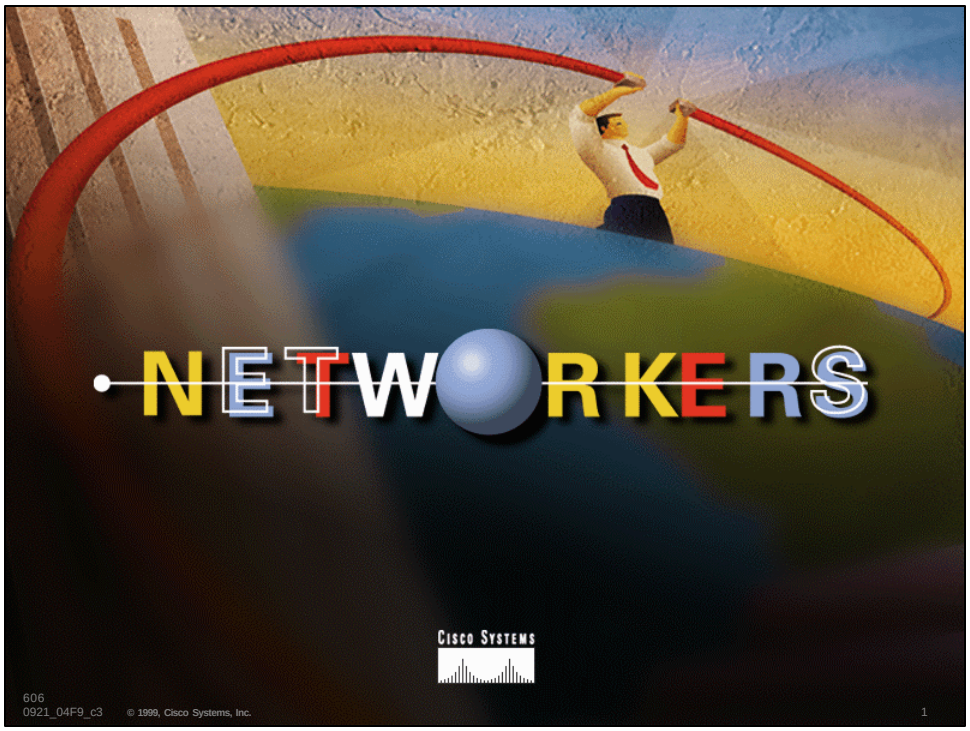
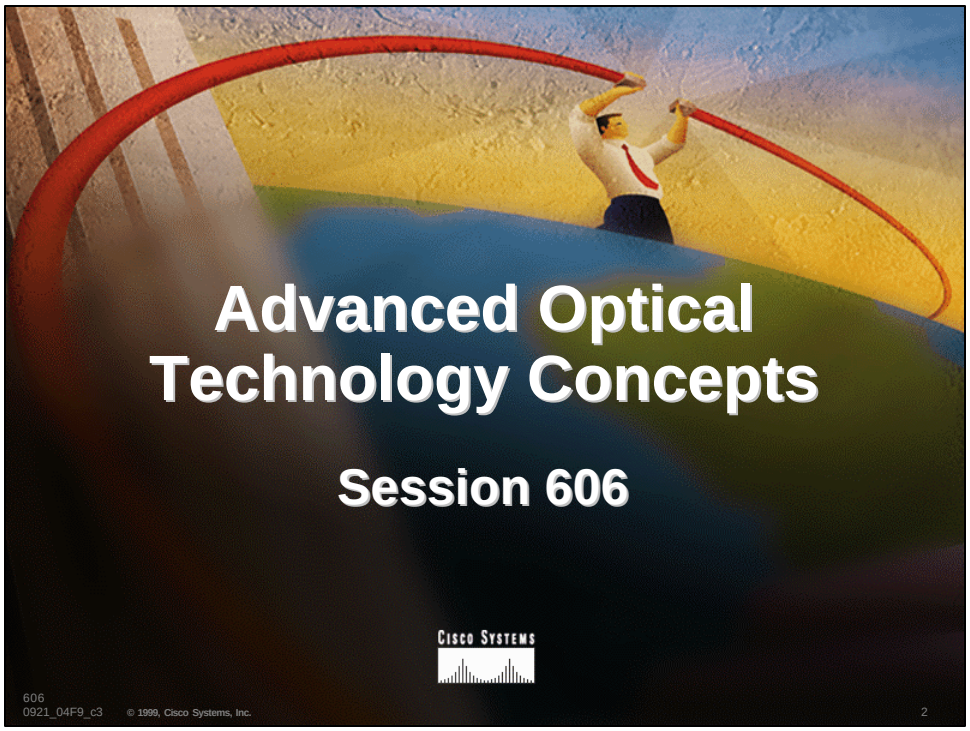




DPT Agenda

- Overview
- SRP Protocol and Features
- Clocking and Synchronization
- Configuration
- Application
- Products

DPT Overview

- Cisco patent pending technology
- New MAC for LAN, MAN and WAN application

  Spatial Reuse Protocol (SRP)
- Based on ring—dual counter rotating ring
- Scalable bandwidth

DPT Overview

- Spatial reuse
- Multicast support
- Support traffic prioritization
- Multiple nodes can transmit simultaneously

DPT Overview

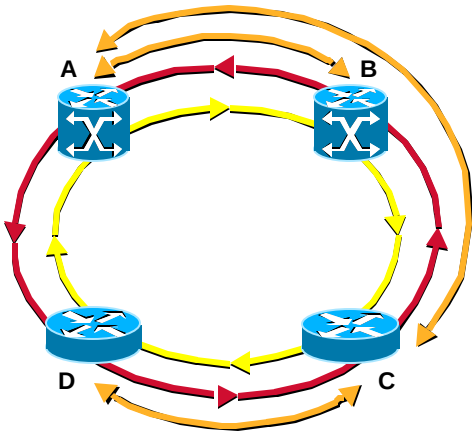
- Uses the SRP fairness algorithm (SRP-fa) to control access to the ring and enforce fairness
  - No token—unlike Token Ring or FDDI
- Scalable to large number of nodes on the ring
  - Unlike SONET/SDH

DPT Overview

- **Uses SONET/SDH framing**
  - **SRP runs in a concatenated SONET/SDH frame**
- **Intelligent Protection Switching (IPS)**
  - **Survivability in the event of fiber facility or node failure, or signal degradation**
- **Plug-and-play operation**

Spatial Reuse

- **The SRP protocol derives it's name from the spatial reuse capability**
- **Concept used in rings to increase overall aggregate bandwidth**
- **Unicast packets travels along ring spans between the src and dest nodes only**
  - **Destination stripping**

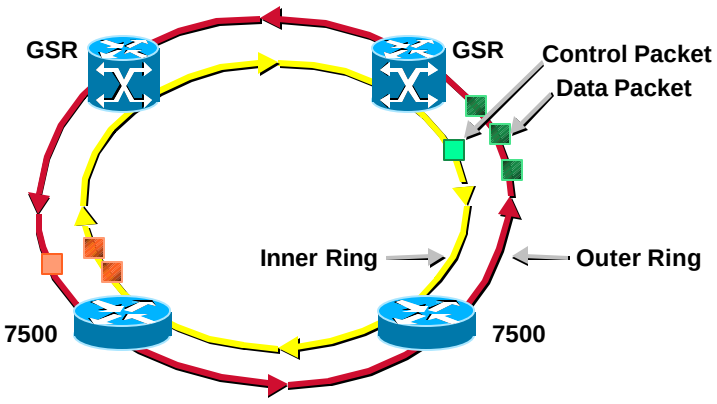


DPT Ring

- A DPT ring is a bi-directional dual counter rotating ring
- The rings are referred to as Outer and Inner rings
- Both rings are used to transport data and control packets

  Data packet is sent in one direction and the corresponding control packet is sent the opposite direction

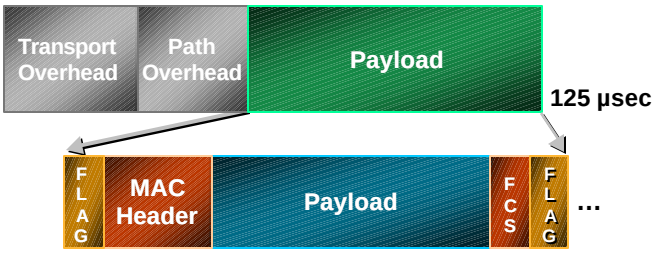
DPT Ring



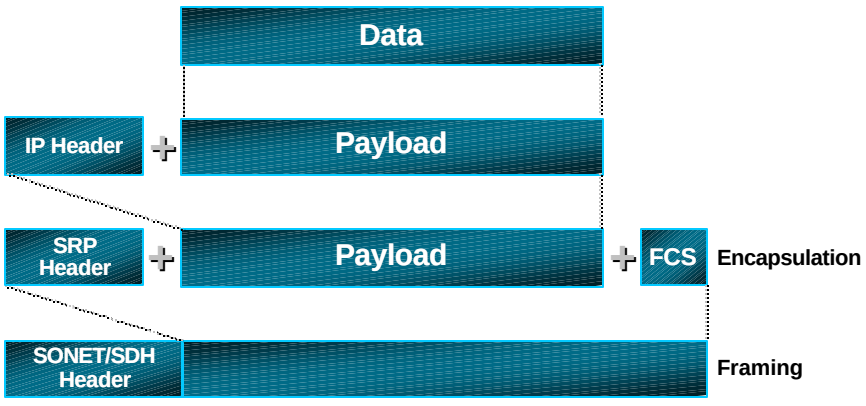
Example of a 4 Node DPT Ring

SRP Packet

- SRP is a media independent MAC layer protocol
- The initial implementation utilizes SONET/SDH framing
- Concatenated payloads only



SRP Packet



SRP Packet Format

- There are currently two versions of the SRP MAC packet header

  Version 1 and 2

- Version 1 is currently in use
- Version 2 is an enhancement to version 1

SRP v1 Generic Header

- **Time to Live (TTL)**
  11 bit hop count field; decremented each time a node forwards a packet; if the TTL reaches zero the packet is stripped from the ring
- **Ring Identifier (RI-bit)**

