

SPARTAN Meeting in Kansas

Optical Network Architecture & Protection Switching Scenarios

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Contents of Talk

1) Future WDM Based

Network Evolution

2) General Issues

3) Protection Architecture Issue

NEC's proposal of

**4 Fiber Bi-directional/Wavelength
path based WDM ring**

Objectives

To achieve flexible/reliable/cost-effective photonic network with open architecture



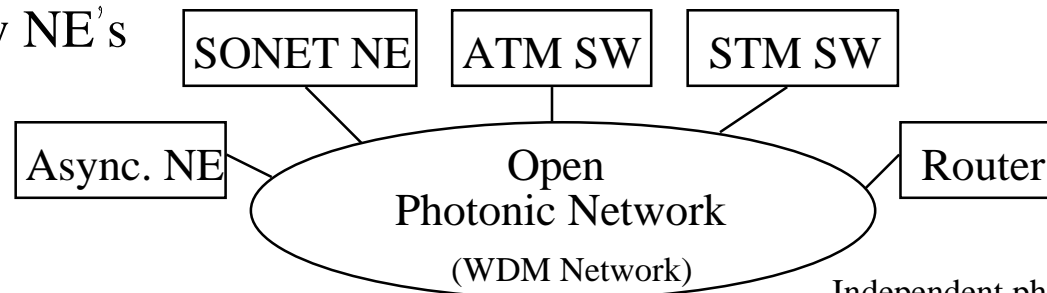
More cost-effective multi-layer network (photonic router, photonic ATM, etc)

