



全光通信网

第四部分 全光网实现方式

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内容

- 三种交叉连接技术的回顾与比较
- 波长交换光网络
- 分组交换光网络
- 突发交换光网络
- **Summary & Comments**



三种交叉连接技术的回顾与比较



定义与交换粒度

Time switching only applicable to SDH signal format.

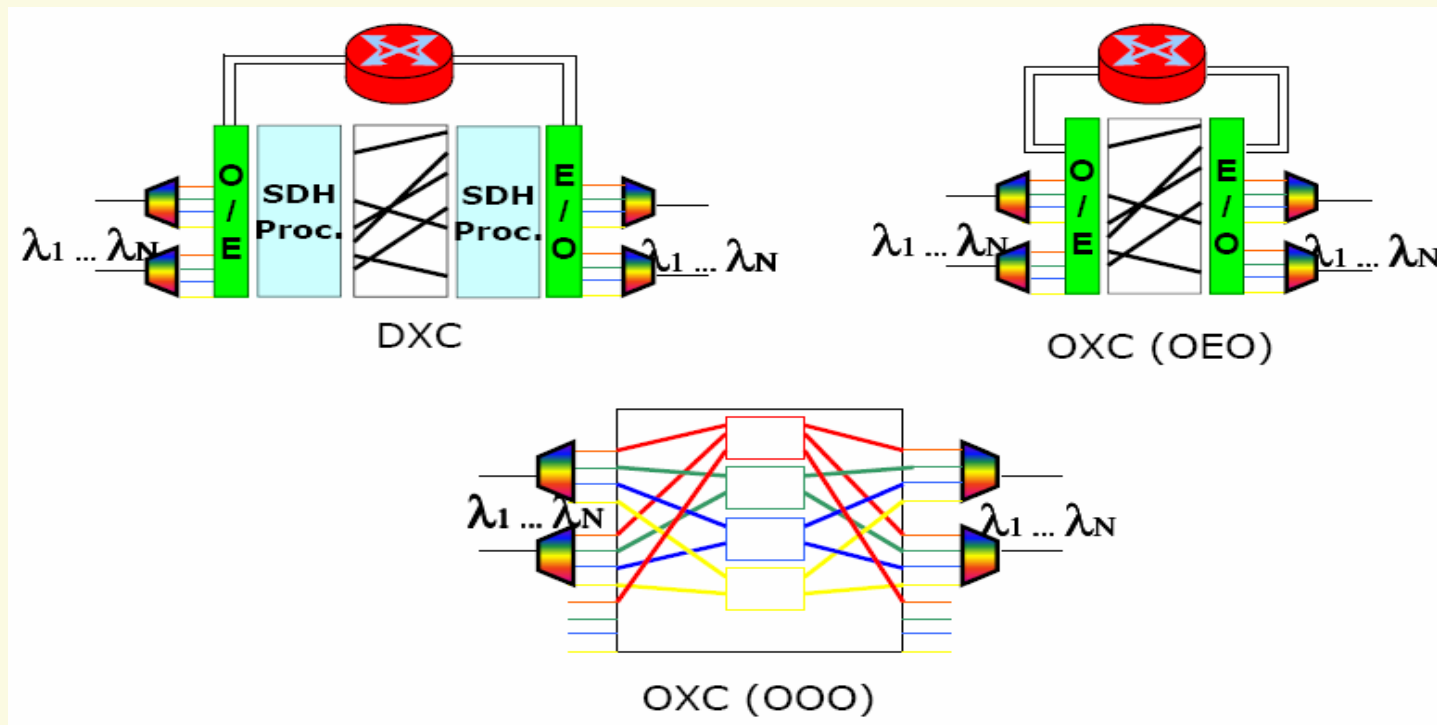
● DXC

- Uses a combination of space and time switching stages. Time switching give tight bonds to SDH and PDH multiplexing formats. Finest granularity 64k -1/0, VC-12 – 4/1, VC-4, 4/4

● OXC

- Only space switching typically of 2.5G or 10Gb/s channels. Can be designed with two types of matrix technology.
 - OEO
 - Utilising an electrical switching matrix
 - OOO
 - Utilising a pure optical switching matrix