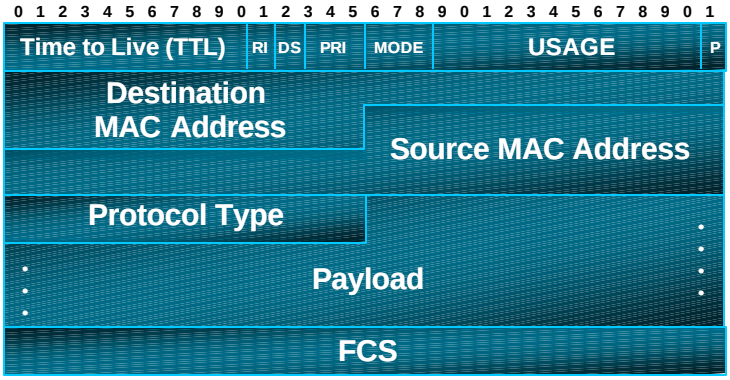
0	Outer Ring
1	Inner Ring

- **Destination Strip (DS-bit)**
  DS == 1 Destination strip
  DS == 0 Source strip
- **Priority Field (PRI)**
  Indicates the priority level of a SRP packet; valid values 0–7, with higher values indicating higher priority
- **Mode**

Value	Description
000–011	Unused
100	Topology Control Message
101	Protection Switching Control Message
110	MAC Keepalive Control Message
111	Reserved

- **Usage**
  SRP-fa bandwidth information
- **Parity Bit**
  Odd parity over previous 31 MAC header bits

SRP v1 Data Packet Format



SRP v1 Fields

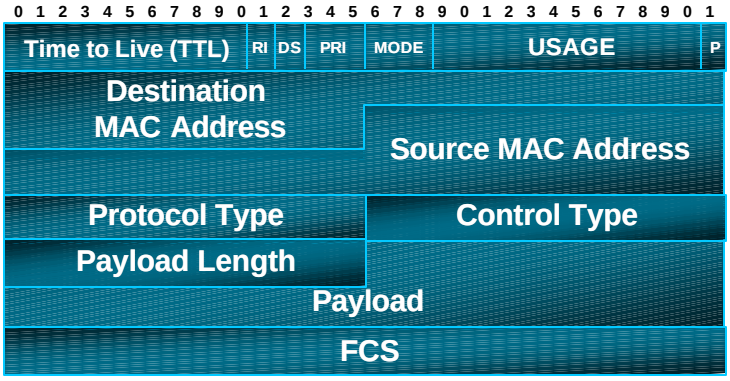
- **Protocol type**

  16 bits field; used like that of EtherType

Value	Protocol Type
0x2007	SRP Control[1]
0x0800	IP Version 4
0x0806	ARP

[1] Temporary Number for Cisco Local List of HDLC-Based Ethertypes

SRP v1 Control Packet Format



SRP v1 Control Fields

- **Control type**

  16 bits field; represents the control message type

Control Type	Description
0x2007	Topology Discovery
0x0800	IPS Message
0x0806	Reserved

- **Payload length**

  16 bits field; payload length of the control message

- **Payload**

  Control message

SRP v1 Control Packets

- MAC keepalive packet
- Topology discovery
- Intelligent Protection Switching (IPS)

SRP v2 Generic Header

- **Time to Live (TTL)**
  8 bit hop count field; decremented each time a node forwards a packet; if the TTL reaches zero the packet is stripped from the ring
- **Ring Identifier (RI-bit)**

0	Outer Ring
1	Inner Ring

- **Mode**

Value	Description
000–011	Unused
100	Topology Control Message
101	Protection Switching Control Message
110	MAC Keepalive Control Message
111	Reserved

- **Priority Field (PRI)**
  Indicates the priority level of a SRP packet; valid values 0–7, with higher values indicating higher priority
- **Parity Bit**
  Odd parity over previous 31 MAC header bits

SRP v2 Data Packet Format

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SRP v2 Control Packet Format

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SRP v2 Control Packets

- Usage
- Topology discovery
- Intelligent Protection Switching (IPS)

SRP MAC Addressing

- Each interface has a globally unique IEEE 48 bits MAC address
  - Ethernet style
- To support multicast a multicast bit is defined using canonical addressing conventions

SRP Control Packets

- All control packets are sent point-to-point
  - The DA MAC address is set to zero (0x0)
- All control packets except MAC keepalive packets are sent with the highest priority
  - PRI == 0x7

Single Subnet

- In the initial implementation the single subnet approach is used
  - Both Outer and Inner rings are on the same IP subnet
- This enables rapid re-optimization of ring path selection and minimize route flaps in a ring wrap situation

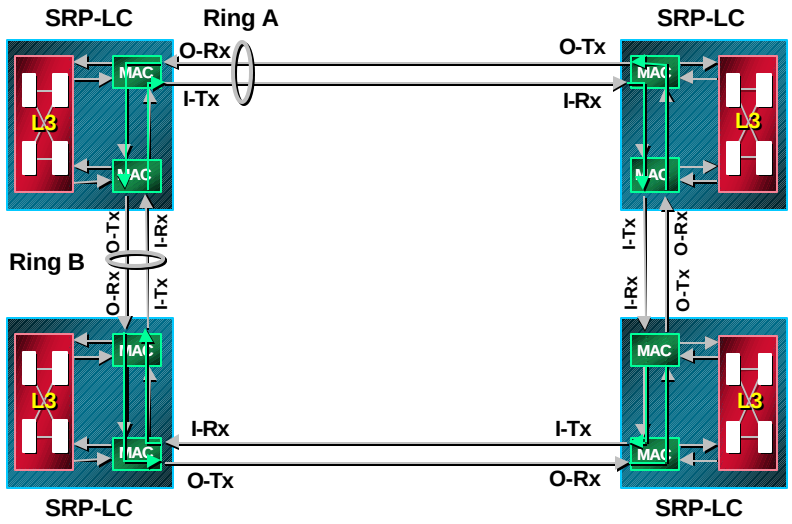
Single Subnet

- Ring wraps are handled by the lower layer and thus transparent to layer 3 routing protocols

SRP Protocol and Features

- Packet processing
- Multicasting
- Priority
- Fairness
- Pass-through
- Ring selection
- Topology discovery
- Intelligent Protection Switching (IPS)
- Management

Ring Packet Flow



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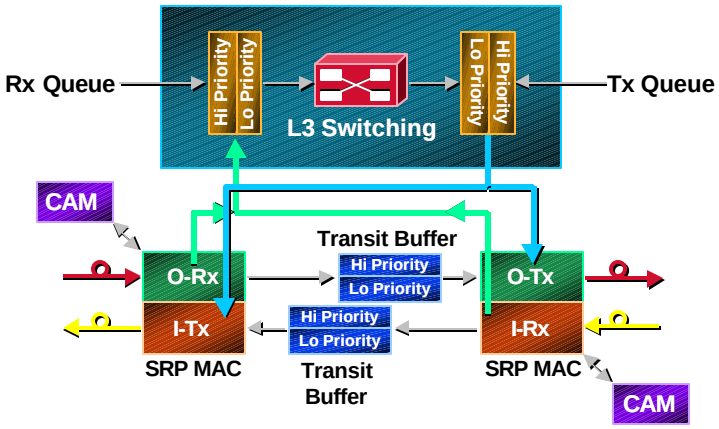
Node Packet Flow



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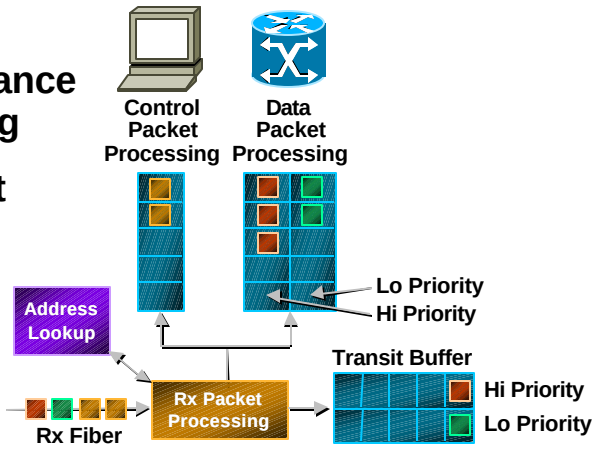
Receive Packet Handling

- Packet acceptance and processing
- Control packet processing
- Multicast handling
- Accounting



Receive Packet Handling

Six Things Can Happen to an Incoming Packet

- Stripped
- Forwarded
- Received and stripped
- Received and forwarded
- Wrapped
- Pass-through

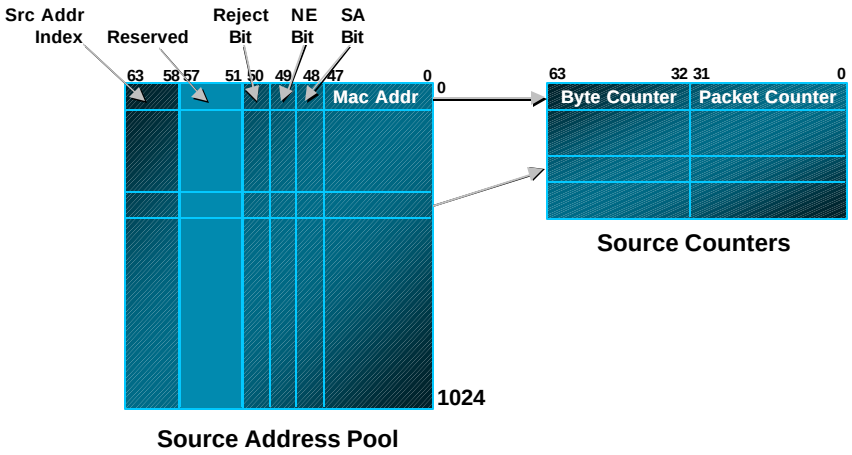
Address Lookup

- Associated with each SRP MAC there is a Content Addressable Memory (CAM)
- The CAM is structured as a source and destination address pool
- The CAM source address pool contains special operation bits
  - Reject bit, NE bit and SA bit

