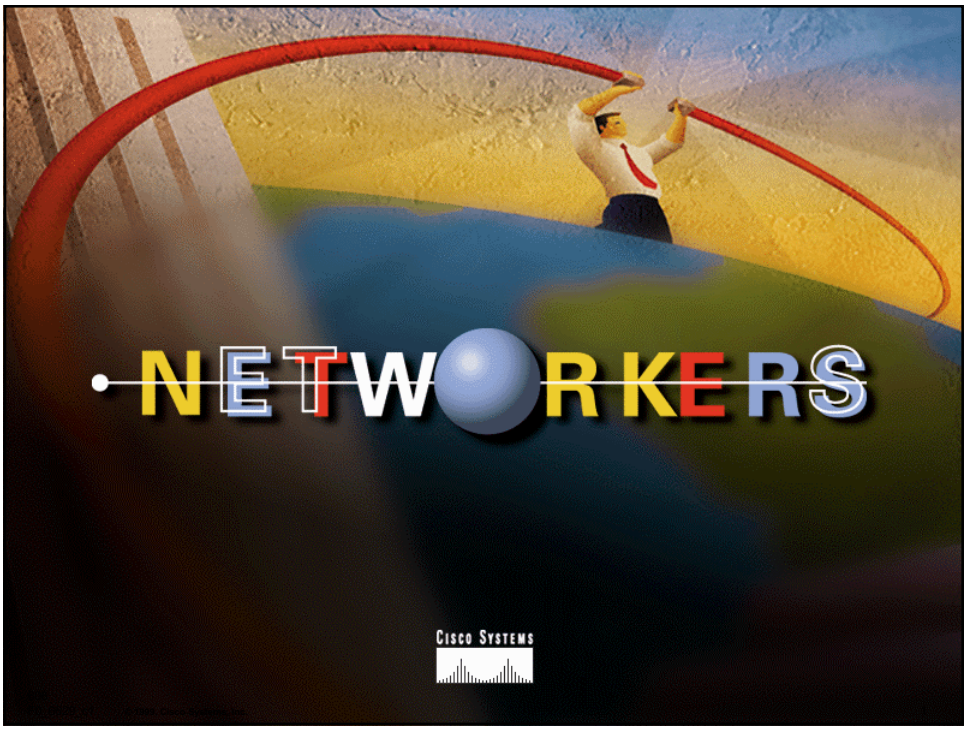

SRP Agenda

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

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SRP Overview

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

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

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SRP Overview

- Multicast support
- Support traffic prioritization
- 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

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SRP Overview

- Intelligent Protection Switching (IPS)
  - Survivability in the event of fiber facility or node failure, or signal degradation
- Media independent protocol
  - Initial implementation uses SONET/SDH framing
- Plug-and-play operation

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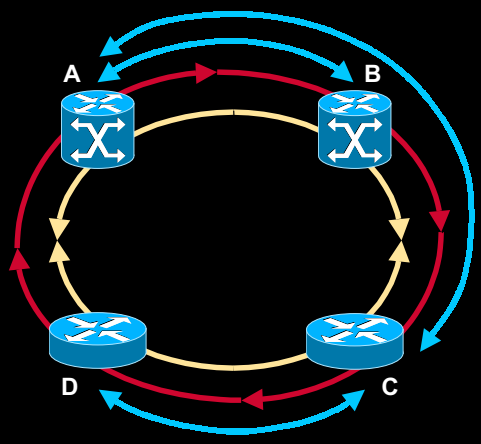
Spatial Reuse

- The SRP protocol derives its name from the spatial reuse capability
- Bandwidth consumed only on traversed segment
- Unicast packets travels along ring spans between the src and dest nodes only
  - Destination stripping



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SRP Ring

- An SRP 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

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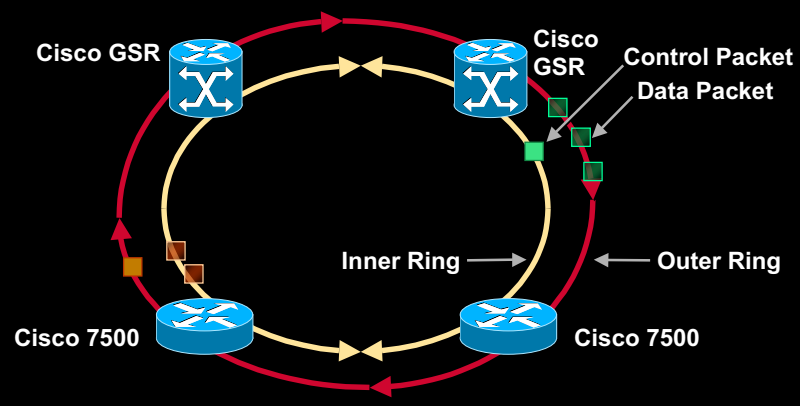
SRP Ring



Example of a 4 Node SRP Ring

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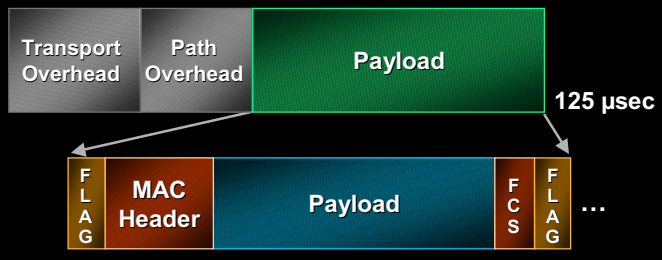
SRP Packet