flexible :software configurable wavelength allocation

reliable :high-speed(msec order) protection

network:ring/mesh, etc. with EMS

open :connectable to any NE's

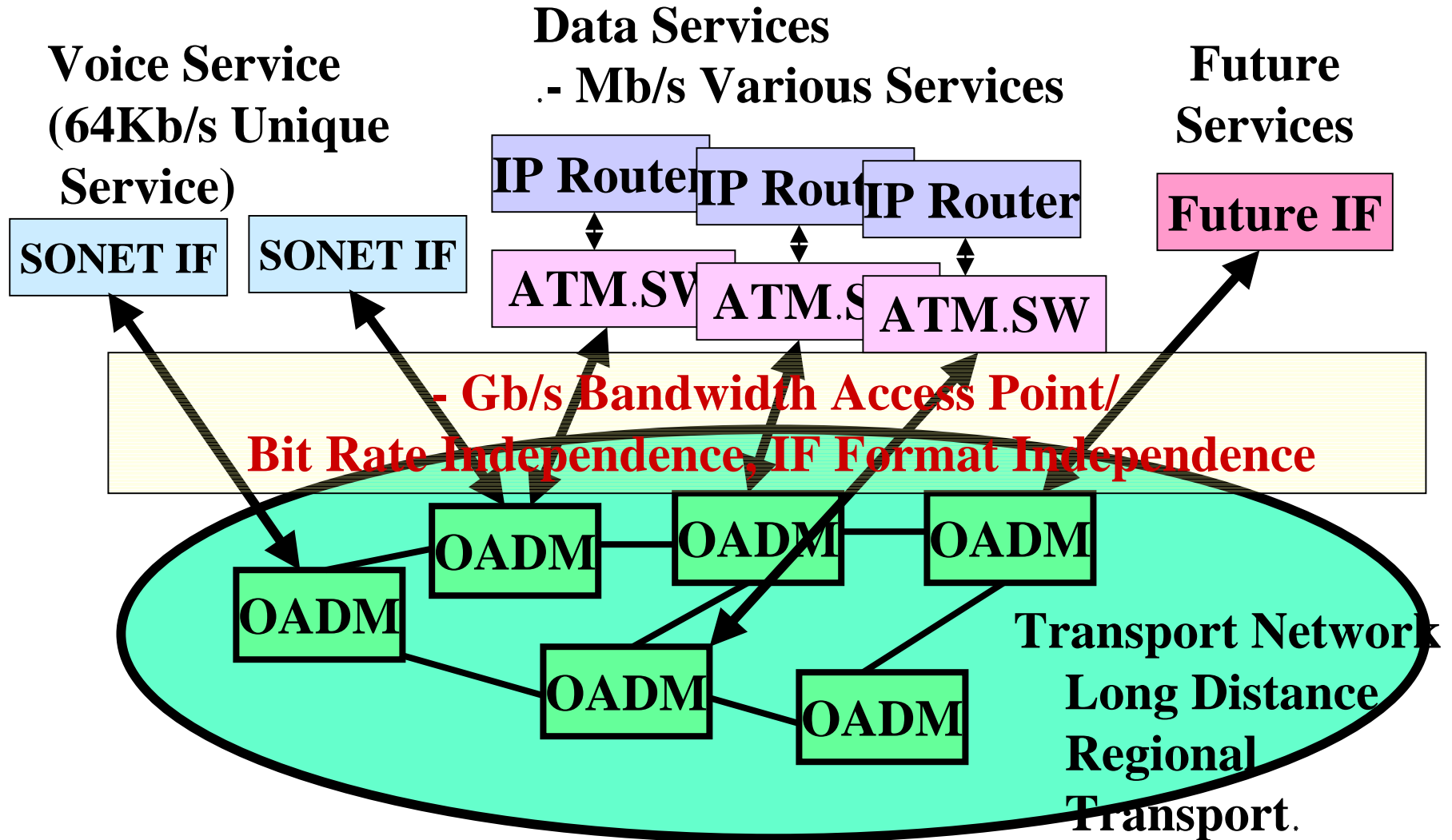


Independent photonic layer

- Reconfiguration
- Protection
- MUX/DEMUX

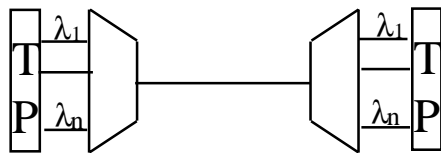
New Transport Architecture

- NEC Proposal -



NEC's Proposal on WDM Network Road Map

Present
Point-to-Point



TP: Transponder

Features:

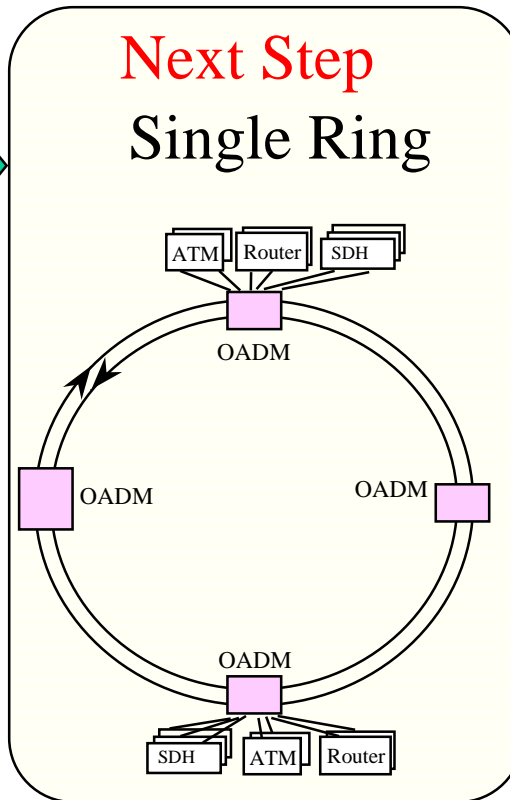
- **DWDM** and ILA

Advantages:

- Low-cost bandwidth increase



Next Step
Single Ring



Features:

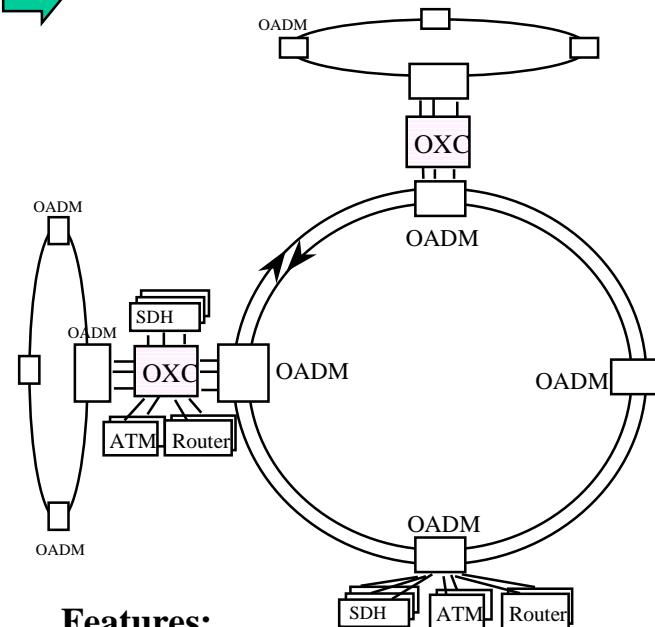
- OADM ring with **fast protection**
- Wavelength path based protection

Advantages

- Low-cost accommodation of any NEs (direct OADM and ATM/Router connection)



Photonic Network Era
Multiple Rings



Features:

- **OXC**, network design

Advantages:

- Wide deployment of photonic network
- OXC/Photonic switch (Photonic router, Photonic ATM)

General Issues

- **Role of New Transmission/Switching Network**

 - Create New Simple/Cost-effective Network

- **Protection Architecture**

 - Ring protection(OADM) / Mesh restoration(OXC)

- **Network Management Issues**

 - Fault/Configuration/Performance (Information Modeling)

 - ex. Fault isolation, Performance monitoring

 - Account/Security

Others....