Address Lookup

- The CAM source address pool also has a subset of byte and packet counters associated with it
- Users can selectively filter or do source accounting for packets arriving from a specific node on the ring

SRP v1 CAM



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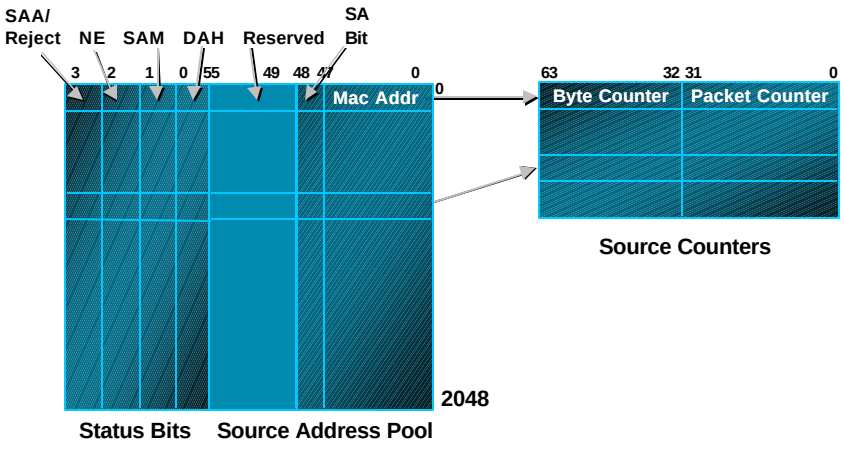
SRP v2 CAM



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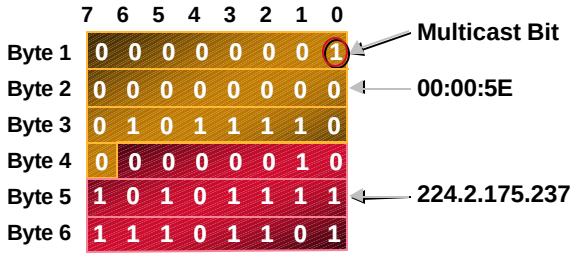
Multicast

- SRP provides direct support for IP multicast
- IP multicast uses class D address space
- The class D multicast address is mapped to the appropriate 48 bit MAC address for transport on the ring

Multicast



Multicast MAC Address == 01:00:5E:02:AF:ED

Multicast Handling

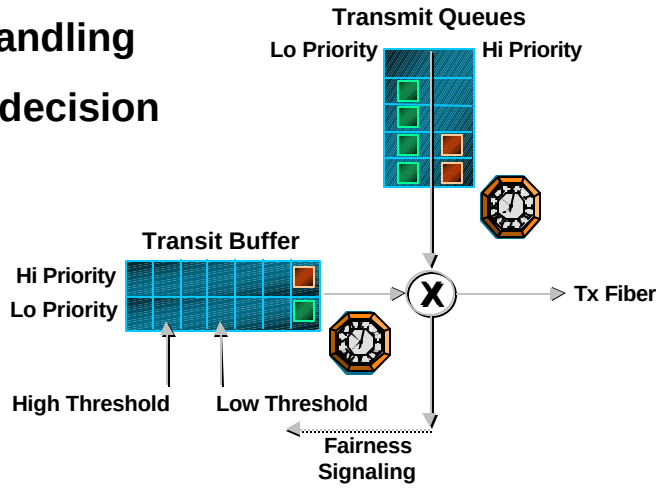
- The source node handles the IP multicast address to MAC address mapping
- Nodes interested in receiving the multicast packet creates an entry for the MAC address in their CAM

Multicast Handling

- Arriving multicast packets with a matching DA are forward to the host processing module
- Unlike unicast packets multicast packets are source stripped
- The multicast packets are placed into the transit buffer for continued circulation

Transmit Packet Handling

- Priority handling
- Transmit decision algorithm
- Fairness



Priority Handling

- SRP provides support for packet prioritization and expedited priority packet handling for the transmit queue and transit buffer
- Motivation—provide support for real time, mission critical applications and control traffic

  Which requires expedited handling and stricter delay bounds and jitter constraints

Priority Handling

- The priority field is set by the node sourcing a packet onto the ring
- The node utilizes a mapping between the IP precedence bits in the ToS field into the SRP MAC header priority field

Priority Handling

- A configured priority threshold is used to determine if the packet should be placed in the high or low priority queues

  Mapping 8 levels of priority to 2 levels

- This is the same for both locally sourced packets and transit packets

Transmit Decision Algorithm

- The following hierarchy is enforced for packet scheduling
  1. High priority transit packets
  2. High priority transmit packets
  3. Low priority transmit packets
  4. Low priority transit packets

Transmit Decision Algorithm

- The packet priority hierarchy can be modified by placing thresholds on the low priority transit buffer depth to ensure
  - The transit buffer doesn't overflow while serving the locally sourced traffic
  - That low priority transit traffic doesn't wait too long behind locally sourced low priority traffic

Transmit Decision Algorithm

- Avoid discarding packets which are already circulating on the ring

SRP Fairness Algorithm

- SRP-fa is the mechanism that ensures
  - Global Fairness—each node gets a fair share of the ring bandwidth
  - Local Optimization—node maximally leverage the spatial reuse properties of the ring
  - Scalability—the ability to build large rings with many nodes that spans across large geographically distributed area

SRP-fa (Transmit)

MY_USAGE £ ALLOW_USAGE £ MAX_ALLOW

- Incremented when transmitting low priority transmit packets
  - MY_USAGE = MY_USAGE + PAK_LEN
- MY_USAGE gets decremented by a fixed fraction at regular intervals

← Transmit Rate Counter

Threshold

- ALLOW_USAGE set according to feedback received by neighbours
- Can decay upwards to MAX_USAGE

- MAX_ALLOW static pre-configured parameter

SRP-fa (Forward)

FWD_RATE

- Incremented when transmitting low priority transmit packets
  - FWD_RATE = FWD_RATE + PAK_LEN
- FWD_RATE gets decremented by a fixed fraction at regular intervals

← Forward Rate Counter

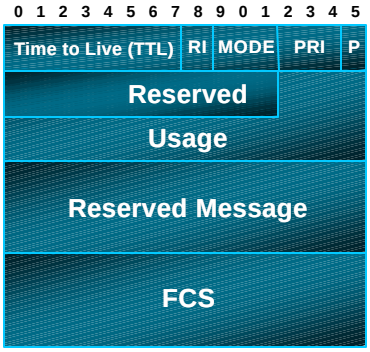
SRP-fa

- High priority transmit packets are not rate controlled by the SRP-fa
  - Committed Access Rate (CAR)
- Excess transit packets are not rate limited by the node instead it generates a fairness message

SRP-fa

- Throttling is done by not sourcing packets until
  - MY_USAGE < ALLOWED_USAGE
- Usage field contains bandwidth information and are sent periodically even if there is no new bandwidth information to send
  - Where there is no new bandwidth information to send a null value is sent

SRP v2 Usage Packet Format



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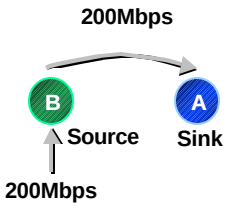
SRP-fa Operation Example



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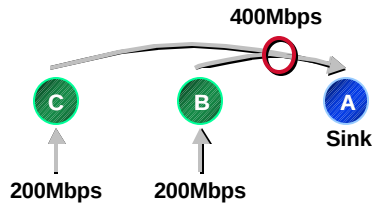
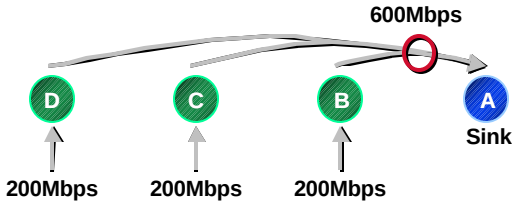
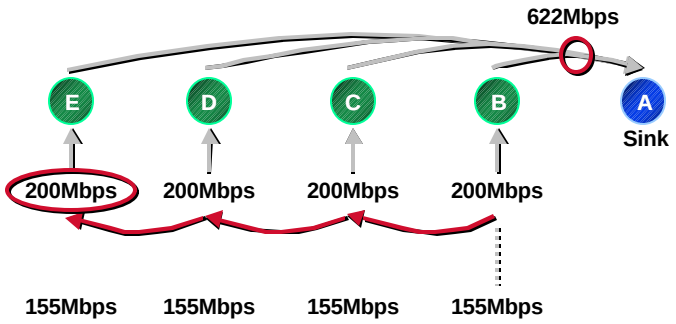
SRP-fa Operation Example



SRP-fa Operation Example



SRP-fa Operation Example



Topology Discovery

- Each node performs topology discovery by sending out topology discovery packets on the Outer ring
- Each node on the ring appends its MAC address binding, updates the length field and sends it to the next node on the ring

Topology Discovery

- If there is a wrap on the ring the wrapped node will indicate a wrap when appending its MAC binding and wraps the packet
- When a topology packet follows a wrap, MAC binding and wrap status are not appended to the packet