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

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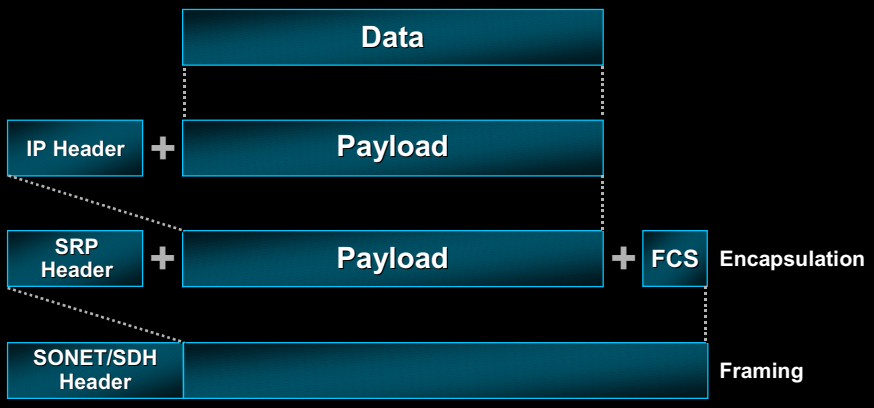
SRP Packet



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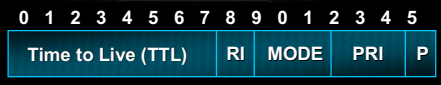
SRP v2 Generic Header



- **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	Control Message (Pass to Host)
101	Control Message (Locally Buffered)
110	Unused
111	Data Packet

- **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 15 MAC header bits

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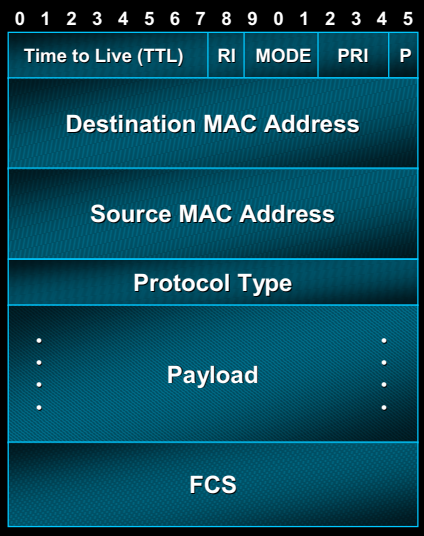
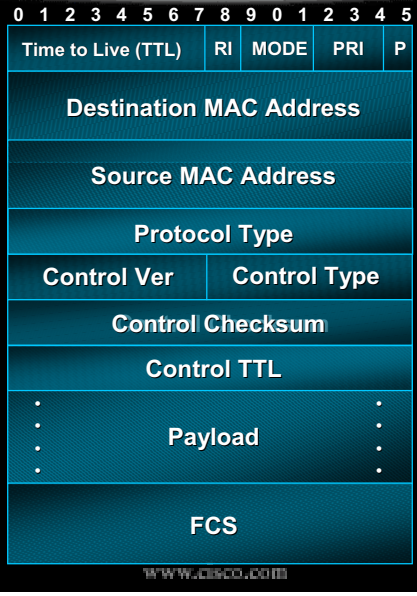
SRP v2 Data Packet Format



SRP v2 Control Packet Format



SRP v2 Control Packets

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

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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