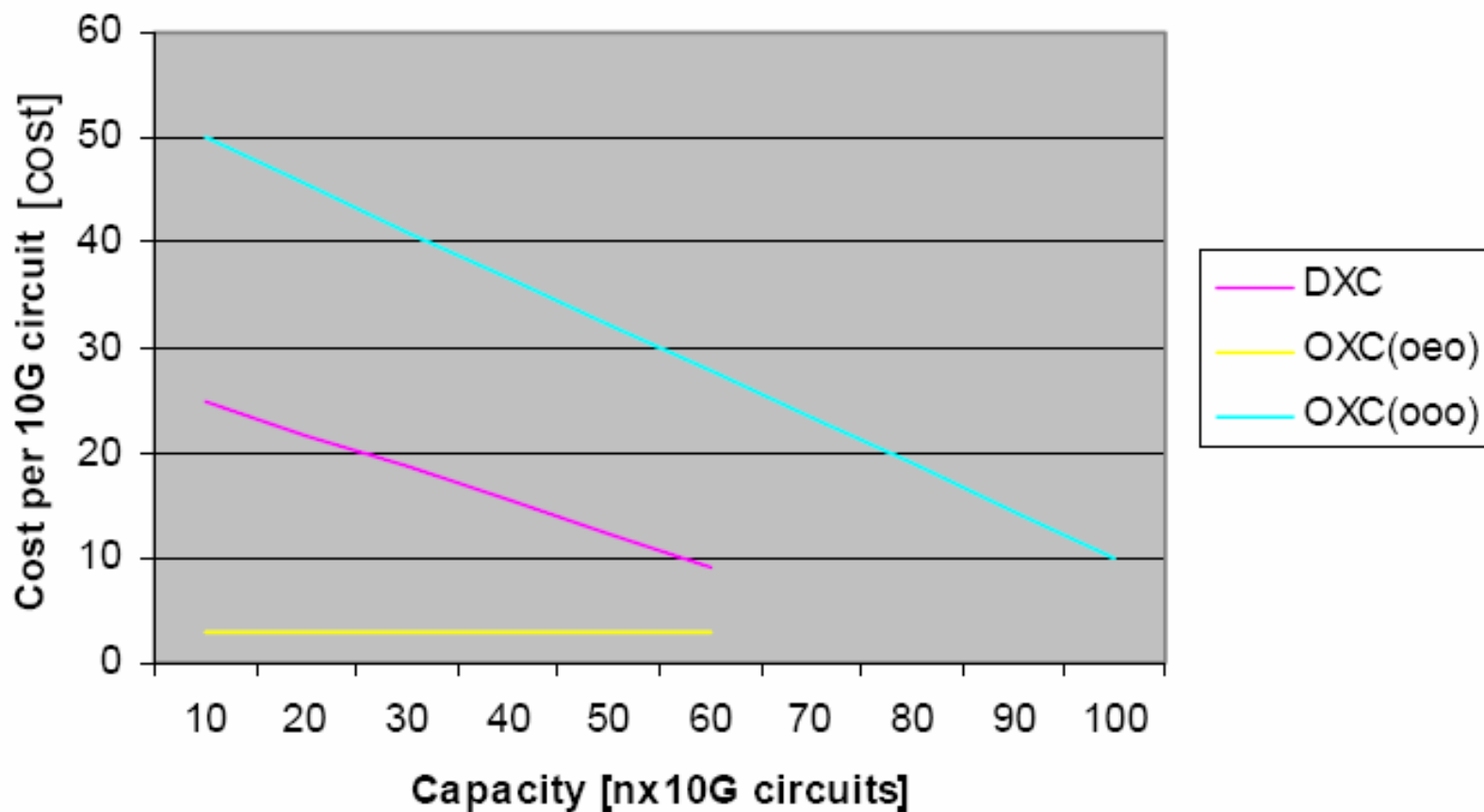
三种交叉连接技术



- ❑ **DXC:** 在电域采用空间交换和PDH和SDH数字交叉连接设备，交换粒度64K, 1.55M, 2M, 具有最大的组网灵活性，但速率限制在2.5G以下
- ❑ **OXC(OEO):** 仅在电域完成空间和波长光交换，交换粒度2.5~10G, 具有较好的透明性，但交换容量受电子设备处理速度的限制
- ❑ **OXC(OOO):** 仅在光域完成空间和波长交换，交换粒度2.5~10G, 具有Tb/s的交换容量，对信号透明，潜在的低建设和维护成本



目前的成本





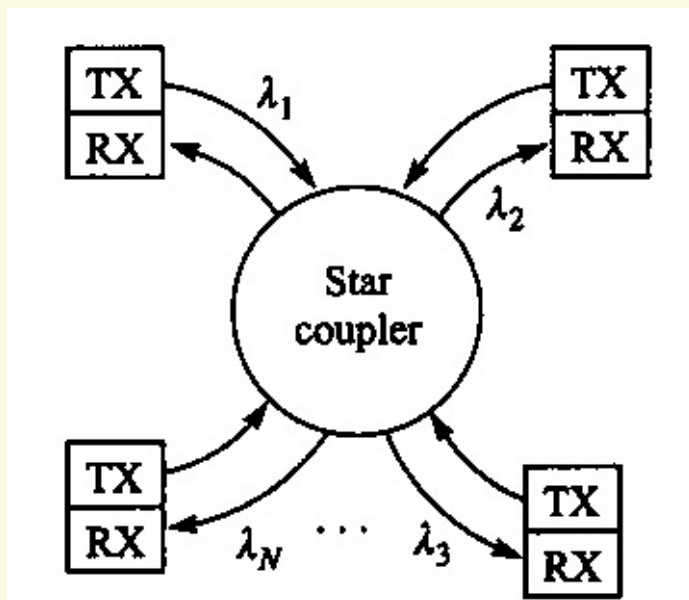
波长交换光网络



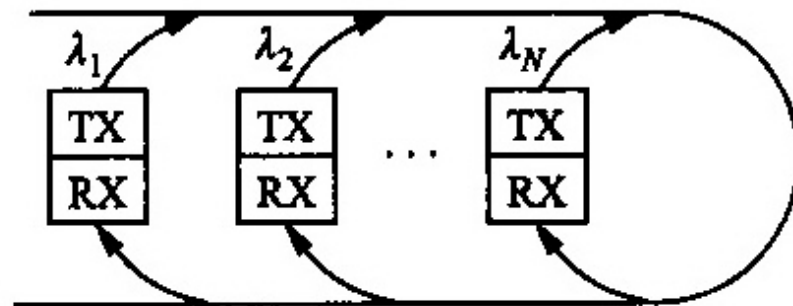
波长路由全光网络概况

- Current state:
 - Pseudo-static virtual topology
 - Off-line design
 - » Routing and Wavelength assignment (RWA)
 - » Wavelength conversion: dense, sparse, full, limited
- Emerging: Intelligent Optical Networks (ION)
 - Rapid provisioning and restoration of connections
 - Dynamic virtual topology
 - Requires intelligent and unified control plane