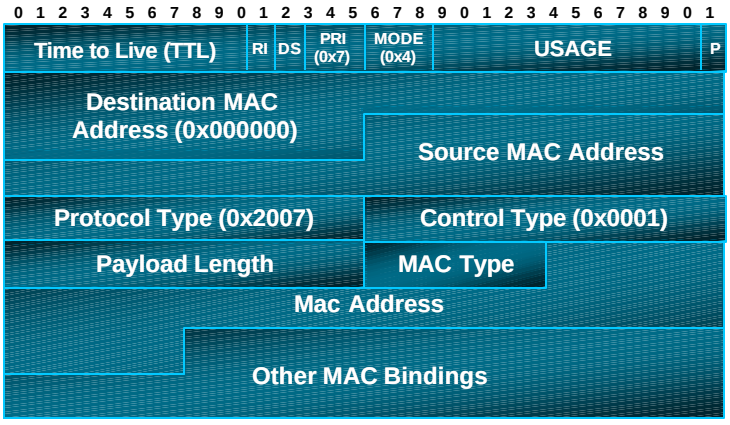
Topology Discovery

- The packet has to be received on the same ring ID before it can be accepted
- Upon receiving 2 consecutive topology packets that are identical the node builds the topology map

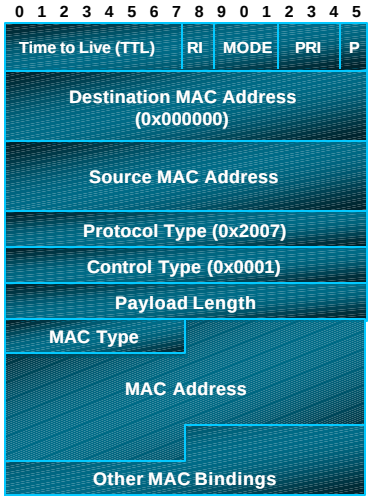
Topology Discovery

- The topology map includes information such as the MAC address and wrap status of each node on the ring

Topology Packet Format (v1)



Topology Packet Format (v2)

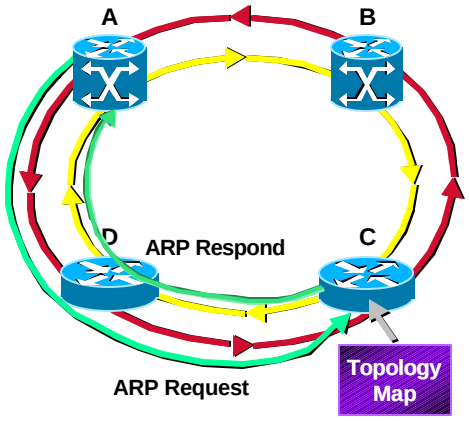


MAC Type

MAC Type—8 Bits	
0	Reserved
1	Ring ID 0—Outer Ring 1—Inner Ring
2	Wrap Status 0—Node Unwrapped 1—Node Wrapped
3–7	Reserved

Ring Selection

- Ring selection is done by ARP'ing
- ARP request is sent on Outer and Inner ring in alternating order
- Responding node uses its topology map to determine which ring to send the respond
- Requesting node uses respond to determine ring selection

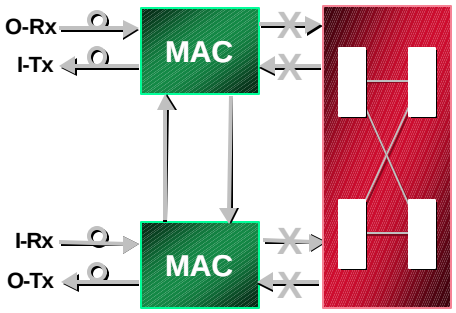


Ring Selection

- When a node detects a ring wrap it issues a gratuitous ARP which is used to update the ARP table of all nodes on the ring
- Static ARP can be used to force the selection of a particular ring

Pass-Through Mode

- Handles router hardware or software problem
- Automatic or manual triggers
- Avoid ring wraps or partitioning



Pass-Through Mode

- In this mode the node appears invisible to the ring
- Control and data packets are passed directly to the transit buffer without any CAM look-up or control packet detection
- The transit buffer still has high and low priority queues but behaves as a simple buffer

Pass-Through Mode

- The node cannot source packets onto the ring
- TTL not decremented
- FWD_RATE counter not incremented
- SRP-fa not executed

Pass-Through Mode

- There are two ways the SRP MAC will go into pass-through mode
  - Watchdog timer expires
  - CLI
- To exit pass-through mode
  - L3 is up and running again
  - CLI

Intelligent Protection Switching

- IPS provides SRP with a powerful self healing feature which automatically recovers from fiber facility or node failure, or signal degradation
- IPS is analogous to the self healing properties of SONET/SDH rings
  - but without the need to allocate protection bandwidth

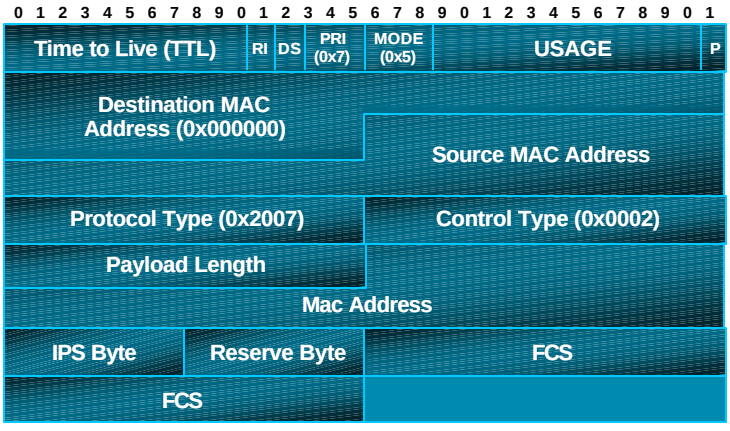
IPS

- Proactive fault and performance monitoring
- Event detection and reporting
- Signal processing and propagation to communicate faults detected or clearances
  - Allow for rapid recovery and restoration

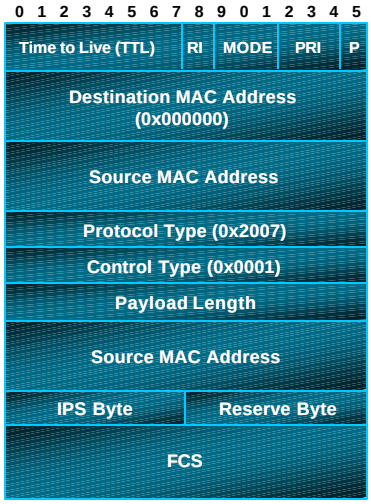
IPS

- Topology knowledge independence
- Ring wrapping to bypass failed fiber or node
  - Transparent to the Layer 3 routing protocols
- Protection switching event hierarchy
- Ring restores in £ 50 msecs

IPS Packet Format (v1)



IPS Packet Format (v2)



IPS Byte

IPS Byte—8 Bits	
0–3	IPS Request Type 1111—Lockout of Protection (LO) 1101—Forced Switch (FS) 1011—Signal Fall (SF) 1000—Signal Degrade (SD) 0110—Manual Switch (MS) 0101—Wait to Restore (WTR) 0000—No Request (0)
4	Path Indicator 0—Short (S) 1—Long (L)
5–7	Status Code 010—Protection Switch Completed [Traffic Wrapped] (W) 000—Idle (0)

IPS Request Type (Automatic)

- **Signal Fail (SF)**

  Performs a wrap; caused by a "hard failure"—LOS, LOF, Line BER above a specified threshold, Line AIS, keepalive failure or excessive CRC errors

- **Signal Degrade (SD)**

  Performs a wrap; caused by "soft failure"—Line BER above a specified threshold or excessive CRC errors

- **Wait to Restore (WTR)**

  When a wrap condition clears instead of unwrapping immediately the node waits for a configured period of this before unwrapping; this is to prevent protection switch oscillation

IPS Request Type (Operator Originated)

- **Lockout of Protection (LO)**

  Prevents ring wraps anywhere in the ring; if a wrap is present it causes it to drop (note: feature not supported at FCS)

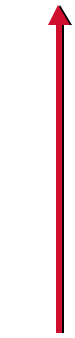
- **Forced Switch (FS)**

  Performs a wrap at the node at which this command was issued and at the adjacent node

- **Manual Switch (MS)**

  Similar to FS but at a lower priority

Protection Request Hierarchy



- Lockout of Protection (LO)
- Forced Switch (FS)
- Signal Fail (SF)
- Signal Degrade (SD)
- Manual Switch (MS)
- Wait to Restore (WTR)
- No Request (IDLE)

Protection Request Hierarchy

- Request ³ SF and < LO can co-exist
- LO request can co-exist
- Request < SF cannot co-exist with other request
- A node always honors the highest of short path request and self detected request (fault)

Protection Request Hierarchy

- When there are more request of type < SF the first request to complete the long path signaling takes precedence
- When there exist 2 request of the type < SF on both the inner and outer ring the node chooses the request on the outer ring

Path Indication

- Short path
- Long path

Path Indication

- **Short path**
  - **Short path IPS packets {Req,Src,Stat,S} are IPS packets sent over the adjacent failed span**
  - **Short path IPS packets are never forwarded, it is stripped by the receiving node**
  - **A node wraps and unwraps only on the short path request (never on the long path)**

Path Indication

- **Long path**
  - **Long path IPS packets {Req,Src,Stat,L} are IPS packets sent around the ring**
  - **Long path IPS packets are always forwarded**
  - **IPS packets are newer wrapped**
  - **Long path IPS packets are used to maintain protection hierarchy**

IPS Triggers

- **Hard failure**
  - Signal Fail (SF)
- **Soft failure**
  - Signal Degrade (SD)
- **Operator**
  - Lockout of Protection (LO)
  - Forced Switch (FS)
  - Manual Switch (MS)

SONET/SDH Overhead Usage

- **Loss of Frame (LOF)**
  - A1 and A2 overhead bytes
- **Loss of Signal (LOS)**
- **Alarm Indication Signal (AIS)**
- **Bit Error Rate (BER)**
  - B2 overhead byte

IPS States

- Idle
- Pass-through
- Wrapped

IPS States

- **Idle**

  The node is ready to perform a protection switch; at this state it sends IPS idle packets {0,Self,0,S} to both of the adjacent nodes

- **Pass-through**

  The node enters this state when it receives a long path IPS packet {Req,Src,Stat,L}