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SRP Control Packets

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

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Single Subnet

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

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SRP Agenda

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

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SRP Protocol and Features

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

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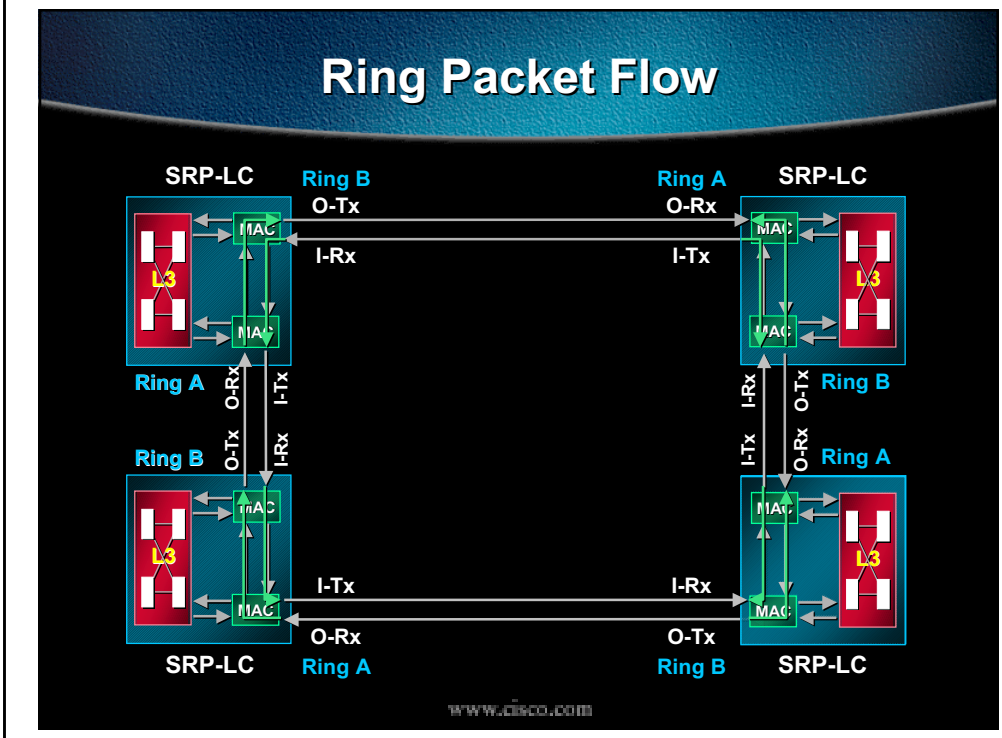
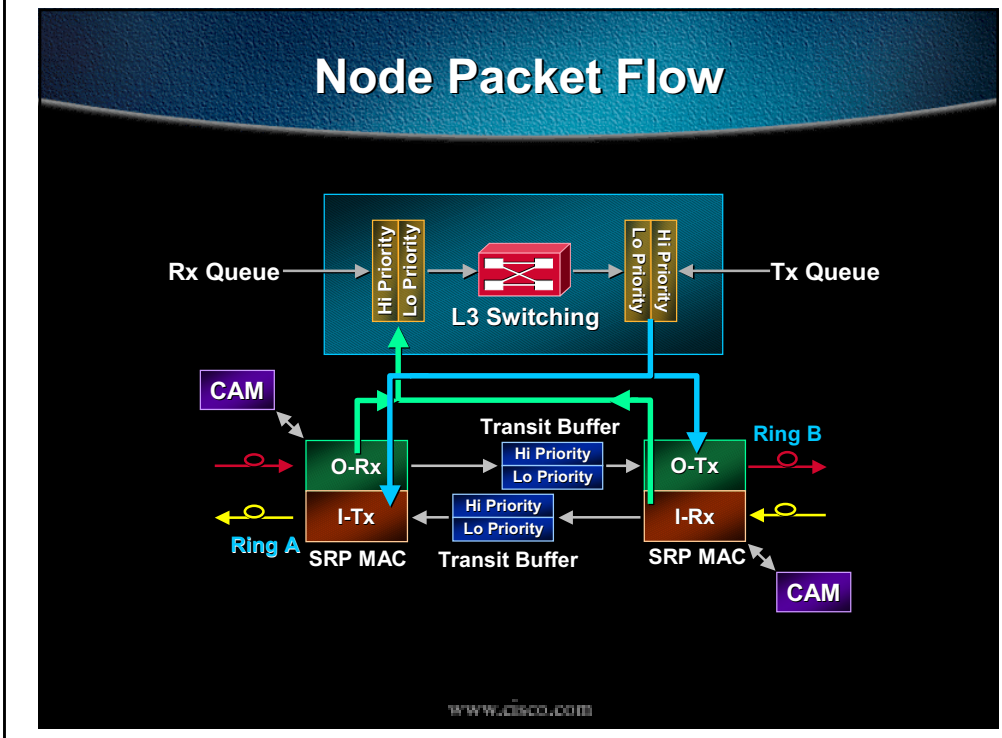
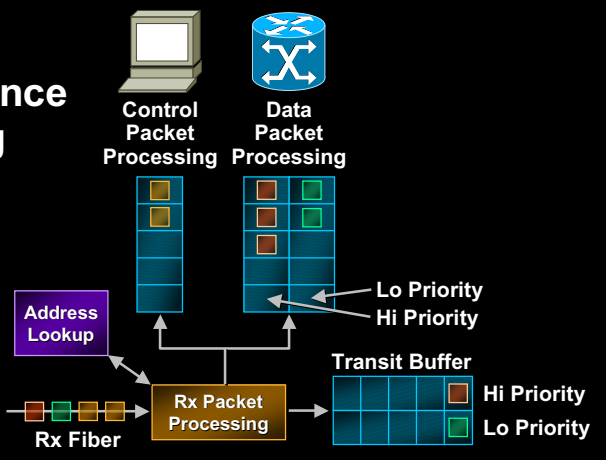




Receive Packet Handling

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



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Receive Packet Handling

Six Things Can Happen to an Incoming Packet

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

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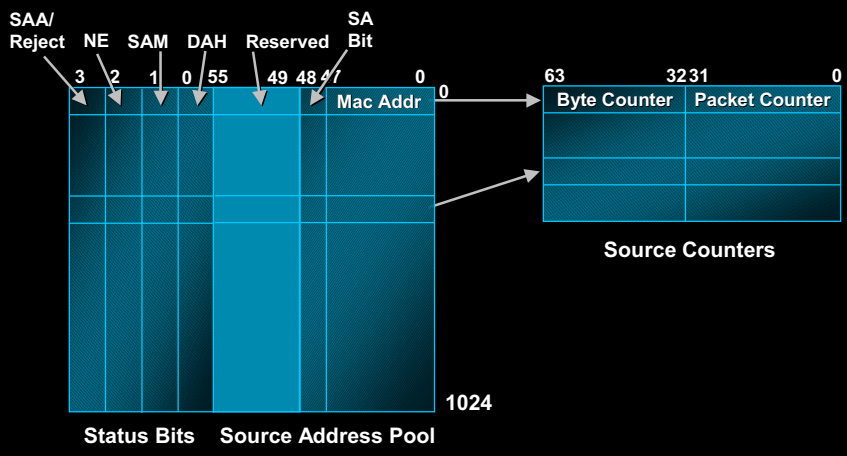
Address Lookup

