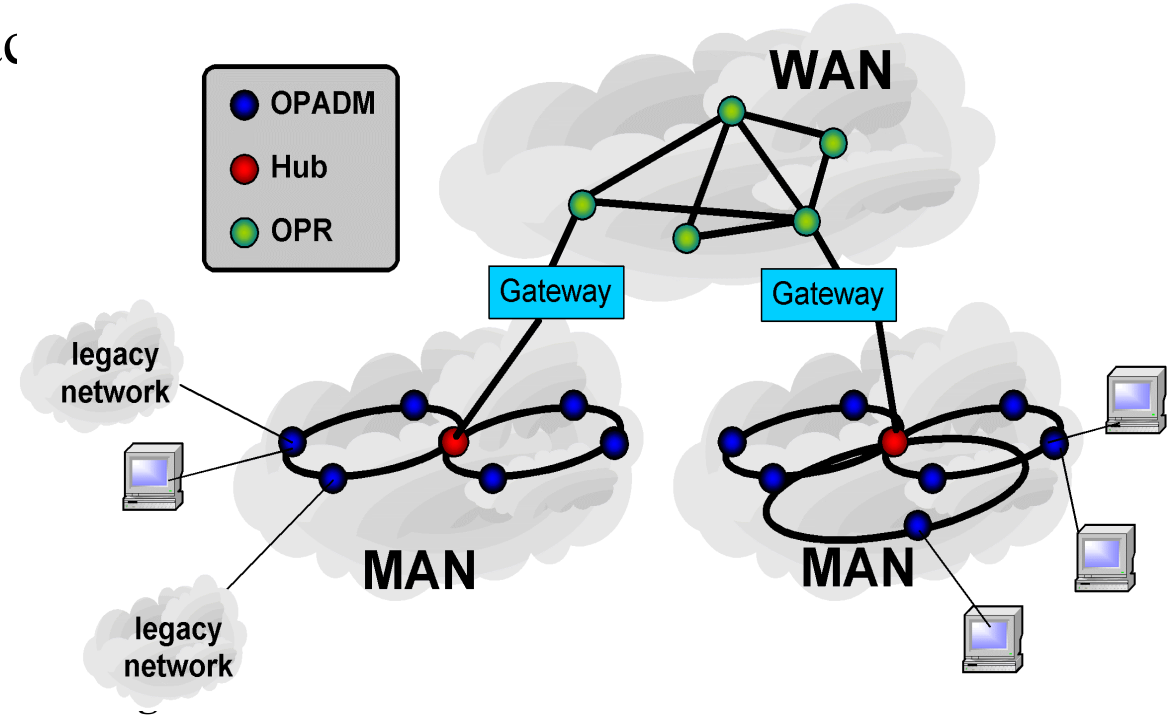
Overall architecture

- Key components
  - OPADM – optical packet add / drop multiplexer
  - Hub
  - Gateway
  - OPR – optical pac
- Coverage
  - MAN and WAN
- Control
  - MPLS-based

MAN

WAN



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Hierarchical MPLS concept

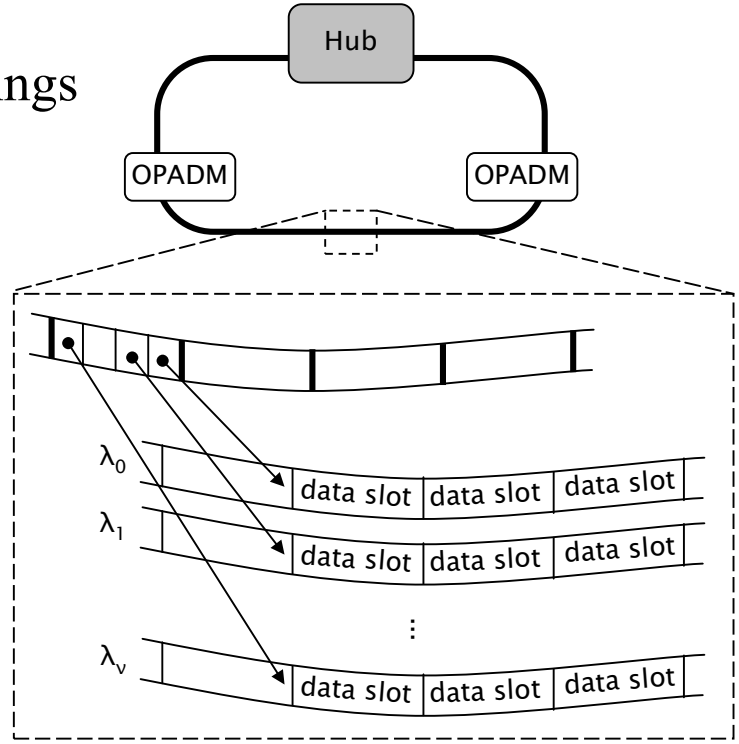
- An MPLS based architecture for mixed-technology networks
- Traffic optimized/conditioned between levels
- Levels of various granularity