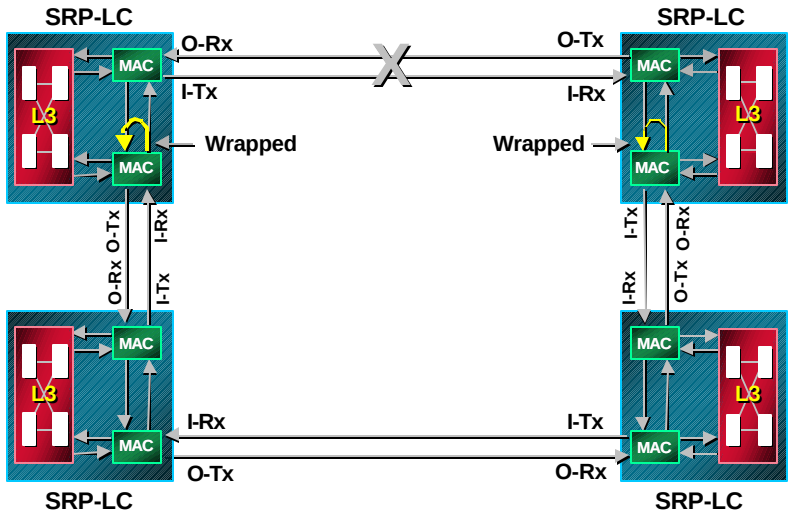
IPS States

- **Wrapped**

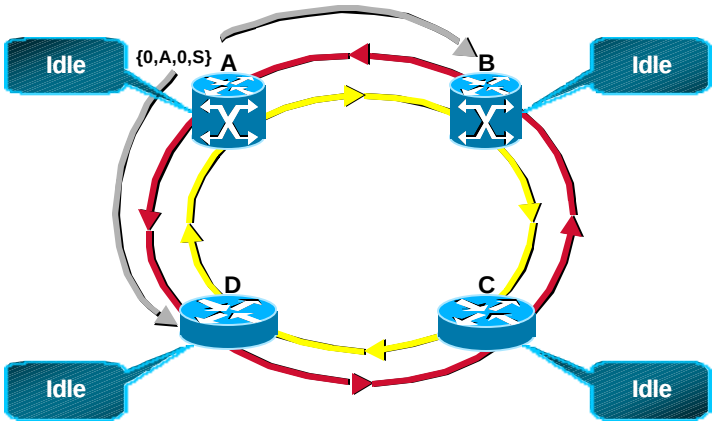
  The node enters this state when it receives a local request or detects a fault or receives a short path IPS packet from an adjacent node

  Performs a wrap

Wrapped Packet Flow



IPS Operation



Normal Working

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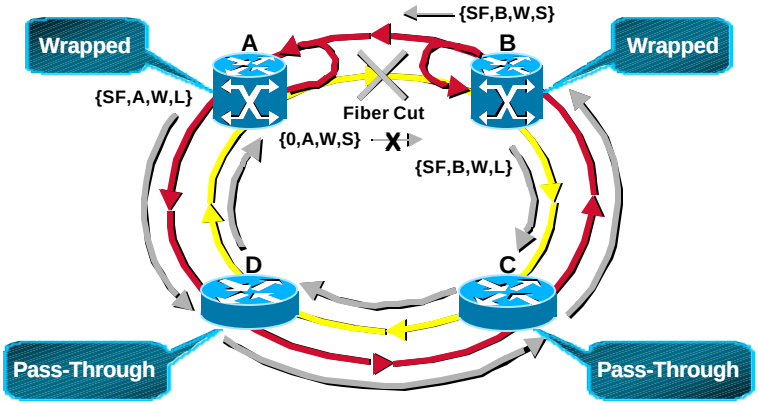
IPS Operation



1 Fiber Failure

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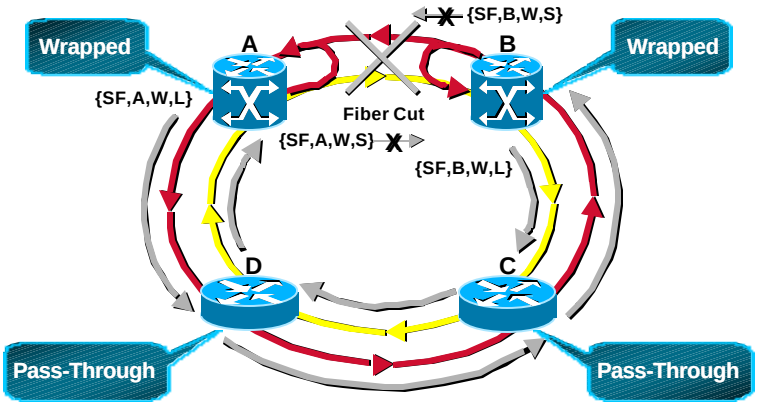
IPS Operation



2 Fiber Failure

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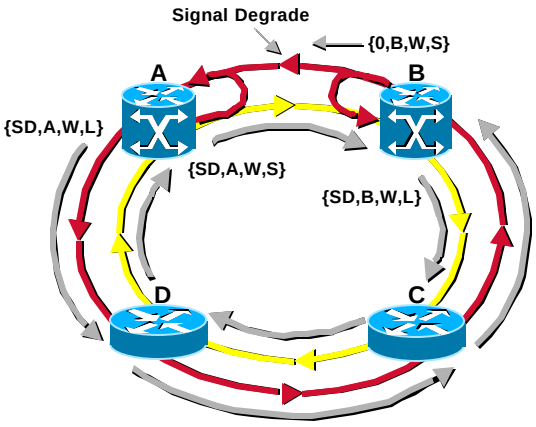
IPS Operation



Signal Degrade

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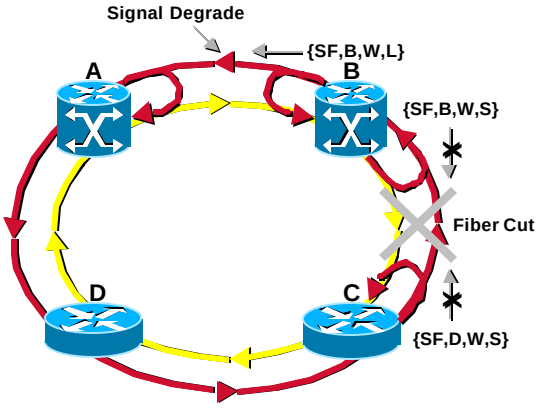
IPS Operation



Signal Degrade and Fiber Failure

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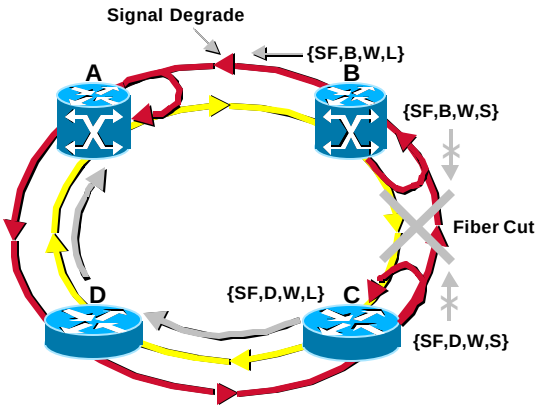
IPS Operation



Signal Degrade and Fiber Failure

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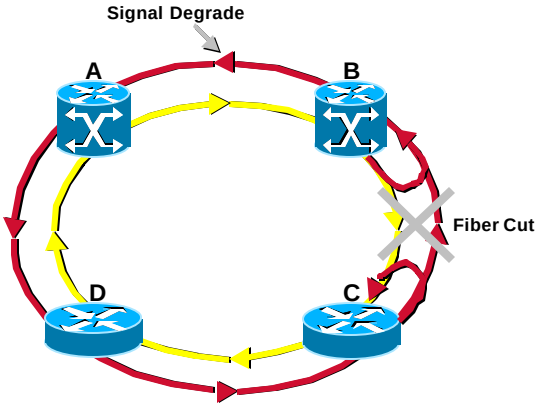
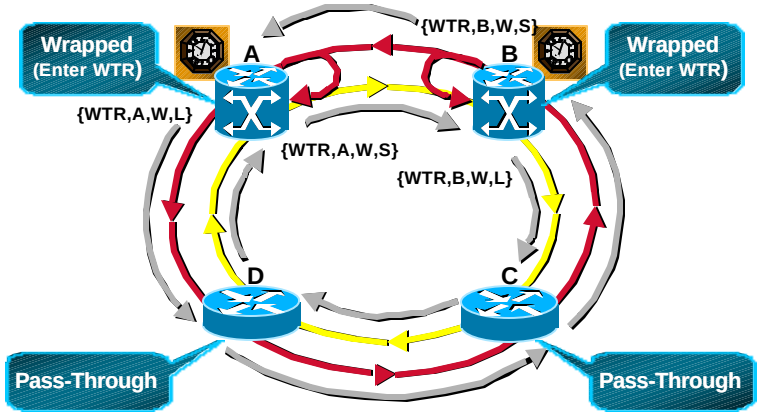
IPS Operation