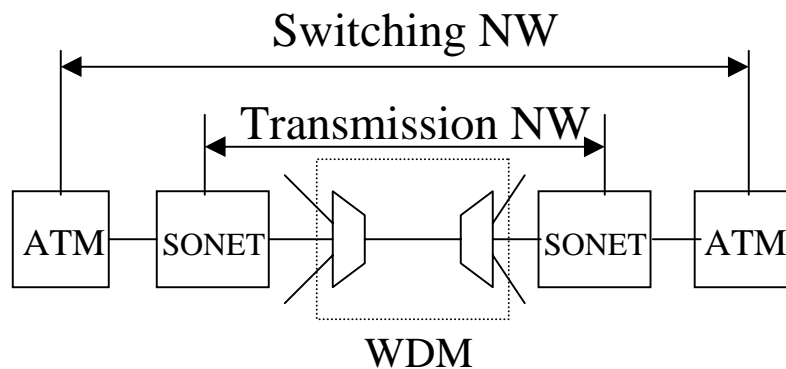
 - Interface Issues

 - Network design/Cost evaluation

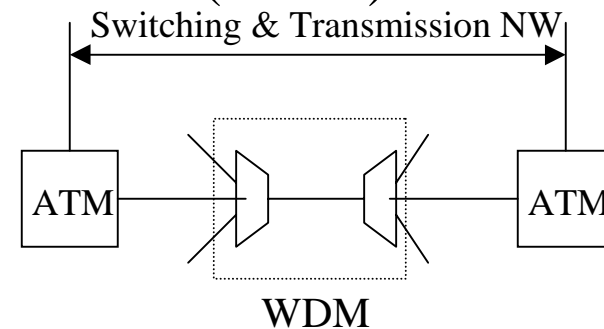
WDM Network Architecture Future Issue

Role of TR & SW NW (Client: ATM SW case)

Current Configuration



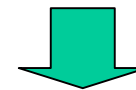
ATM over WDM Configuration (NEW)



- | | | |
|---|----------------------------|---|
| <ul style="list-style-type: none"> • Network protection is provided by SONET • Transmission line is terminated by SONET <ul style="list-style-type: none"> • Synchronization • PMs, Alarms • WDM is a simple transport pipe | <p>→</p> <p>→</p> <p>→</p> | <ul style="list-style-type: none"> • WDM & ATM protection • Simple LTE function by WDM NE <ul style="list-style-type: none"> • Pointer processing? • What kind of PMs, Alarms? • New WDM transport network |
|---|----------------------------|---|



Transmission network & Switching network
are completely separated. →



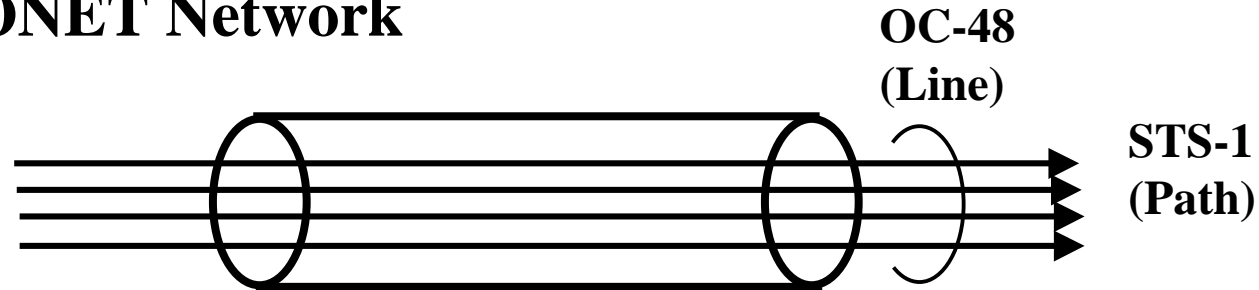
**Clear role definition of new transmission
& Switching network is necessary.
How to make a simple and
cost effective transport ???**

Protection Architecture

Ring protection (OADM-based)