- 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

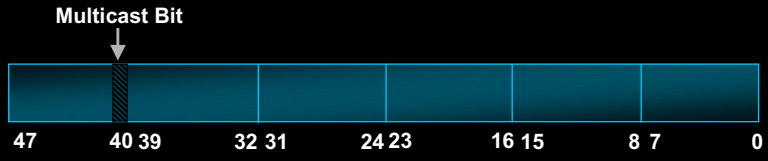
SRP v2 CAM



Multicast

- SRP provides direct support for IP multicast
- Nodes interested in receiving multicast packets creates the following entry in the CAM

0100.5E00.0000 mask 0000.007F.FFFF



Multicast Handling

- Arriving multicast packets are forwarded 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

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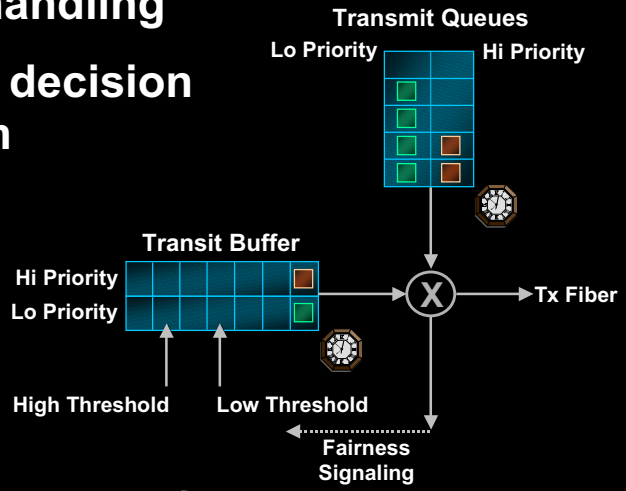
Transmit Packet Handling

- Priority handling
- Transmit decision algorithm
- Fairness



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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

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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

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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

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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 Neighbors
- Can Decay Upwards to MAX_ALLOW

- MAX_ALLOW Static Pre-Configured Parameter

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SRP-FA (Forward)

FWD_RATE

- 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

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

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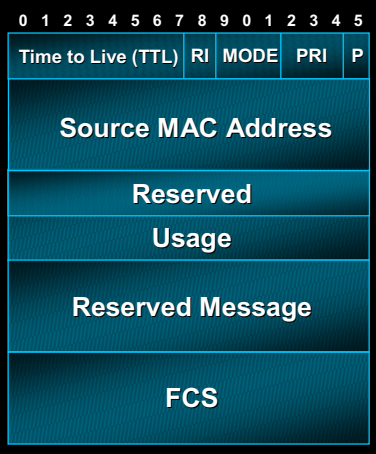
SRP v2 Usage Packet Format



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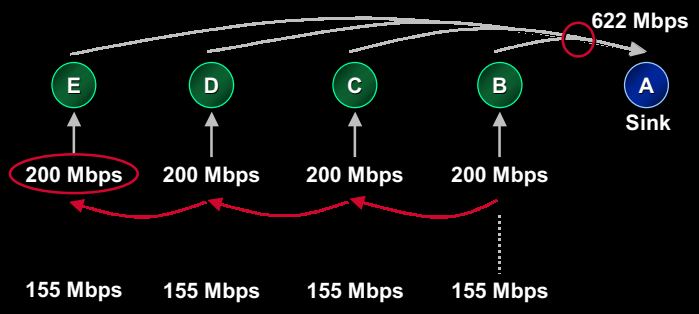
SRP-FA Operation Example



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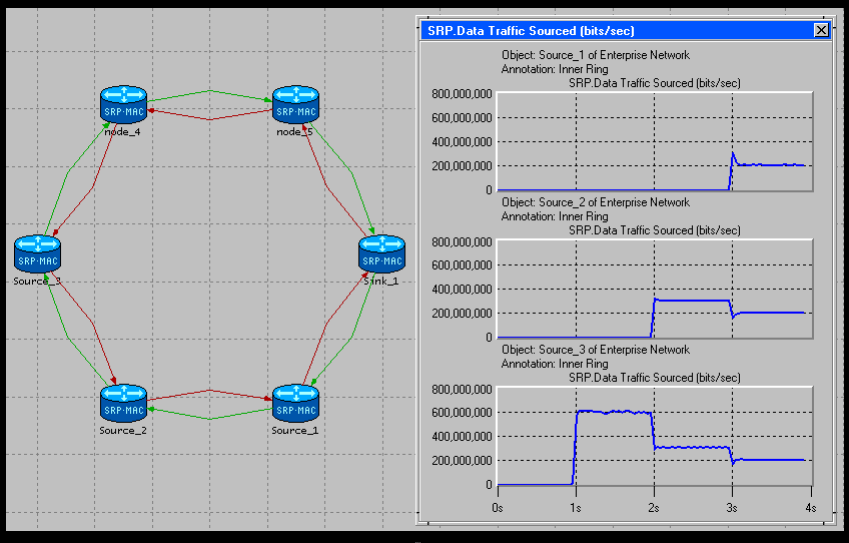
SRP-FA Operation Example



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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

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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

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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