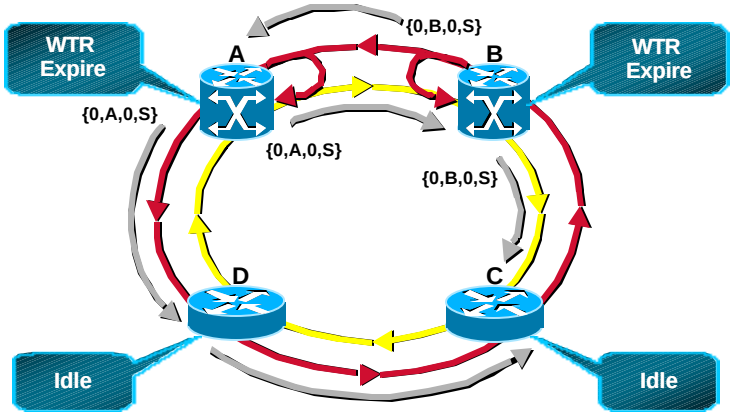
Signal Degrade and Fiber Failure

IPS Operation



Fault Clears

IPS Operation



Fault Clears

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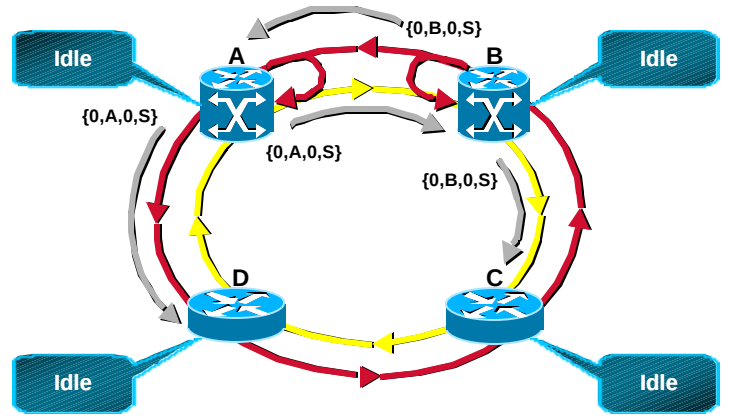
IPS Operation



Fault Clears

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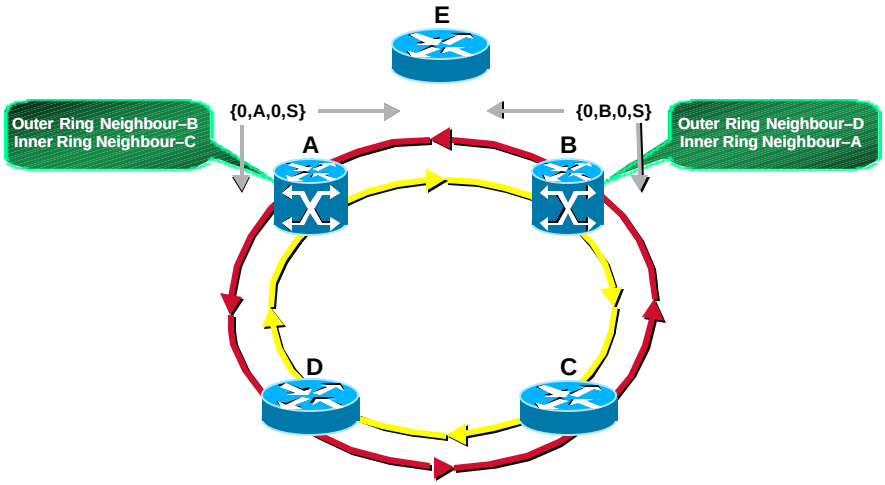
Detecting a New Neighbour



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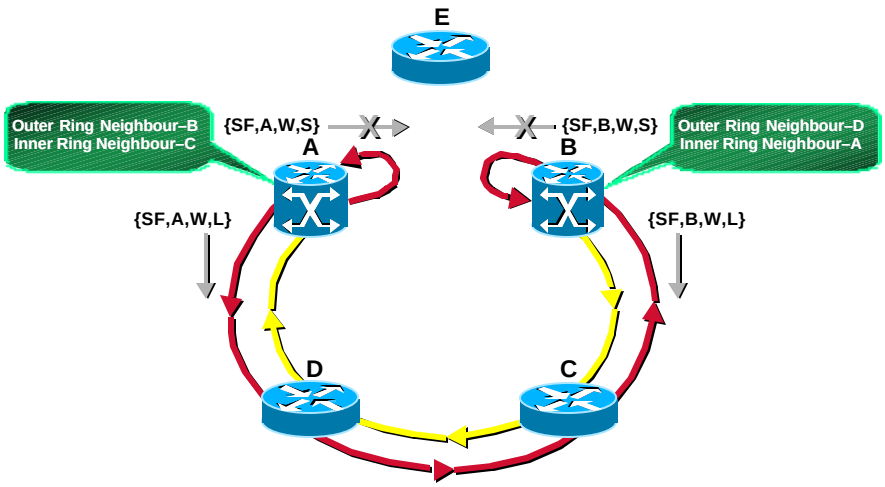
Detecting a New Neighbour



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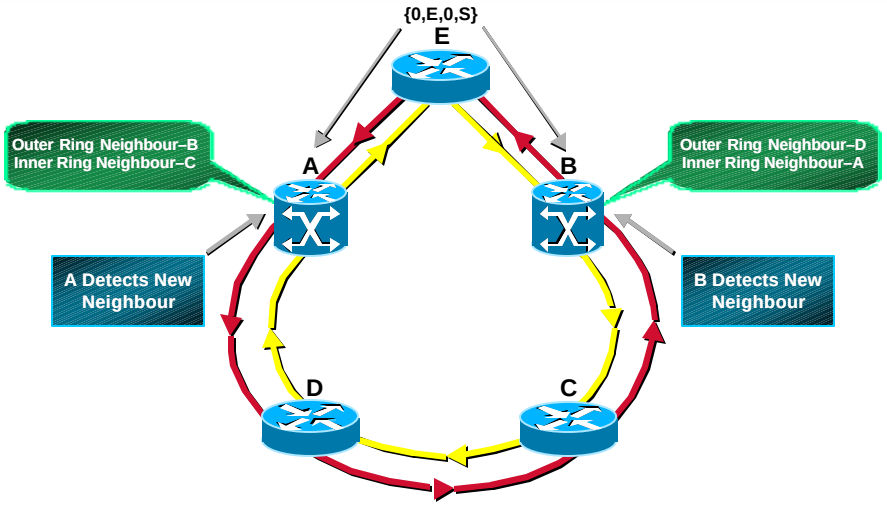
Detecting a New Neighbour



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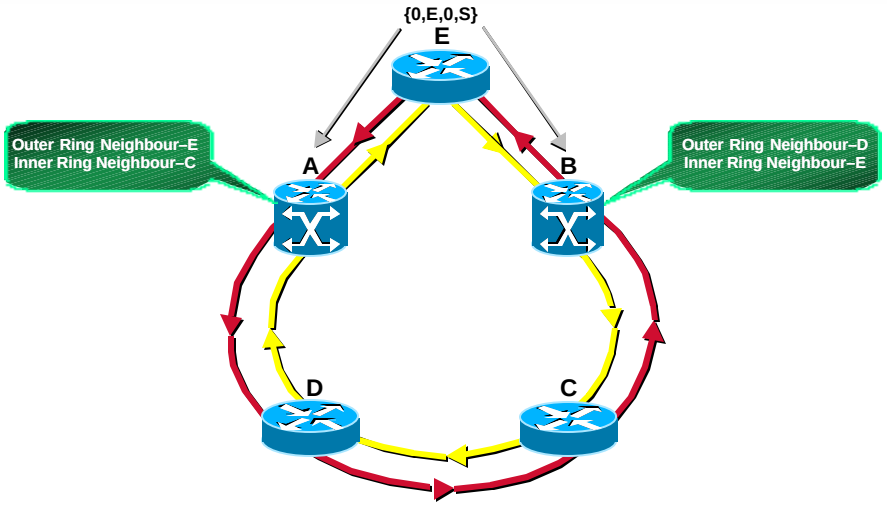
Detecting a New Neighbour



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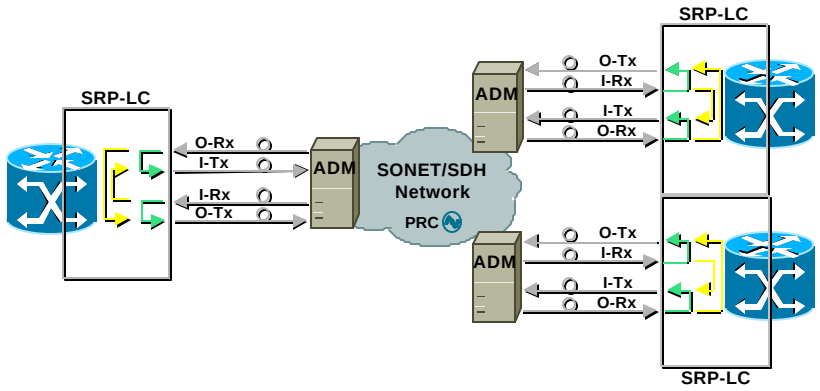
DPT Management

- **RFC 1595 SONET/SDH MIB**
  - **Current status and alarm**
  - **Current and historical Errored Seconds (ES), Severe Errored Seconds (SES), Severe Errored Framing Seconds (SEFS), Coding Violations (CV) and Unavailable Seconds (UA) counts**
- **Topology discovery MIB**
- **SRP MAC statistics**

Clocking and Synchronization

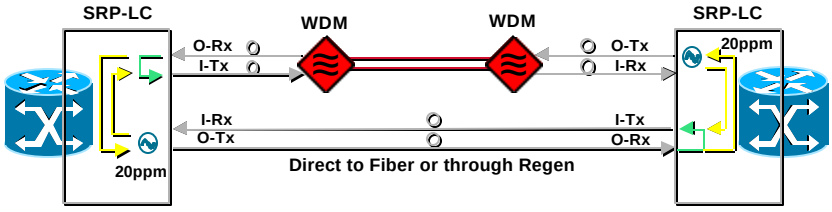
- **3 scenarios**
  - **ADM**
  - **WDM**
  - **Direct to fiber**

ADM



- Clock derived from SONET/SDH network
- Looped or line timed

WDM or Direct to Fiber



- Clock derived from internal oscillator
- Internal oscillator has an accuracy of ± 20ppm
- Internal clocking
  - Similar to doing POS back to back