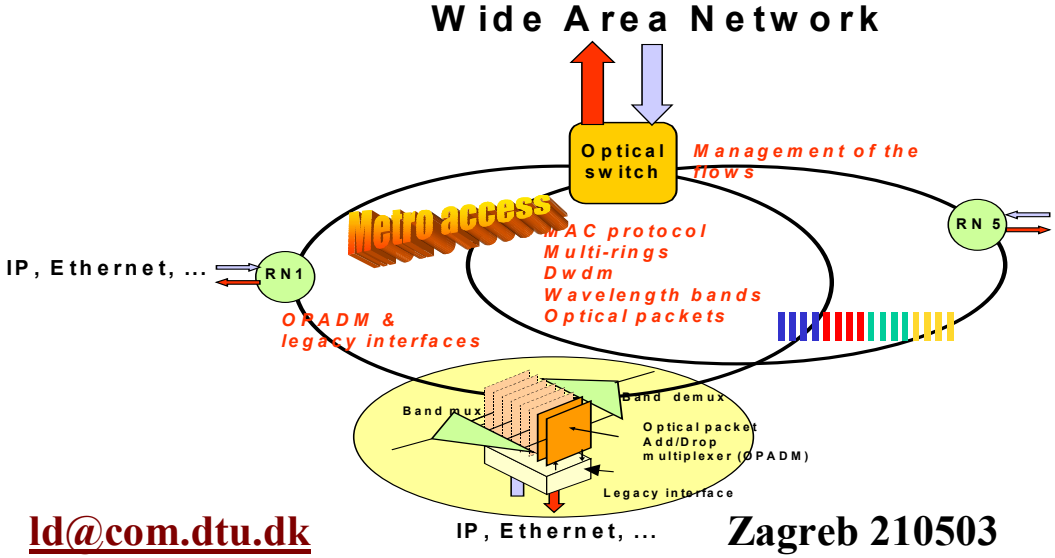
Level	Bandwidth granularity
Electrical MPLS	Packets
Optical MPLS	Larger packets
Wavelength routed	Wavelengths