广播选择网络 (Single-Hop)



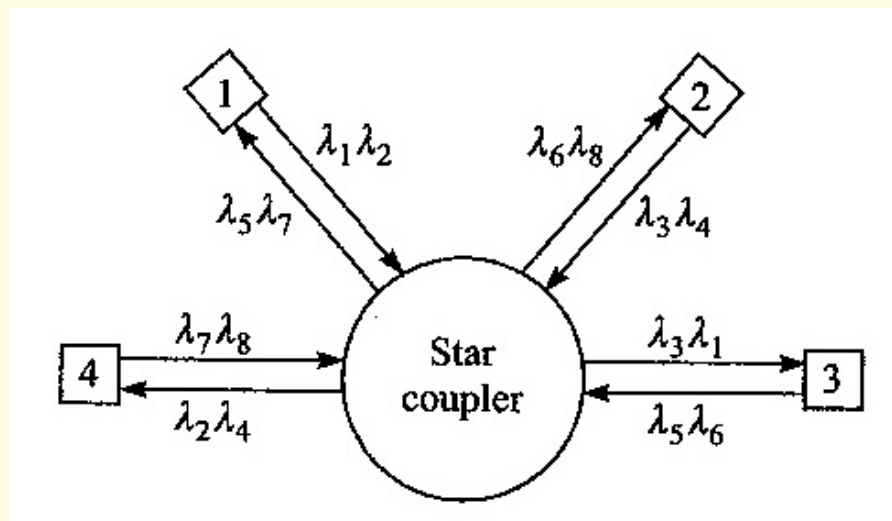
无源星型网络



无源总线型网络

- 网络结构简单
- 在通信开始前需要告知接收端以设定其滤波器状态
- 需要解决冲突问题

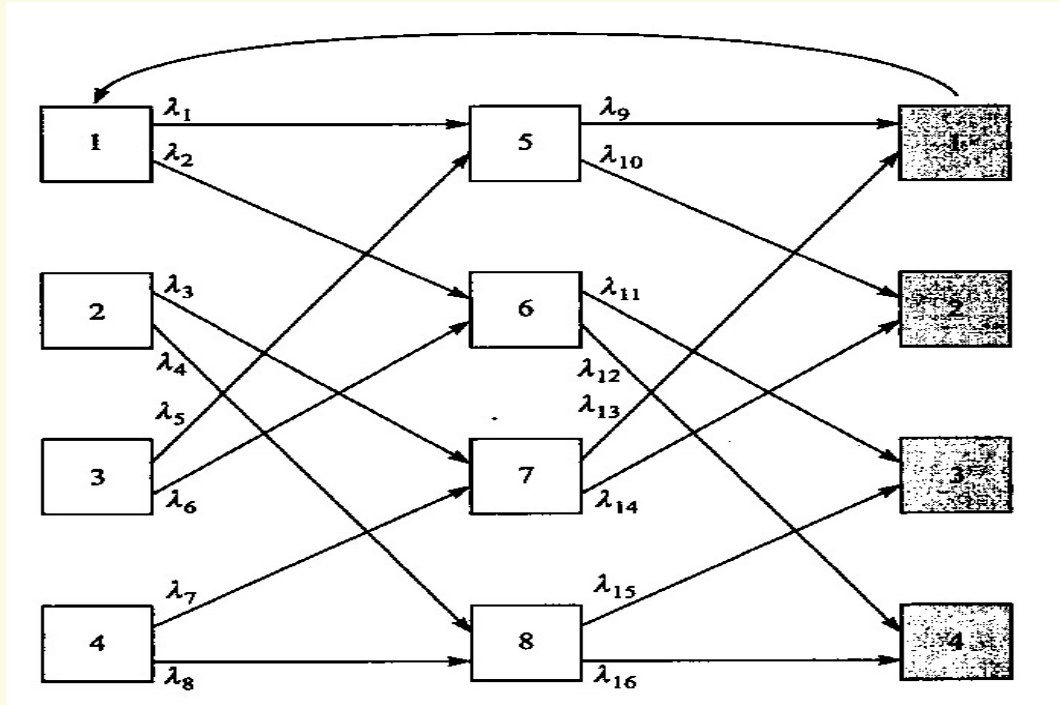
广播选择网络 (Multi-Hop)



星型（环形逻辑）网络

- 对每个节点进行适当的固定波长分配
- 节点仅需在少量波长上进行切换，无须快速波长调谐
- 冲突问题得到缓解
- 需要进行多次交换

光混洗网 (Shuffle Net Multi-Hop)