Path and Line in SONET/WDM Network

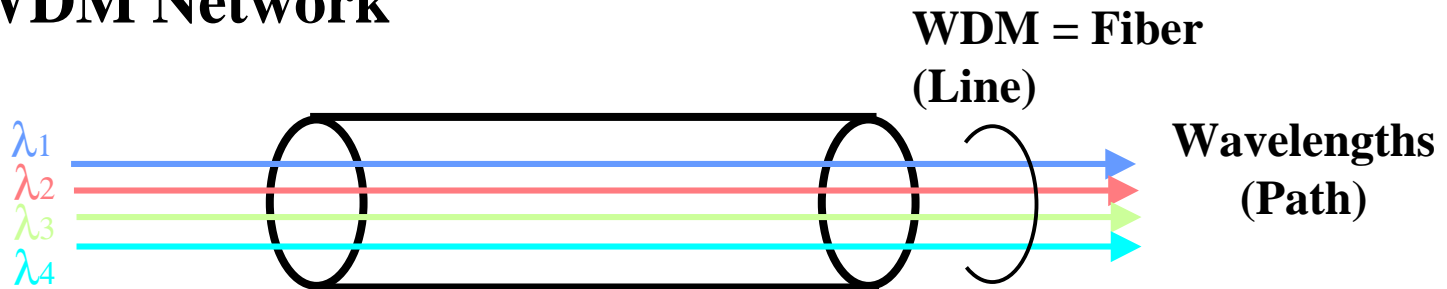
a) SONET Network



Optical Fiber

- Line Monitoring (B1 monitoring)
- Individual Path monitoring

b) WDM Network



Optical Fiber

- Line Monitoring (?)
- Individual Path monitoring based

WDM Self-healing Ring Category

Working Allocation Protection unit	Uni-Directional (U)	Bi-Directional (B)
Wavelength Path Protection (WP)	1+1 Protection Easy to realize	1:1 Protection
Fiber Line Protection (FL)	Not Effective	1:1 Protection

3 categories : UWPSR /BWPSR/BFLSR

Comparison among WDM Self-Healing Ring Network

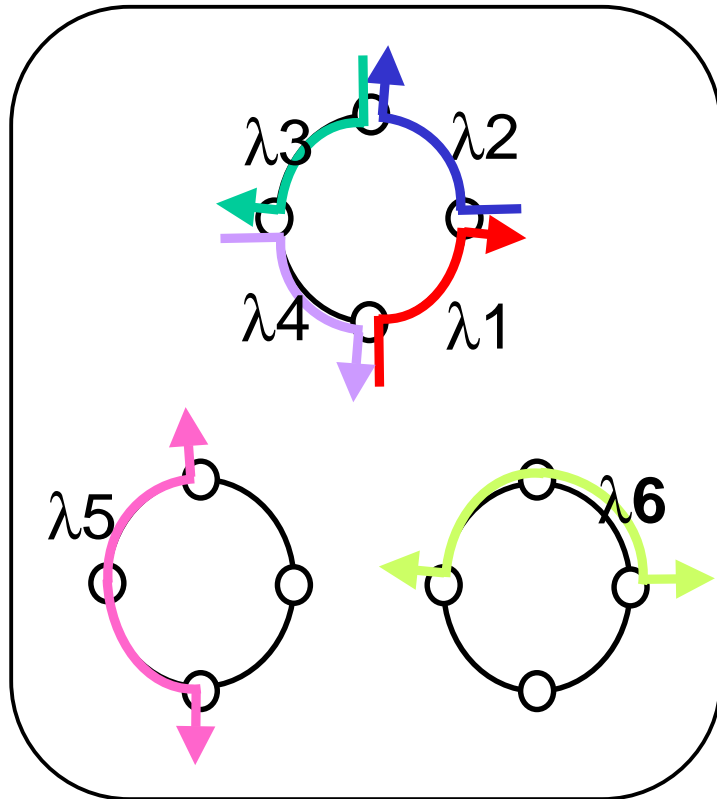
	Bi-Directional Fiber Line Protection (BFSR)	Uni-Directional Wavelength Path Protection (UWPSR)	Bi-Directional Wavelength Path Protection (BWPSR)
Wavelength Path Utilization Star DP* Mesh DP Cyclic DP	Excellent (Good Excellent Perfect (1 wavelength))	Good (Good Good Fair)	Excellent (Good Excellent Perfect (1 Wavelength))
Initial NEs Cost (Initial Installation Cost for near Future Demand)	Fair	Good	Fair
Protection Speed	Good	Excellent	Good
Ring Length without Regenerators	Fair	Good	Good
Reconfiguration after Failure Recovery	Necessary (Revertive)	Not Necessary (Non-Revertive)	Necessary (Revertive)

* DP:Demand Pattern

Efficient Wavelength Accommodation(1)