+ wavelength bands, fibers

The d a v d optical packet MAN

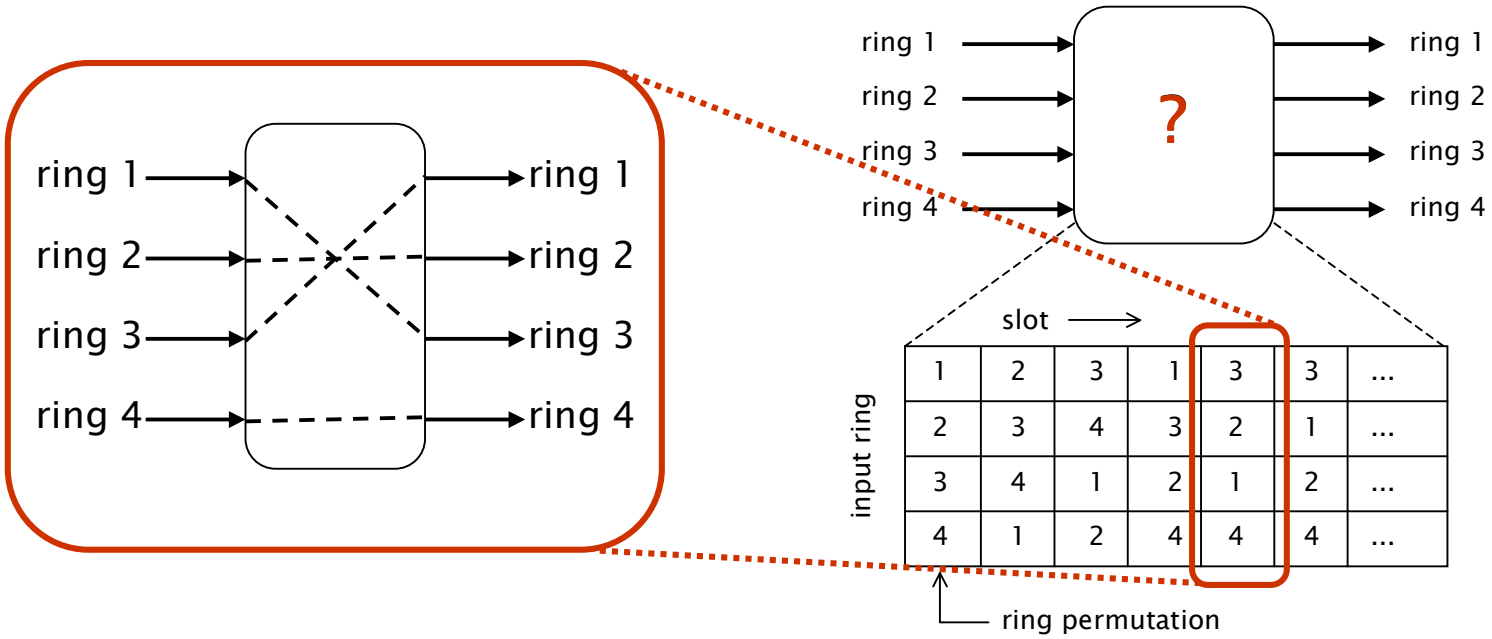
- Topology - interconnected physical DWDM rings
- Each physical ring -> several logical rings
- Ring nodes – OPADMs - provide
  - Ring connectivity
  - Legacy network interfaces
- Inter ring traffic controlled by a *hub*



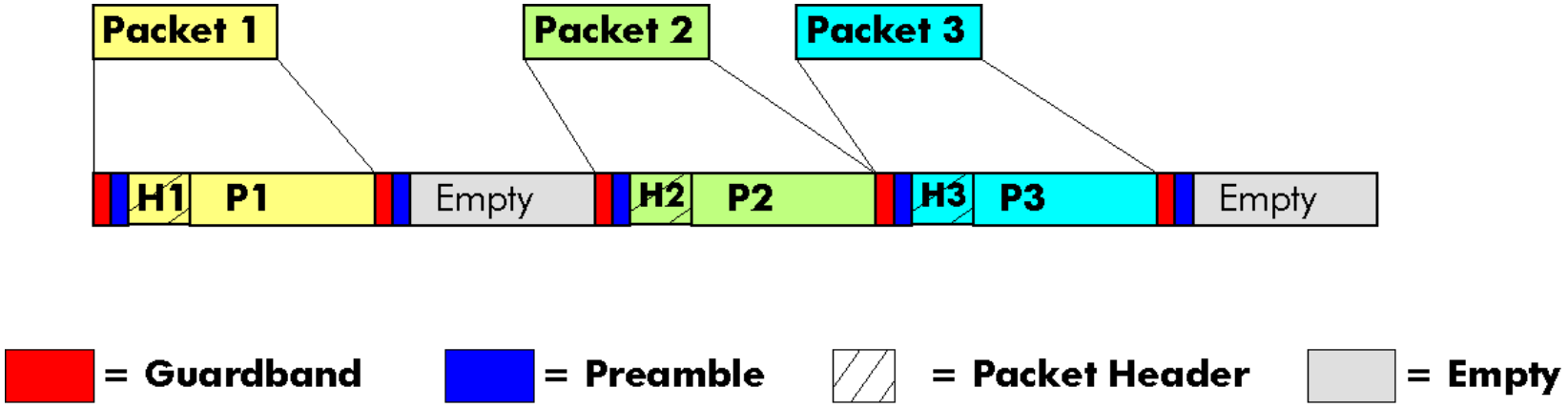


The metro part: MAN

- Hub functionality:
  - each timeunit Hub switches traffic between rings
  - permutations to switch multislots between (logical) rings
  - permutations to use are based on measurements of "demand"



Packet formats



For synchronisation reasons fixed size packets
(at transport level) is preferable for small units (nano-micro sec).
Variable service units handled by sequence of fixed size packets.