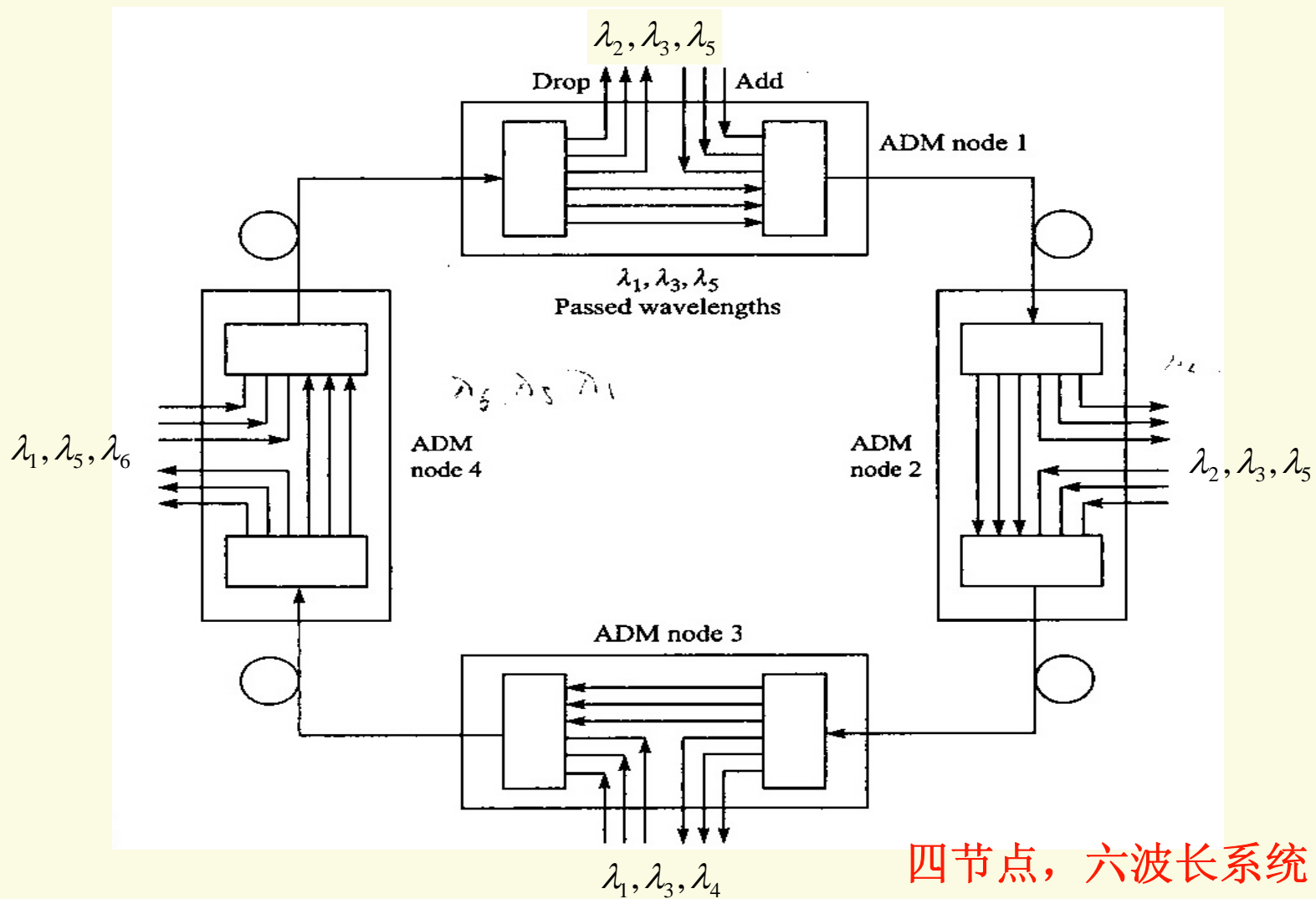
$$(p, k) = (2, 2)$$

p : 每个节点上的固定收发器对的数目; k : 节点的列数

支持的总节点数: $N = k p^k$

需要的总波长数: $N_\lambda = k p^{k+1}$

环形波长路由网络





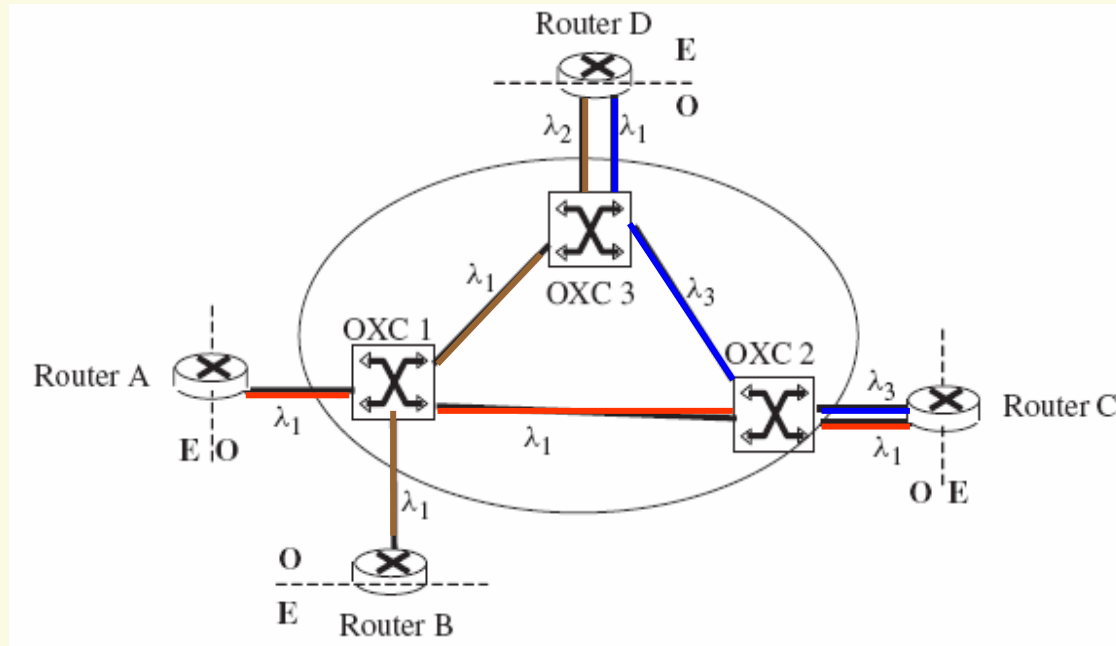
可重构波长路由网络



Lightpaths of the Wavelength Routing Optical Networks

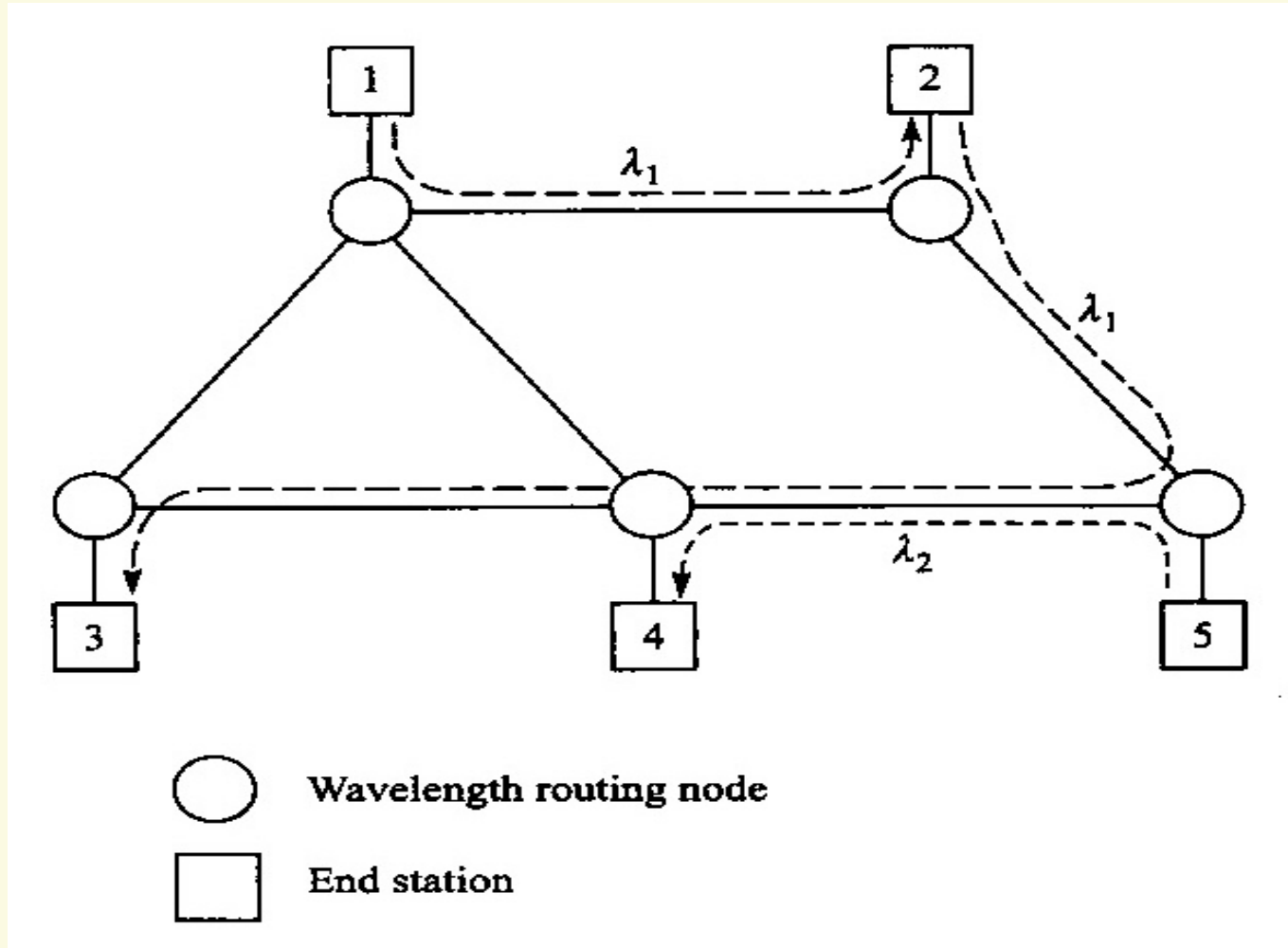
- **Circuit-switched network.**
- **This connection is a circuit-switching connection and is established by using a wavelength on each hop along the connection's path.**

Examples



- Lightpaths from router A to C over OXCs 1 and 2; from B to D over OXCs 1 and 3; and from C to D over OXCs 2 and 3.
- OXC 3 contains wavelength converter
- Assumed single fiber carrying W wavelengths,
- Unidirectional transmission.