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Topology Discovery

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

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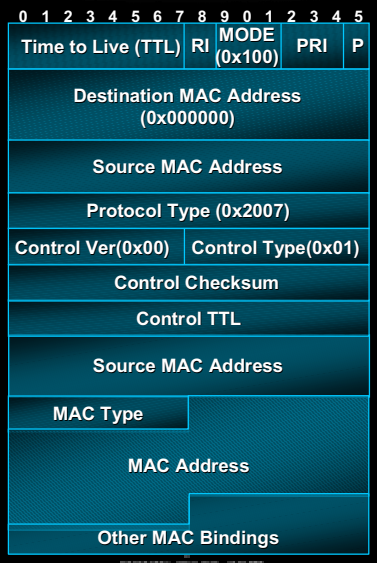
Topology Packet Format (v2)



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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

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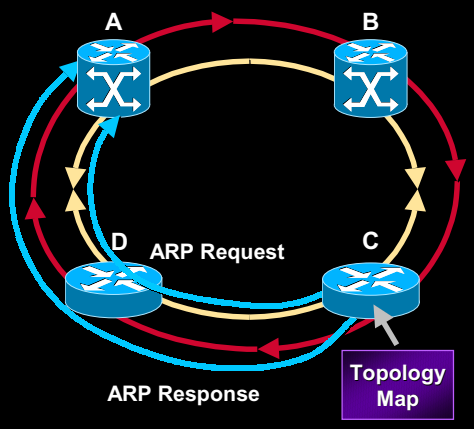
Ring Selection

- Ring selection is done by ARP'ing
- Responding node uses its topology map to determine which ring to send the response
- Requesting node uses response to determine ring selection



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Ring Selection

- When a node detects a ring wrap or unwrap it flushes the ARP cache to trigger a ring selection
- Static ARP can be used to force the selection of a particular ring

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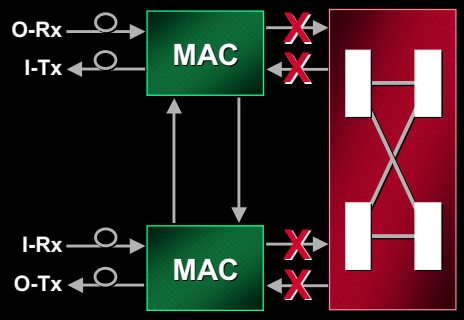
Pass-Through Mode

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



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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

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Pass-Through Mode

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

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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

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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

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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

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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

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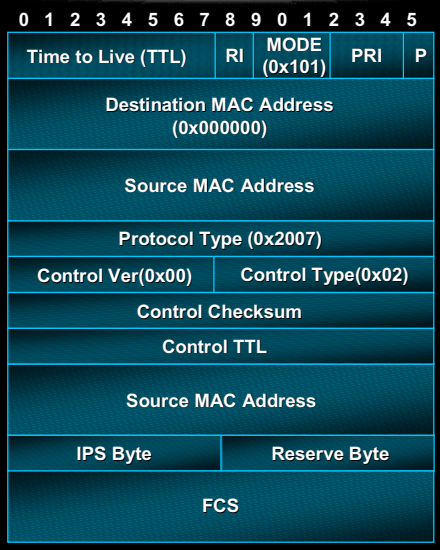
IPS Packet Format (v2)



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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, keep alive 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

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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)

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Protection Request Hierarchy

- Request ≥ 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)

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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

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Path Indication

- Short path
- Long path

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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)

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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

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IPS Triggers

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

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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

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IPS States

- Idle
- Pass-through
- Wrapped

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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

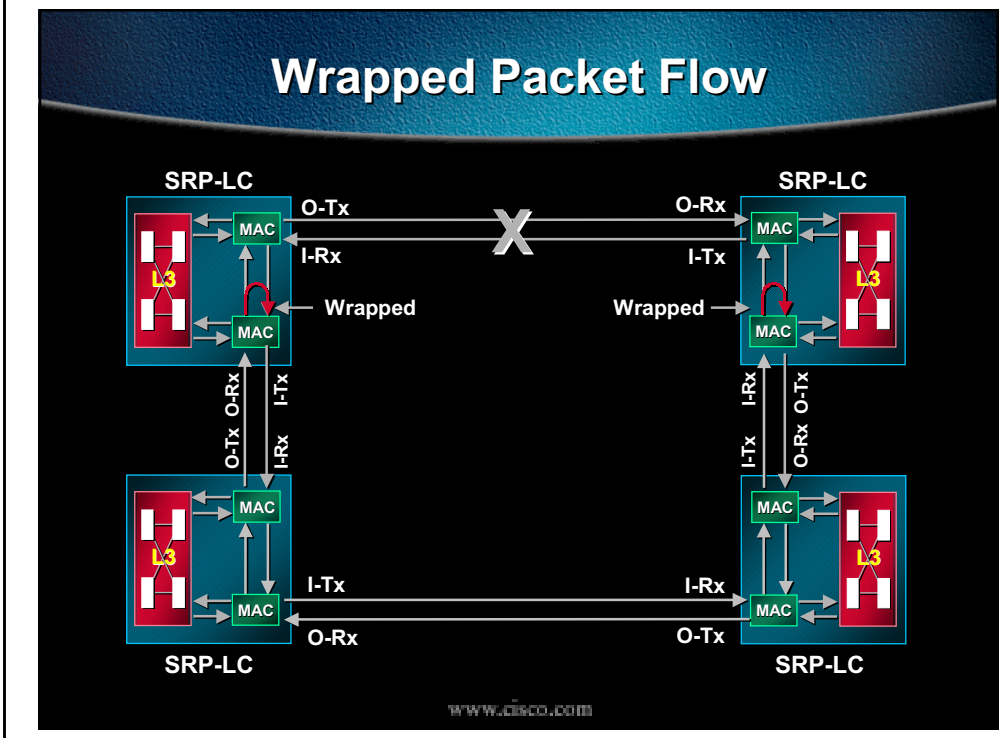
  The node enters this state when it receives a long path IPS packet {Req,Src,Stat,L}