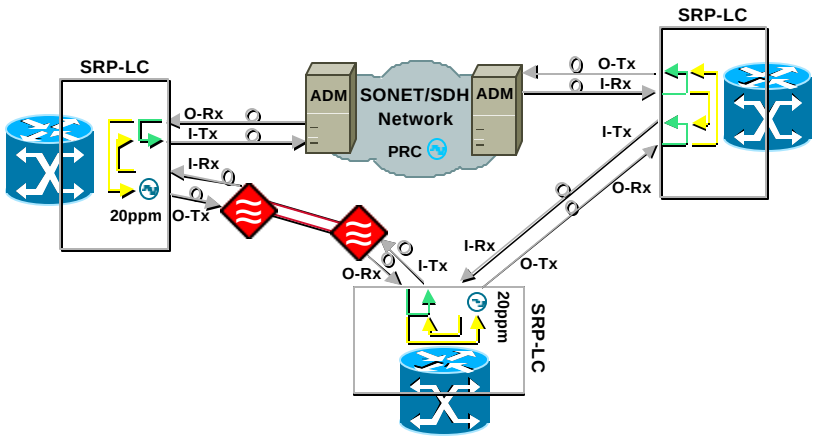
WDM or Direct to Fiber

- No need for central clock source
- No complex clocking requirements
- No BITS interface

  BITS—Building Integrated Timing Supply

- Although it is a ring topology clocking is point-to-point

Mix



Configuration Commands

```
mfr-jc1(config-if)#int srp 0/0
mfr-jc1(config-if)#ip addr 10.0.0.5 255.0.0.0
mfr-jc1(config-if)#no shut
```


Configuration Commands

```
mfr-jc1(config-if)#int srp 0/0
mfr-jc1(config-if)#srp ?
  clock-source    Configure clock source
  count           Count packets based on source mac address
  flag            Specify SONET/SDH overhead values
  framing         Specify SONET/SDH framing and corresponding
                   s1s0 defaults
  ips             Modify IPS parameters
  reject          Reject packets based on source mac address
  topology-timer  Specify topology timer
```

Configuration Commands

```
mfr-jc1(config-if)#srp clock-source ?
  internal  Use internal clock (default)
  line      Recover clock from line

mfr-jc1(config-if)#srp clock-source internal ?
  a  Specify clock source on side A (default internal)
  b  Specify clock source on side B (default internal)
  <cr>

mfr-jc1(config-if)#srp clock-source line ?
  a  Specify clock source on side A (default internal)
  b  Specify clock source on side B (default internal)
  <cr>
```


Configuration Commands

```
mfr-jc1(config-if)#srp flag ?
  c2    Path Signal Label byte (default 0x16)
  j0    Section Trace byte (default 0xCC)
  s1s0  Bits s1 and s0 of H1 byte (default 0)

mfr-jc1(config-if)#srp framing ?
  sdh    Select SDH framing and s1s0=2
  sonet  Select SONET framing and s1s0=0 (default)

mfr-jc1(config-if)#srp framing sonet ?
  a  Specify framing and s1s0 on side A (default SONET, s1s0=0)
  b  Specify framing and s1s0 on side B (default SONET, s1s0=0)
  <cr>
```

Configuration Commands

```
mfr-jc1(config-if)#srp ips ?
  request    Specify IPS request
  timer      Specify IPS timer
  wtr-timer  Specify IPS WTR timer

mfr-jc1(config-if)#srp ips request ?
  forced-switch  Forced Switch request
  manual-switch  Manual Switch request

mfr-jc1(config-if)#srp ips request forced-switch ?
  a  Specify IPS request on side A
  b  Specify IPS request on side B

mfr-jc1(config-if)#srp ips timer ?
  <1-60>  value in seconds

mfr-jc1(config-if)#srp ips wtr-timer ?
  <10-600>  value in seconds
```


Configuration Commands

```
mfr-jc1(config-if)#srp count ?
  H.H.H  48-bit source address

mfr-jc1(config-if)#srp reject ?
  H.H.H  48-bit source address

mfr-jc1(config-if)#srp topology-timer ?
  <10-600>  value in seconds
```

Show Commands

```
mfr-jc1#sh ver
Cisco Internetwork Operating System Software
IOS (tm) GS Software (GSR-P-M), Experimental Version 11.2(19990310:232845)
[gsuwala-gsr_merlin_112eft 166]
Copyright (c) 1986-1999 by cisco Systems, Inc.
Compiled Mon 22-Mar-99 09:43 by gsuwala
Image text-base: 0x600108E0, data-base: 0x60704000

[snip]

cisco 12008/GRP (R5000) processor (revision 0x01) with 131072K bytes of memory.
R5000 processor, Implementation 35, Revision 2.1 (512KB Level 2 Cache)
Last reset from power-on

1 Route Processor Card
1 Clock Scheduler Card(s)
3 Switch Fabric Card(s)
1 one-port OC12 SONET based SRP controller (1 SRP).
1 Ethernet/IEEE 802.3 interface(s)
507K bytes of non-volatile configuration memory.

[snip]
```


Show Commands

```
mfr-jc1#sh int srp 0/0
SRP0/0 is up, line protocol is up
  Hardware is SRP over SONET, address is 1000.0000.5555 (bia 0010.1f42.a400)
  Internet address is 10.0.0.5/8
  MTU 9000 bytes, BW 622000 Kbit, DLY 100 usec, rely 255/255, load 1/255
  Encapsulation SRP, loopback not set
  Last input 00:00:01, output 00:00:00, output hang never
  Last clearing of "show interface" counters 6d21h
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 45000 bits/sec, 2 packets/sec
  5 minute output rate 51000 bits/sec, 3 packets/sec
     1041110404 packets input, 801583966 bytes, 1 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     270 input errors, 270 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     2388439 packets output, 3782249550 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
mfr-jc1#
```


Show Commands

```
mfr-jc1#sh srp ?
  SRP              Spatial Reuse Protocol Interface
  ips              IPS information
  source-counters  Source counter information
  topology         Topology map
  <cr>
```


Show Commands

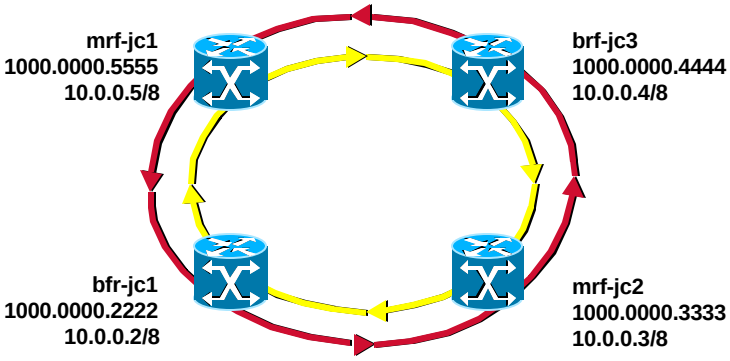
```
mfr-jc1#sh srp

 IPS Information for Interface SRP0/0
 MAC Addresses
   Side A (Outer ring RX) neighbour 1000.0000.4444
   Side B (Inner ring RX) neighbour 1000.0000.1111
   Node MAC address 1000.0000.5555
 IPS State
   Side A not wrapped
   Side B not wrapped
   Side A (Inner ring TX) IPS pkt. sent every 1 sec. (next pkt. after 0 sec.)
   Side B (Outer ring TX) IPS pkt. sent every 1 sec. (next pkt. after 0 sec.)
   IPS WTR period is 10 sec. (timer is inactive)
   Node IPS State IDLE
 IPS Self Detected Requests
   Side A IDLE
   Side B IDLE
 IPS messages received
   Side A (Outer ring RX) {1000.0000.4444,IDLE,S,1024}
   Side B (Inner ring RX) {1000.0000.1111,IDLE,S,1024}
 IPS messages transmitted
   Side A (Inner ring TX) {1000.0000.5555,IDLE,S,1024}
   Side B (Outer ring TX) {1000.0000.5555,IDLE,S,1024}
```


Show Commands

```
 Topology Map for Interface SRP0/0
  Topology pkt. sent every 10 sec. (next pkt. after 4 sec.)
  Last received topology pkt. 00:00:05
  Nodes on the ring: 4
  Hops (outer ring)    Address
        0          1000.0000.5555
        1          1000.0000.2222
        2          1000.0000.3333
        3          1000.0000.4444
mfr-jc1#
```


Sample DPT Topology



Show Commands

```
mfr-jc1#sh cont srp ?
  <0-15>   SRP interface number
  details  show all the details for the interface
  <cr>
```


Show Commands

```
mfr-jc1#sh cont srp
SRP0/0 - Side A (Outer RX, Inner TX)
SECTION
  LOF = 0          LOS = 0             RDOOL = 0            BIP(B1) = 0
  Active Alarms: None
LINE
  AIS = 0          RDI = 0          FEBE = 0          BIP(B2) = 0
  Active Alarms: None
PATH
  AIS = 0          RDI = 0          FEBE = 0          BIP(B3) = 0
  LOP = 0          NEWPTR = 0          PSE = 0           NSE = 0
  Active Alarms: None
APS
  Rx(K1/K2) = 00/00  S1S0 = 00  C2 = 16
CLOCK SOURCE
  Internal
PATH TRACE BUFFER : STABLE
  Remote hostname : bfr-jc3
  Remote interface: SRP0/0
  Remote IP addr  : 10.0.0.4
  Remote Ring id  : Outer
```

Show Commands

```
SRP0/0 - Side B (Inner RX, Outer TX)
SECTION
  LOF = 0          LOS = 0             RDOOL = 0            BIP(B1) = 1638
  Active Alarms: None
LINE
  AIS = 0          RDI = 0          FEBE = 64         BIP(B2) = 5088
  Active Alarms: None
PATH
  AIS = 0          RDI = 0          FEBE = 52         BIP(B3) = 1662
  LOP = 0          NEWPTR = 0          PSE = 0           NSE = 0
  Active Alarms: None
APS
  Rx(K1/K2) = 00/00  S1S0 = 00  C2 = 16
CLOCK SOURCE
  Internal
PATH TRACE BUFFER : STABLE
  Remote hostname : bfr-jc1
  Remote interface: SRP0/0
  Remote IP addr  : 10.0.0.1
  Remote Ring id  : Outer
```