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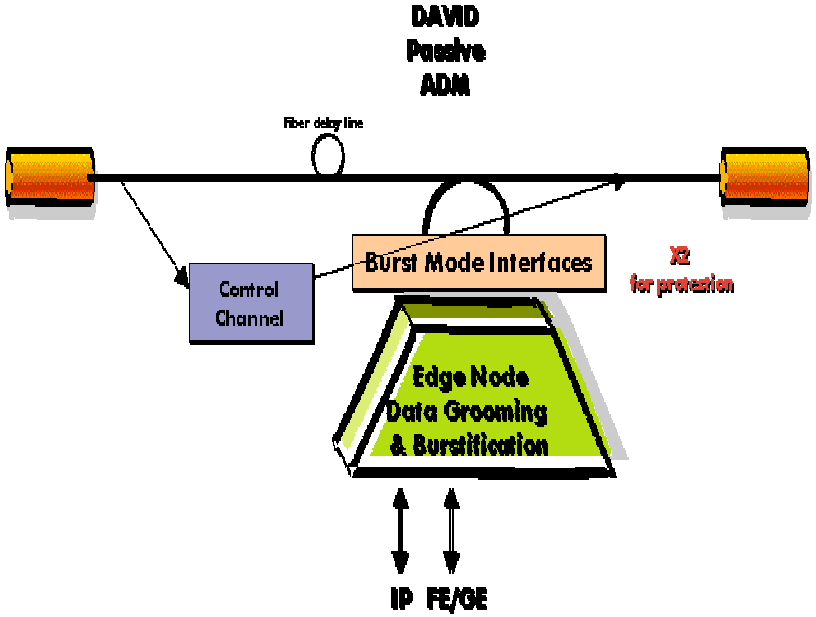
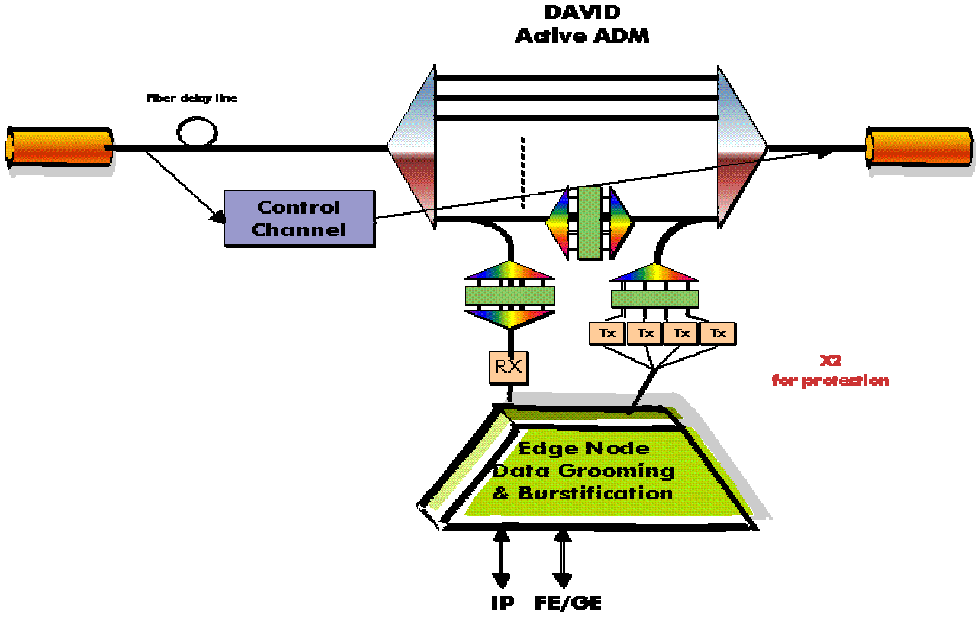
Ring node evolutionary steps
(cost vs. flexibility)

DAVID MAN with passive OPADMs



DAVID MAN with active OPADMs



"Now"

"Future"