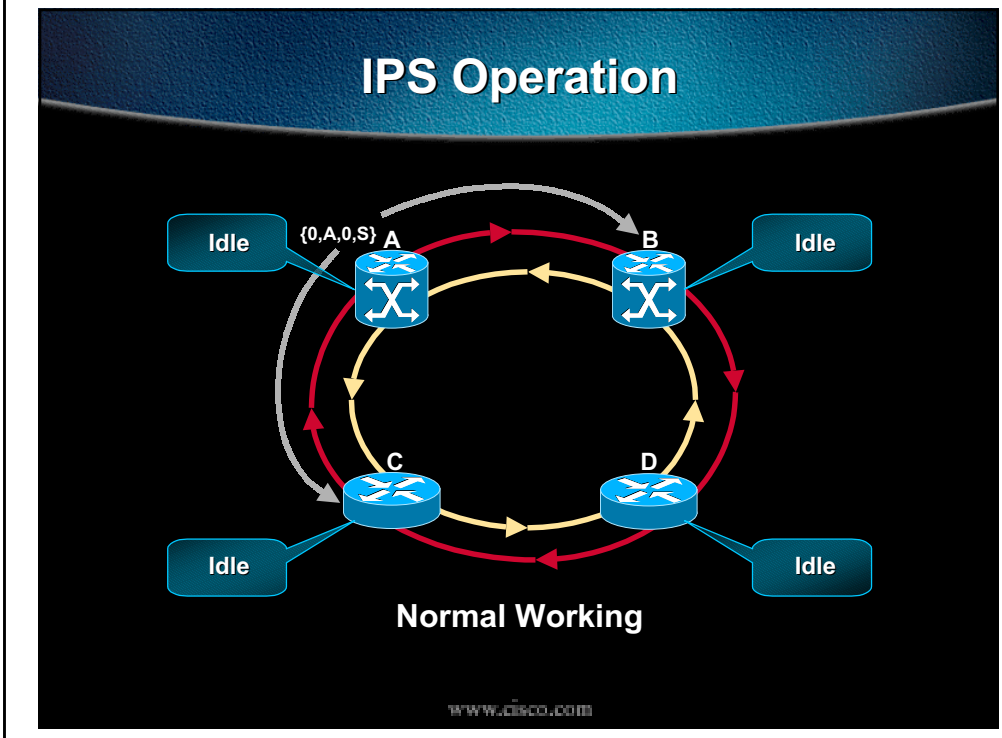
IPS States

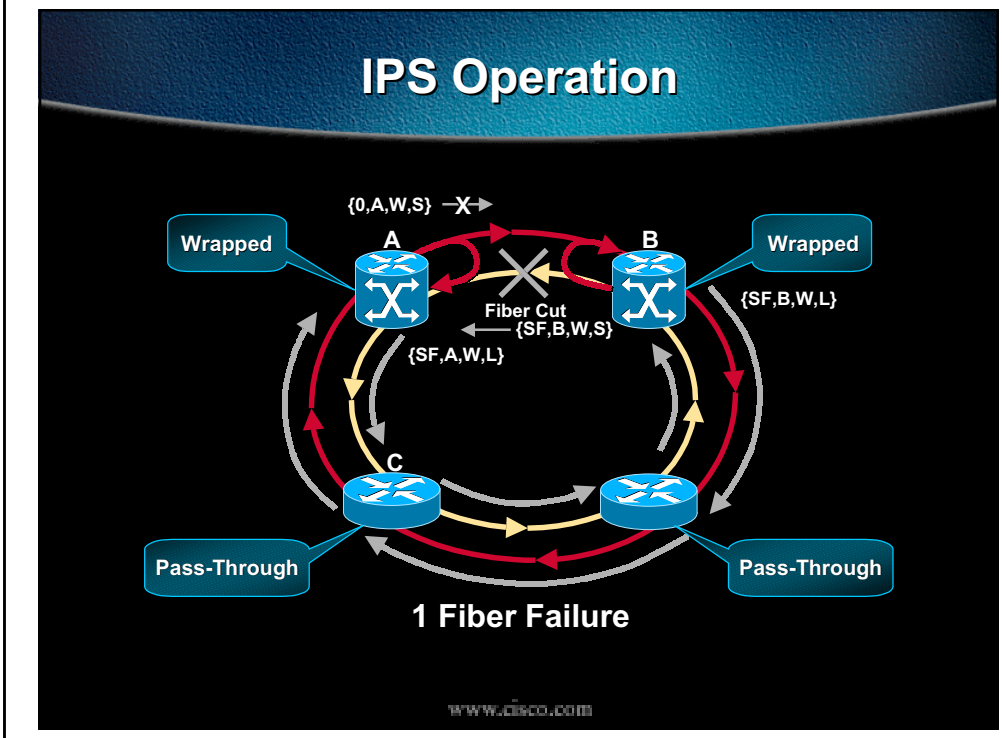
- Wrapped

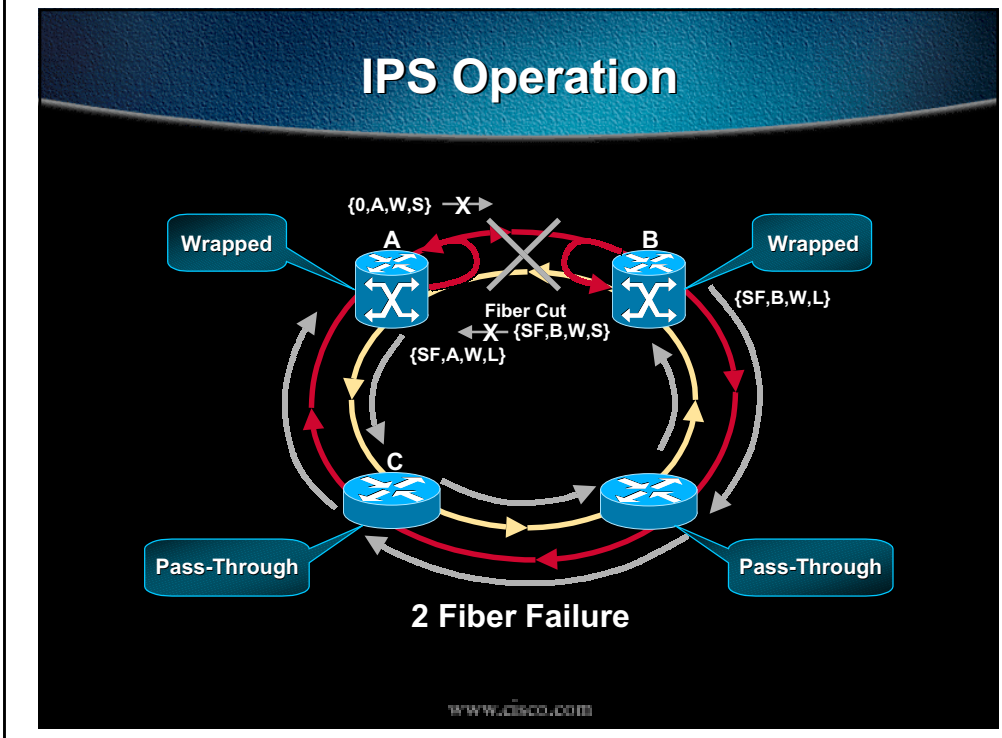
  The node enters this state when it receives a local request or detects a fault or receives a short path IPS packet from an adjacent node

  Performs a wrap