Examples





分组交换光网络



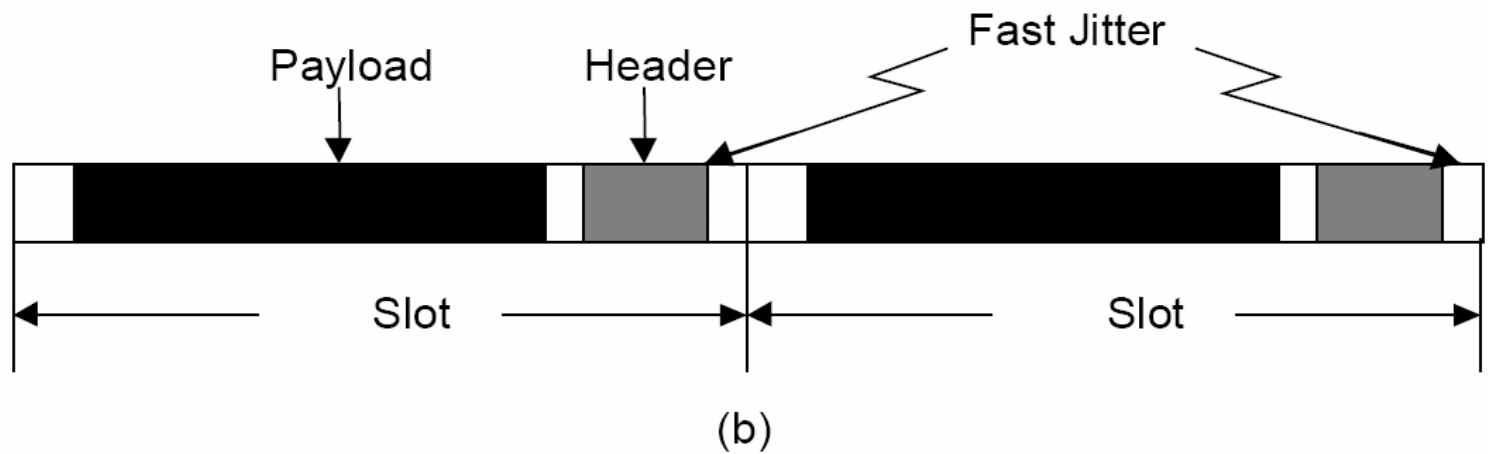
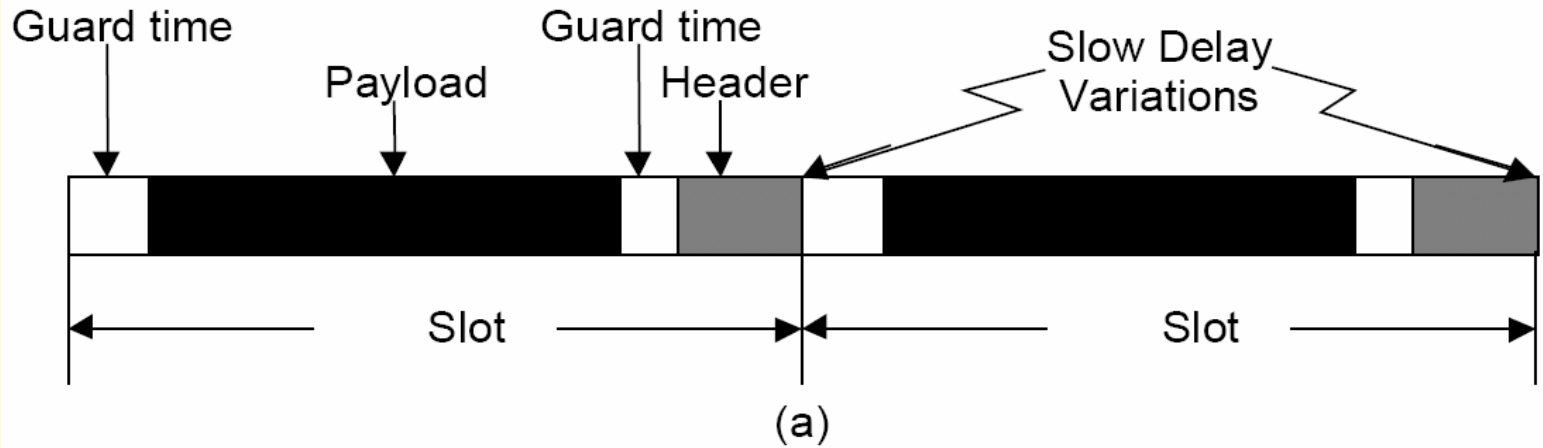
光数据分组

 Positioning of header, payload and guard times.