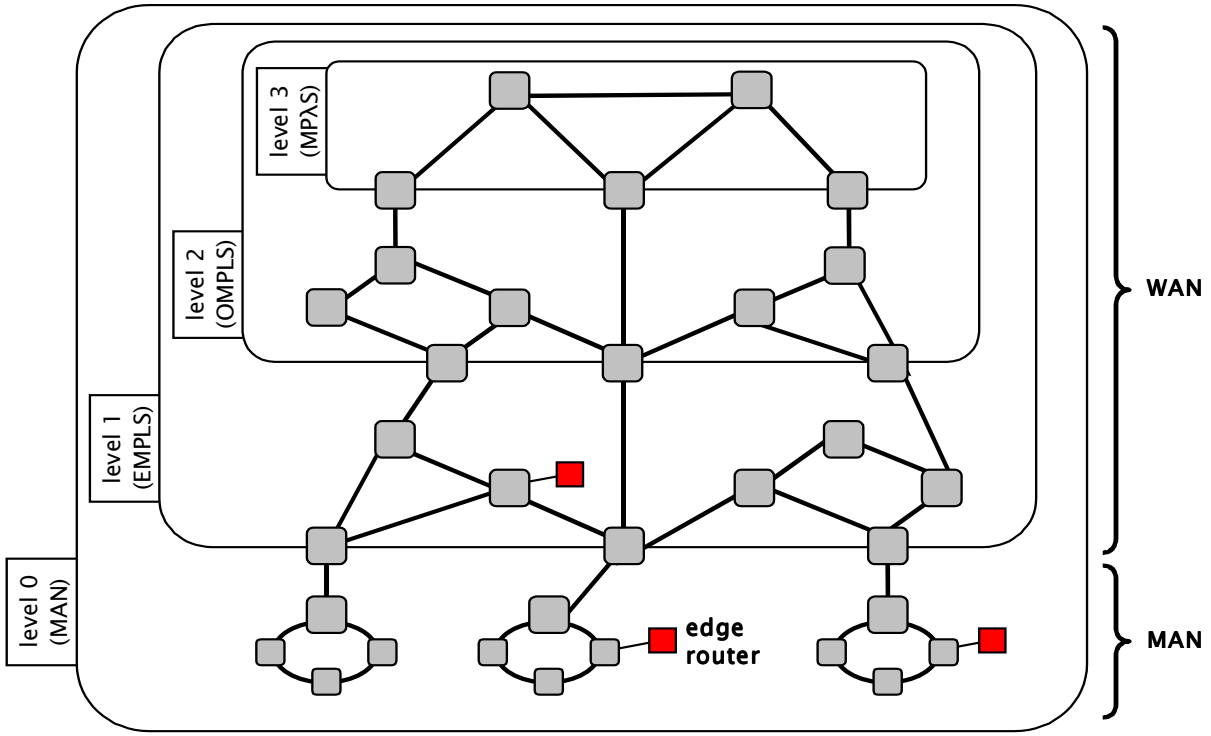
Administrative challanges

ASON vs. GMPLS/MPλS

- Apply the dynamic configuration of service layers to the transport layer(s)
- Integrated control of layers in the network
- Optimised use of the individual layers
- Standard proposals from: IETF, ITU-T, OIF
- Protocol centric solutions (IETF) vs. architectural centric solutions (ITU-T)
- Multi-layer resilience concepts

Administrative challanges

IETF : MPLS/MPλS



Technology hierarchy

When will the next generation of photonic networks become a reality

- Significant effort needed to lower the cost and enable OAM functions of optical components (higher integration and automatic packaging)
- Better understanding of traffic and performance issues in core and metro networks needed to evaluate cost and reliability issues in current proposals.
- Gain consensus on administrative concepts and standard.
- Optical networks must become digital – 3R in all elements as first process

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When will the next generation of photonic networks become a reality

- Dynamic administration of pseudo optical networks (SONET/SDH) in 2-4 years.
- All-optical networks functions in the data plane obtainable in 5-10 years
- All-optical operation in all layers is not realistic with current know technology (and might never be)

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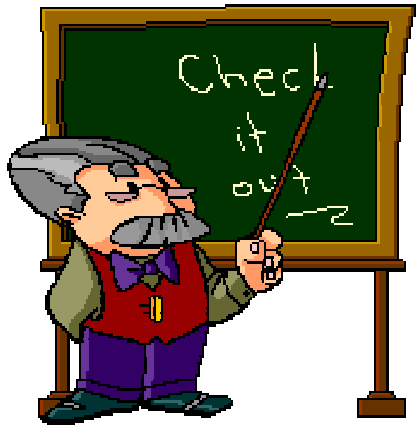

Public demo in October in relation to

PS´2003 (photonics in switching) in Paris

and

(NGPN deliverables @ www.ngni-core.net)