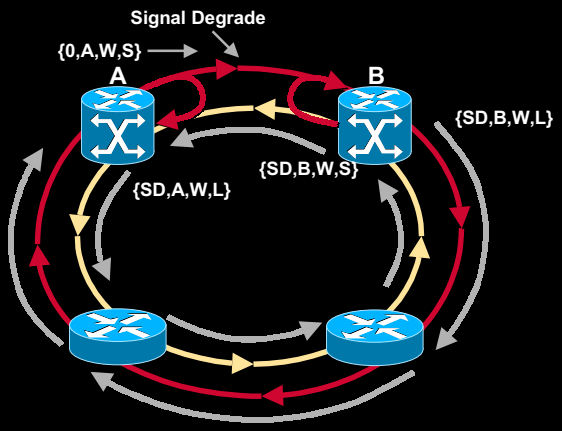








IPS Operation



Signal Degrade

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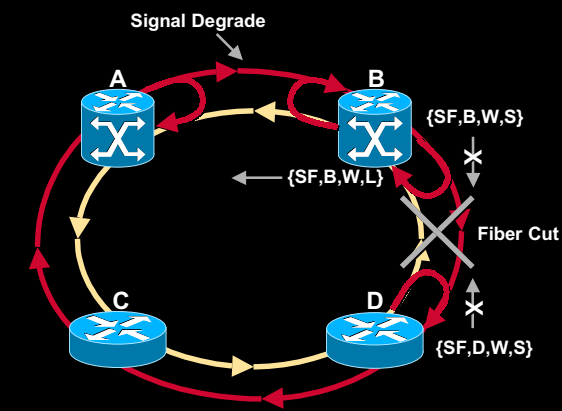
IPS Operation



Signal Degrade and Fiber Failure

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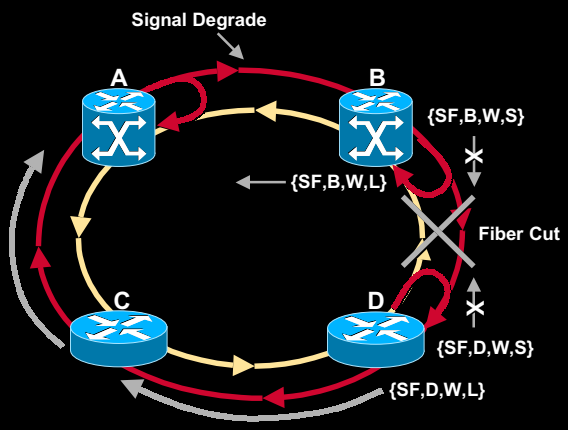
IPS Operation