Mesh Connection Demand Pattern Case

Uni-Directional Ring

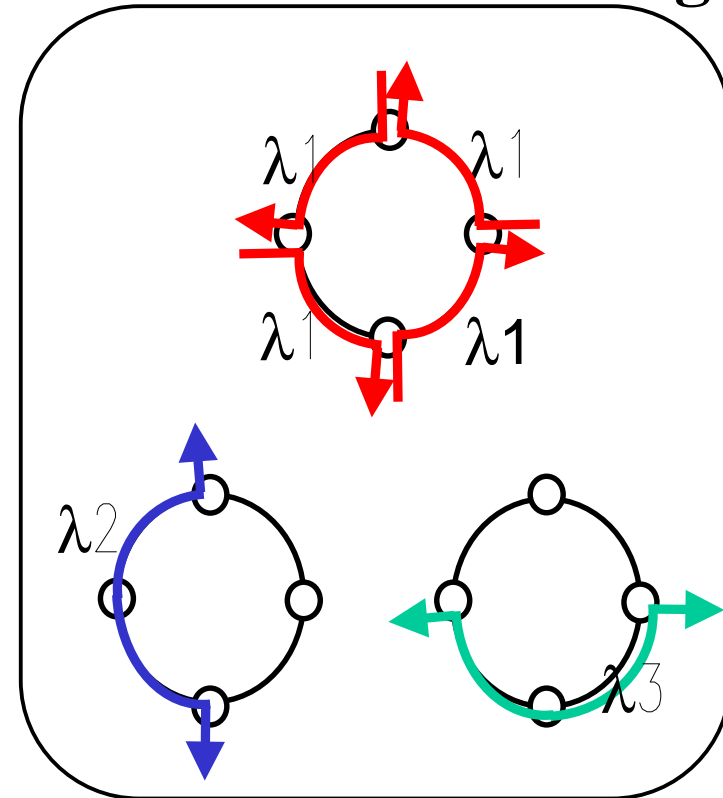


Dedicated 1+1 Protection

6 Wavelengths

UWPSR

Bi-Directional Ring



Shared 1:1 Protection

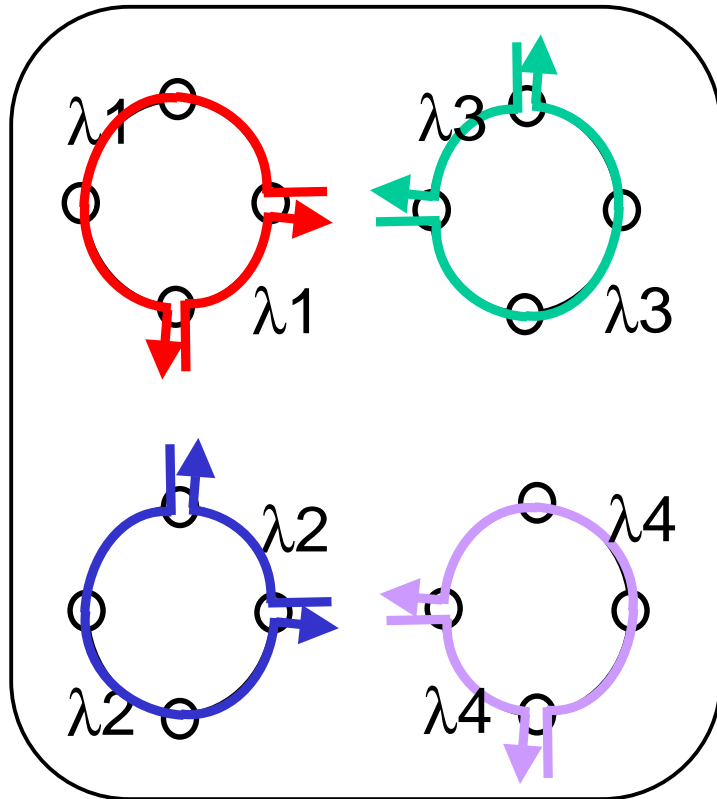
3 Wavelength

BWPSR/BFLSR

Efficient Wavelength Accommodation(2)

Cyclic Demand Pattern Case

Uni-Directional Ring

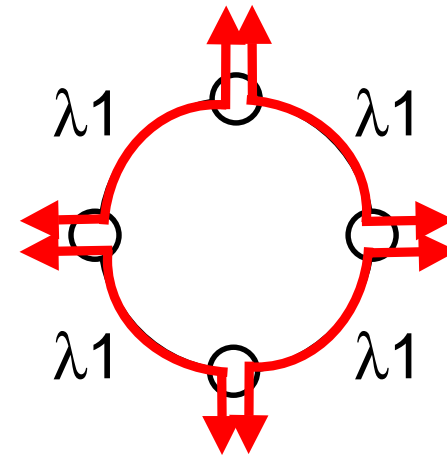


Dedicated 1+1 Protection

4 Wavelengths

UWPSR

Bi-Directional Ring



Shared 1:1 Protection

1 Wavelength

BWPSR/BFLSR

Wavelength Accommodation Efficiency

(Necessary wavelength numbers vs. node number n)