Debug Commands

```
mfr-jc1#debug srp ?
  error     SRP protocol errors
  ips       SRP IPS
  packet    SRP packets
  periodic  SRP periodic activity
  topology  SRP topology
```


Application

- POP Interconnect
- Campus Ring
- Metro/City Ring
- Hierarchical Ring

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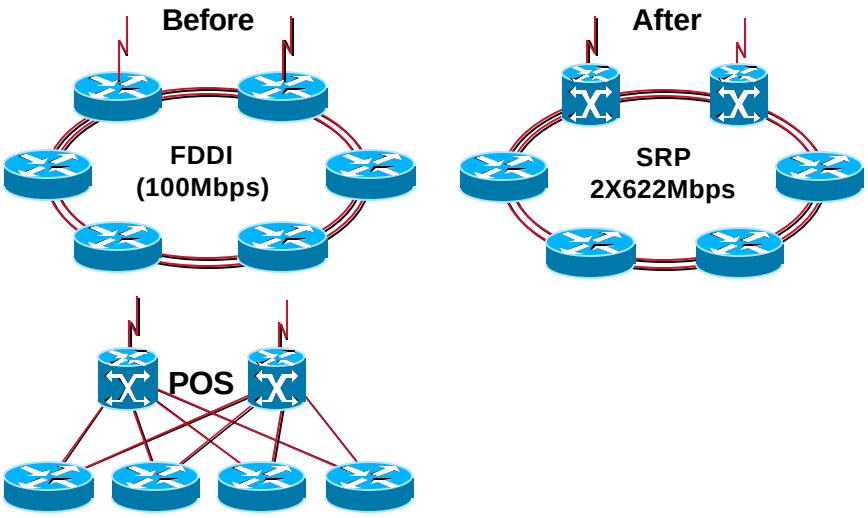
POP Interconnect



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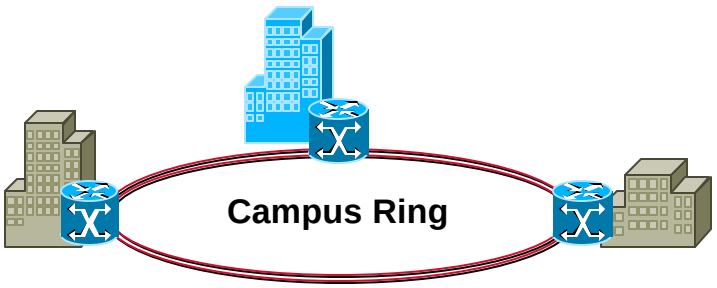
Campus Ring



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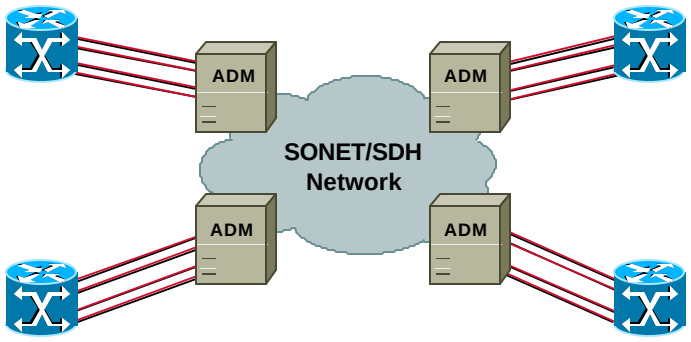
Metro/City Ring—SONET/SDH



Requires Concatenated Interfaces on the ADM

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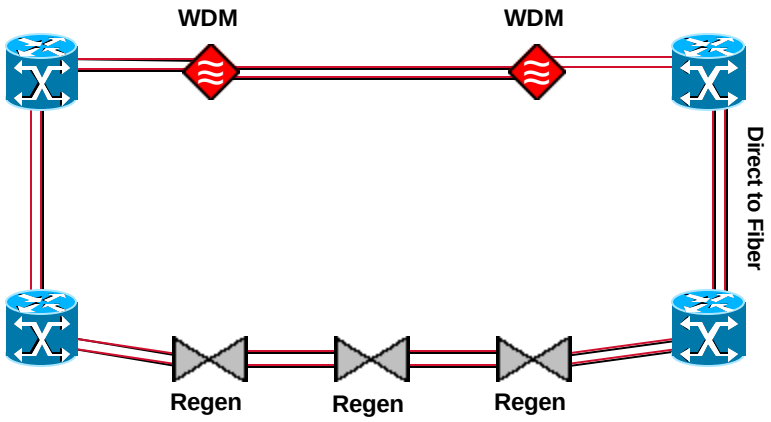
Presentation_ID.scr

Metro/City Ring—Direct to Fiber/WDM



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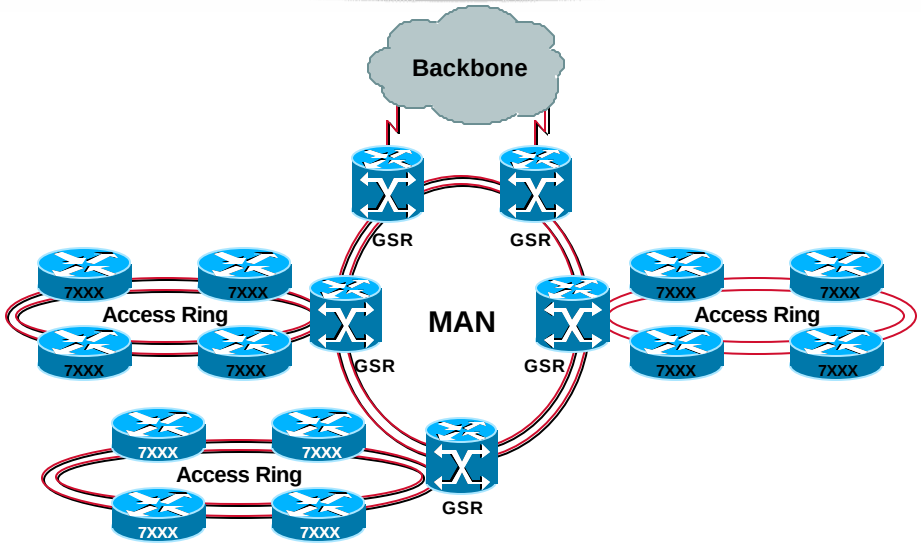
Hierarchical Ring



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DPT Product Highlights

- GSR linecard
- 7500 dual wide port adapter
- Multi-mode and single-mode
- IR and LR
- 1310 nm

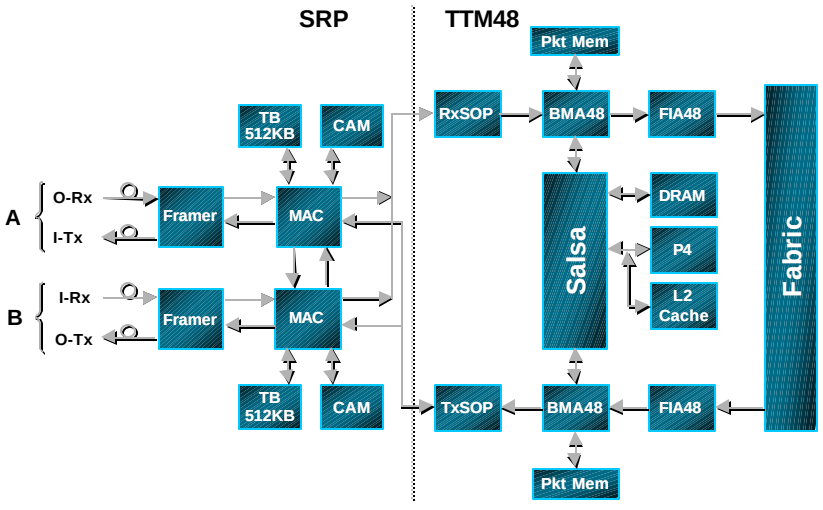
DPT Products Highlights

- Concatenated SONET/SDH frames only
  - Initially OC-12c or AU4-4-4c
- Initial MAC implementation on FPGA
- Ring Access Controller ASIC (RAC)
  - OC-48/STM-16 rings

DPT GSR Line Card

- **Initial release single SRP OC-12/STM-4 ring**
  - **Dual port—coming**
- **Initial release based on the TTM-48 engine**
- **Full fabric required**

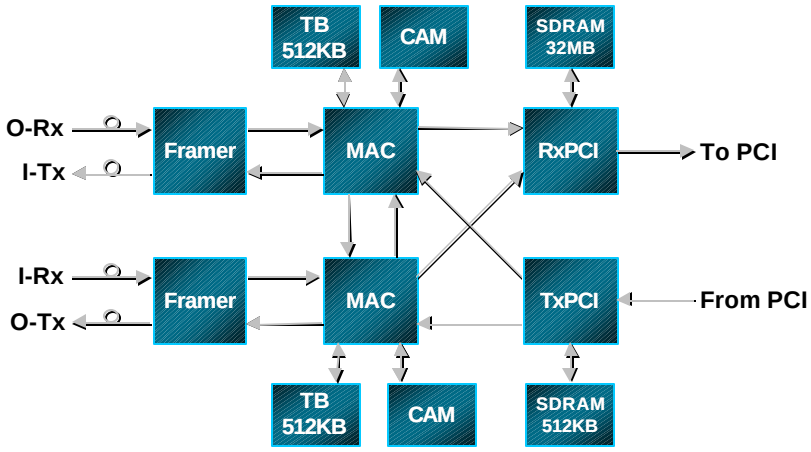
GSR DPT Linecard



DPT Port Adaptor

- Single SRP OC-12/STM-4 ring
- Dual wide PA
- Hardware-based layer 2 CoS
  - 32 Mbytes Rx buffering
  - RED and DRR
- FCS release on VIP2-50 migrating to VIP4

7500 DPT PA



Conclusions

- Innovative and scalable packet ring technology
- LAN, MAN and WAN applications
- Cost effective and bandwidth efficient
- IP services enabler