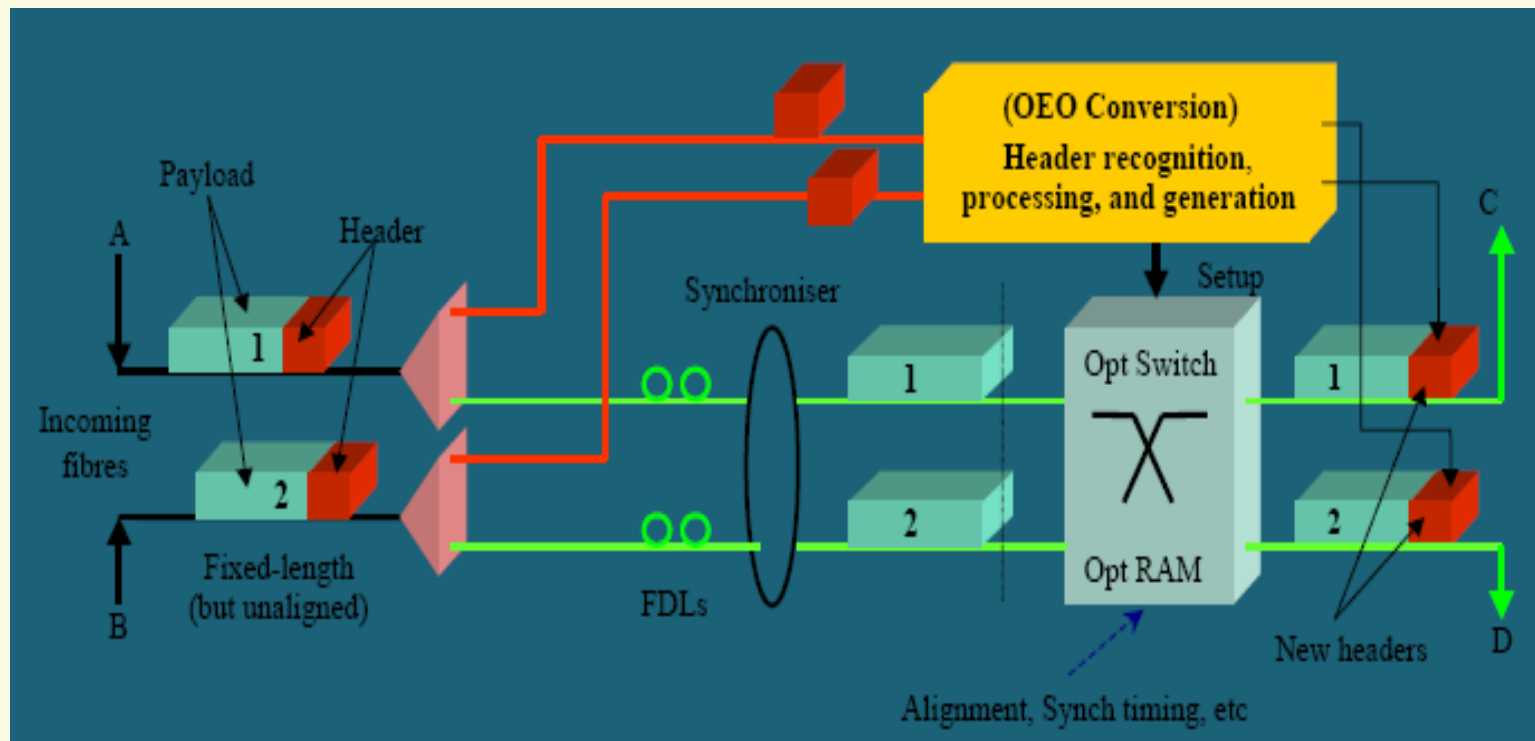
 Two main cases

- Headers define the beginning of timeslots. Guard time between header and payload as well as after the payload.
- A guard time is placed between the beginning of the slot and the header.