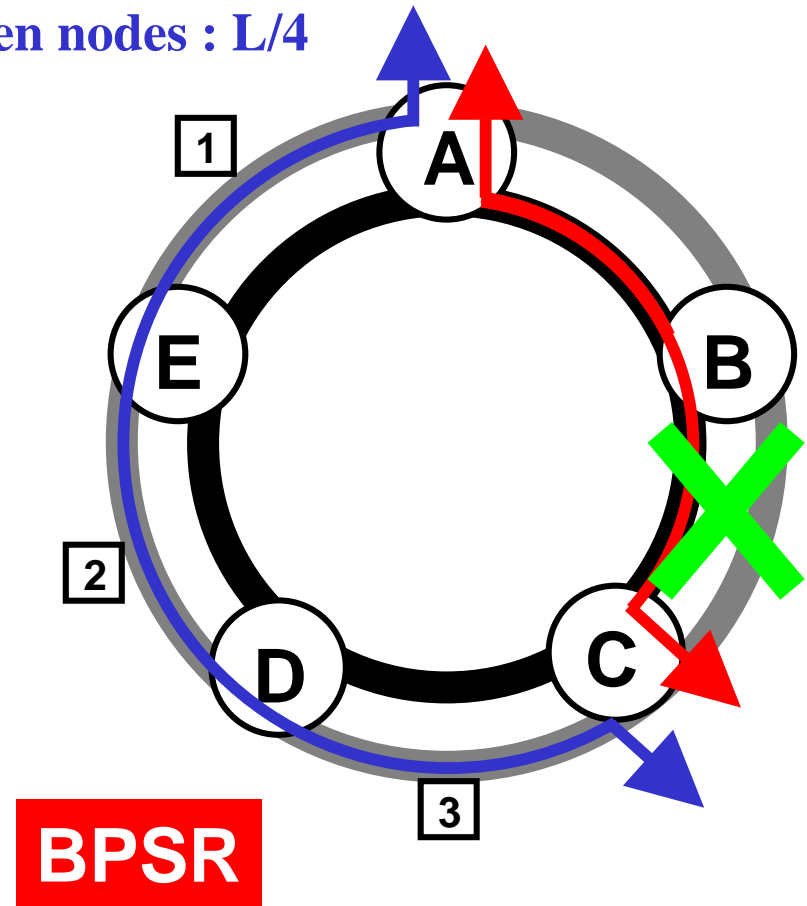
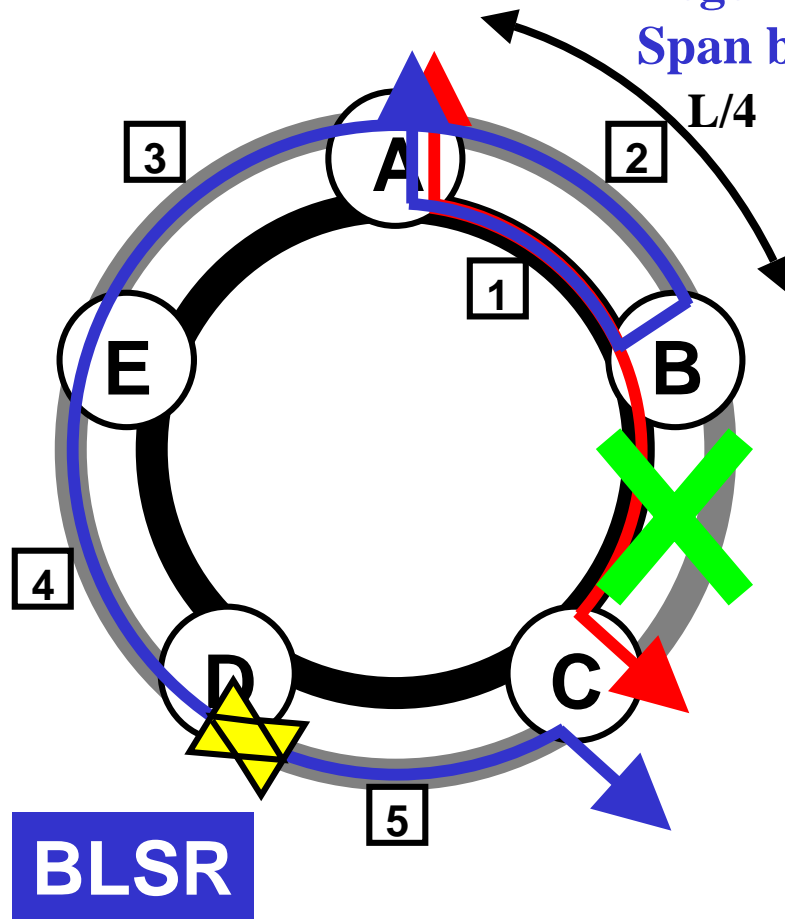
	UWPSR(2F)	BFLSR(4F)	BWPSR(4F)
Cyclic type demand pattern	n Fair	1 Perfect	1 Perfect
Star type demand pattern	n-1 Good	(n-1)/2 n: odd n / 2 :even Good	(n-1)/2 n:odd n / 2 :even Good
Mesh type demand pattern	n(n-1)/2 Good	(n+1)(n-1)/8 n: odd n(n+2)/8 n: even Excellent	(n+1)(n-1)/8 n: odd n(n+2)/8 n:even Excellent


Regenerator Spacing Consideration

Evaluated Example

Regenerator span : L

Span between nodes : $L/4$



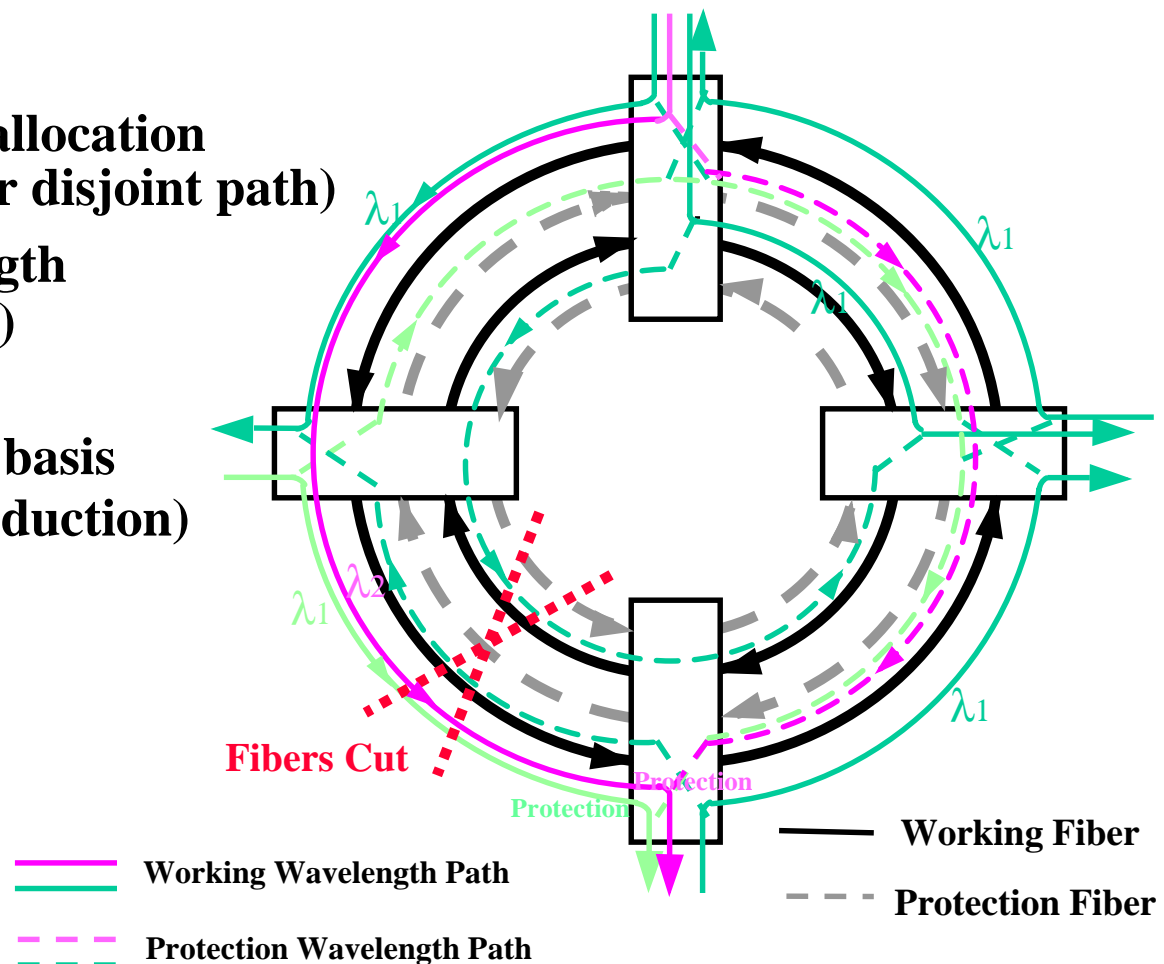
 : Regenerator (O/E, E/O conversion)