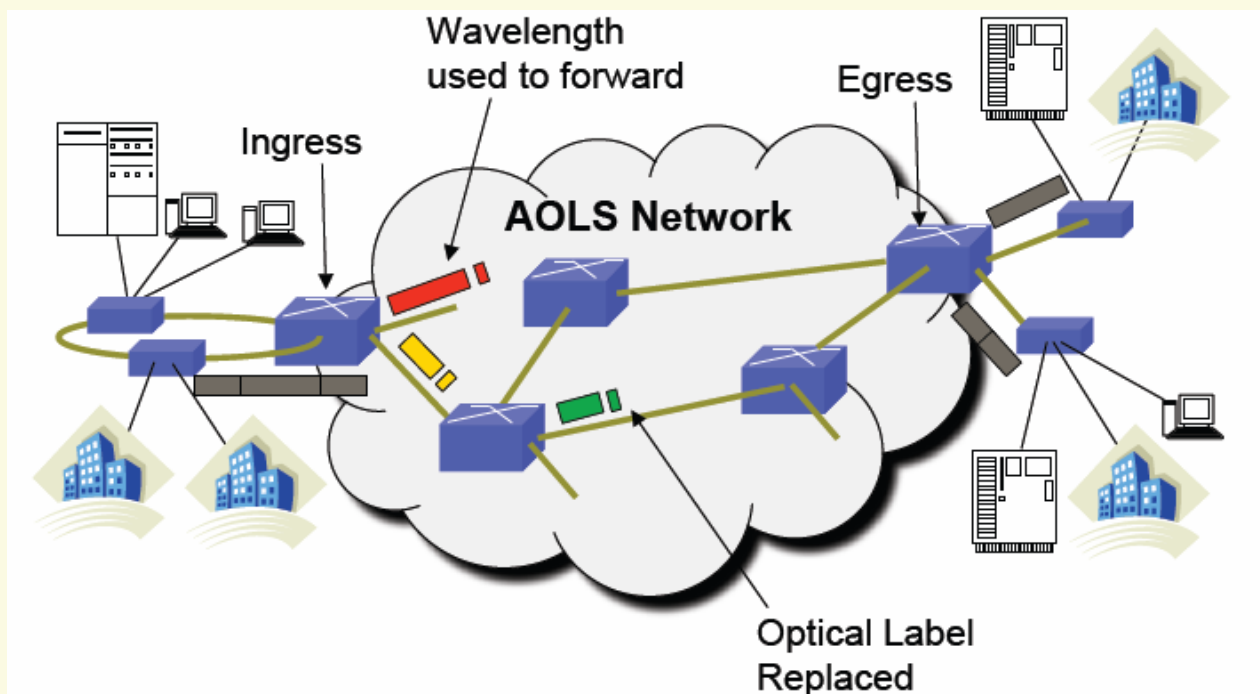
光数据分组格式



光分组交换节点



光标记交换网络



关键技术：

- 光标记的写入、读取和擦除技术
- 光分组的同步与缓冲存储技术
- 路由冲突的处理与控制

目前，尚有很多极具挑战性的关键技术问题需要解决！



突发交换光网络



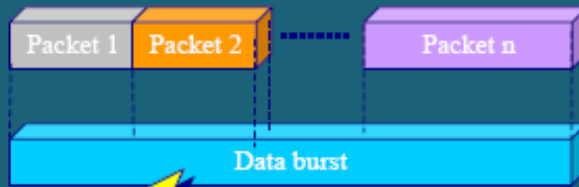
光突发交换

- ❏ 低速控制信号在专用波长信道中传输
- ❏ 在节点上控制信号被转变为电信号实现控制功能
- ❏ 发送突发分组前，先由控制信号进行资源和路由预定
- ❏ 类似于ATM技术



OBS: an interim solution?

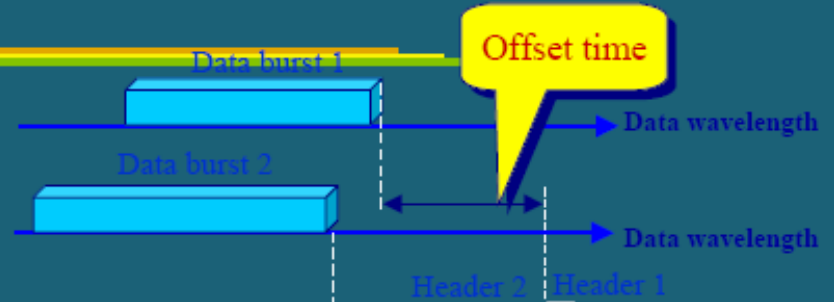
- Same destination
- Same packet type



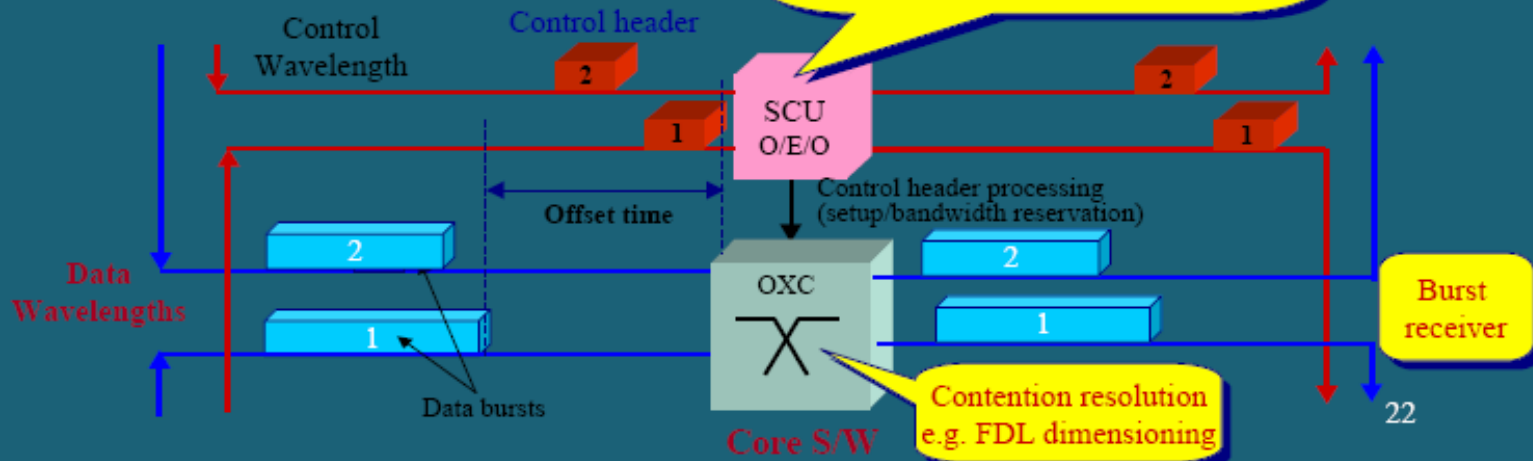
Edge device: "Burstification"

- Burst assembly
- Offset time management

- +
- Control Header
 - burst duration
 - offset time
 - src/dest addr
 - QoS parameters



- Control scheduling
- Data scheduling
- Protection & Restoration
- Resv' Mech' & Contention resolution





Summary

Looking into the future



Mems Optical Switches

- Micro-electro-mechanical-system
- Movable torsion mirrors to redirect propagation direction of light.



Optical Tag Switching

- Invented to simplify router processing by assigning a label to packets.



Summary

Looking into the future

Photonic Slot Routing

- Packets transmitted in the same time slot on all wavelengths are switched jointly.

Optical Burst Switching

- Data burst, consisting of multiple packets, sent after a control packet has reserved the necessary resources.



Comments

- ☞ Optical networks offers extremely high transfer rates.
- ☞ Still need for a lot of research.
- ☞ Often complicated and expensive hardware.
- ☞ Header processing is one of the greater bottlenecks.