NEC's WDM Ring Proposal

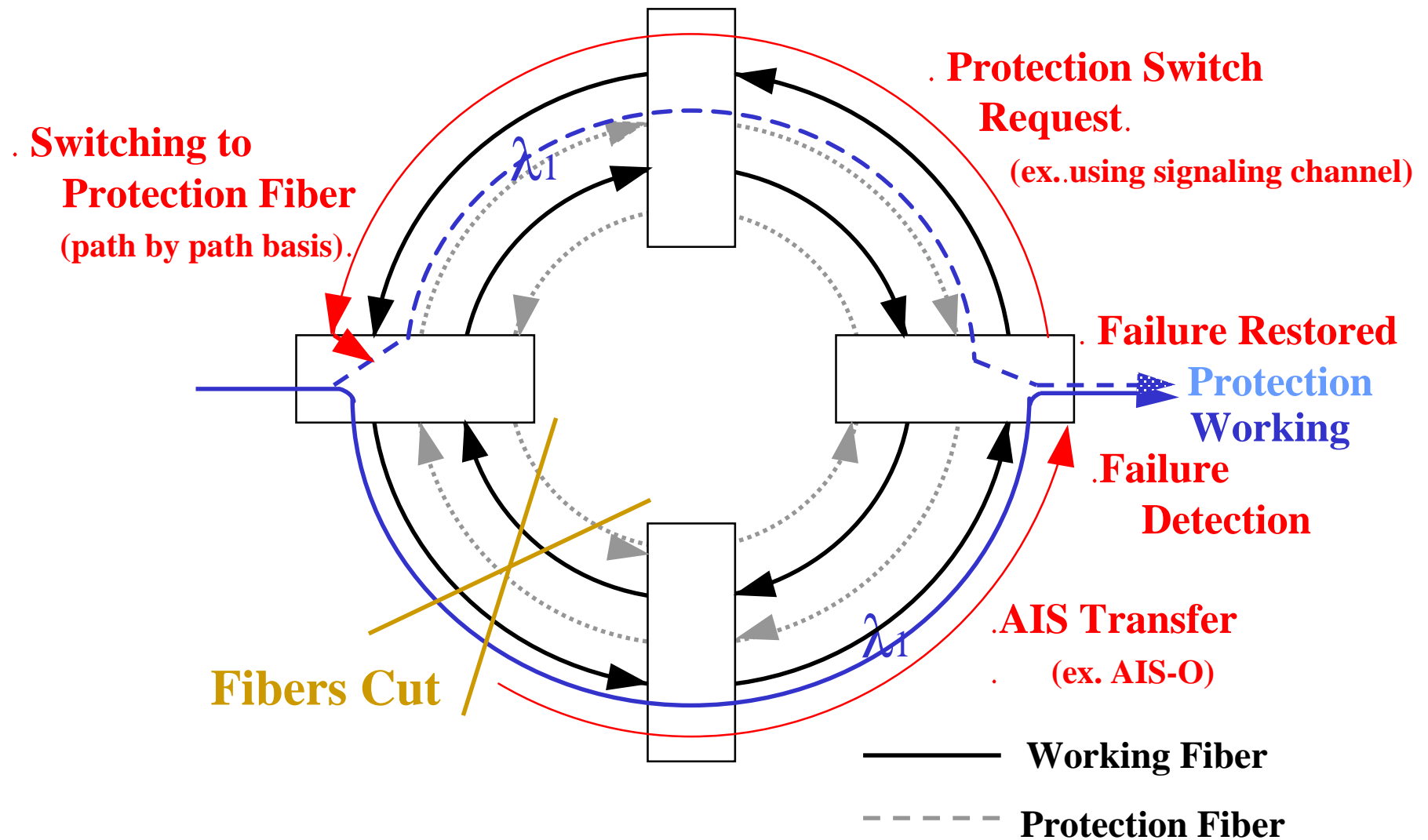
4 Fiber Bi-Directional/Wavelength-Path based WDM Ring (4 Fiber BWPSR)

Good points:

- Efficient wavelength allocation
(wavelength reuse for disjoint path)
- Expansion of ring length
(no loop-back switch)
- Smooth introduction
(on each wavelength basis introduction)



Protection Operation Process for Bi-directional/Wavelength-based Protection Network



Summary

1. **WDM Ring Network with Self-healing Functions** are discussed. (Ring Network base.)
 - .B(F)LSR
 - .U(W)PSR
 - .B(W)PSR (NEC's proposal)**
2. **B(W)PSR is the best solution** for the future capacity explosion.
3. **Clarification of WDM Self-healing transport networks' role is necessary to be discussed.**