Signal Degrade and Fiber Failure

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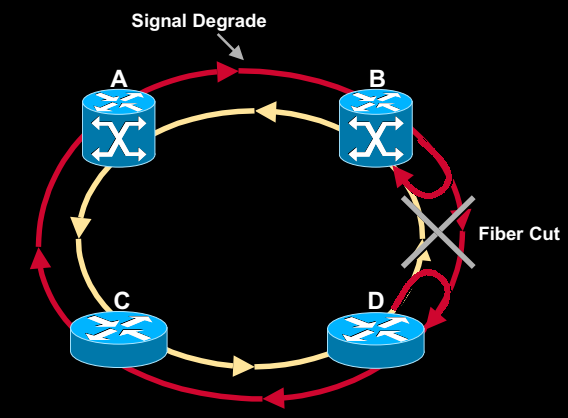
IPS Operation



Signal Degrade and Fiber Failure

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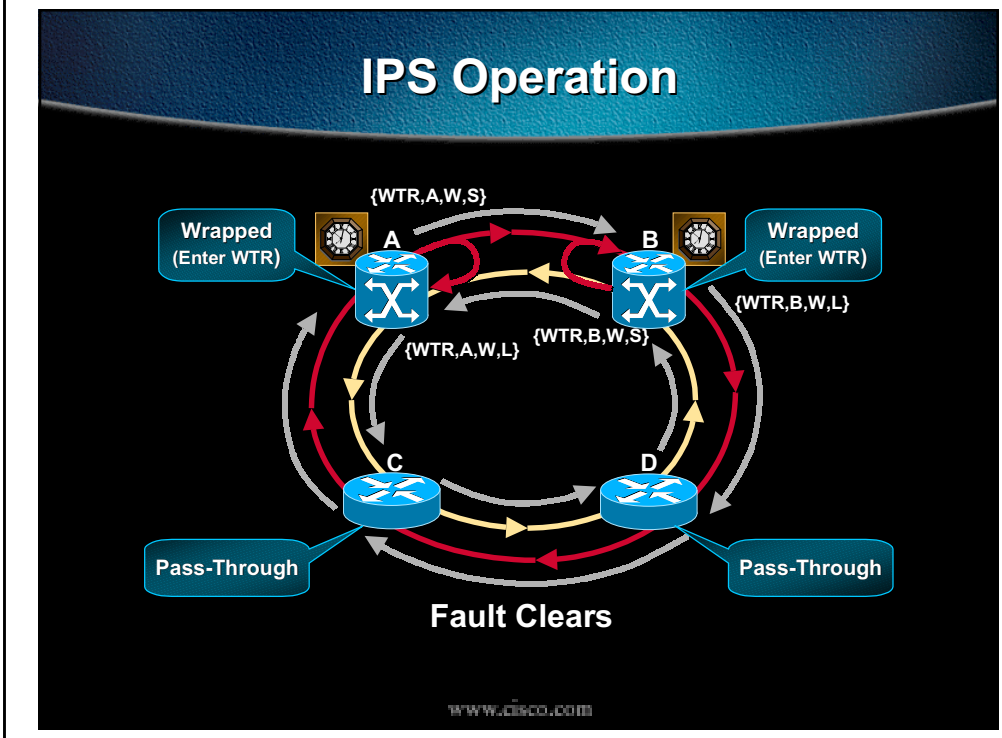
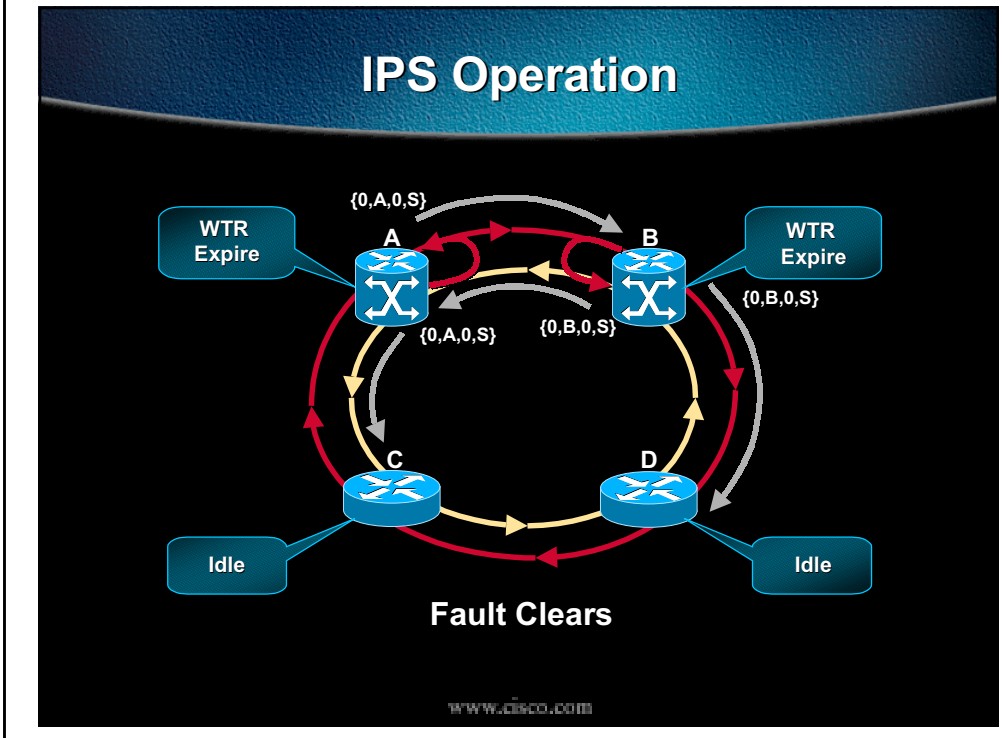
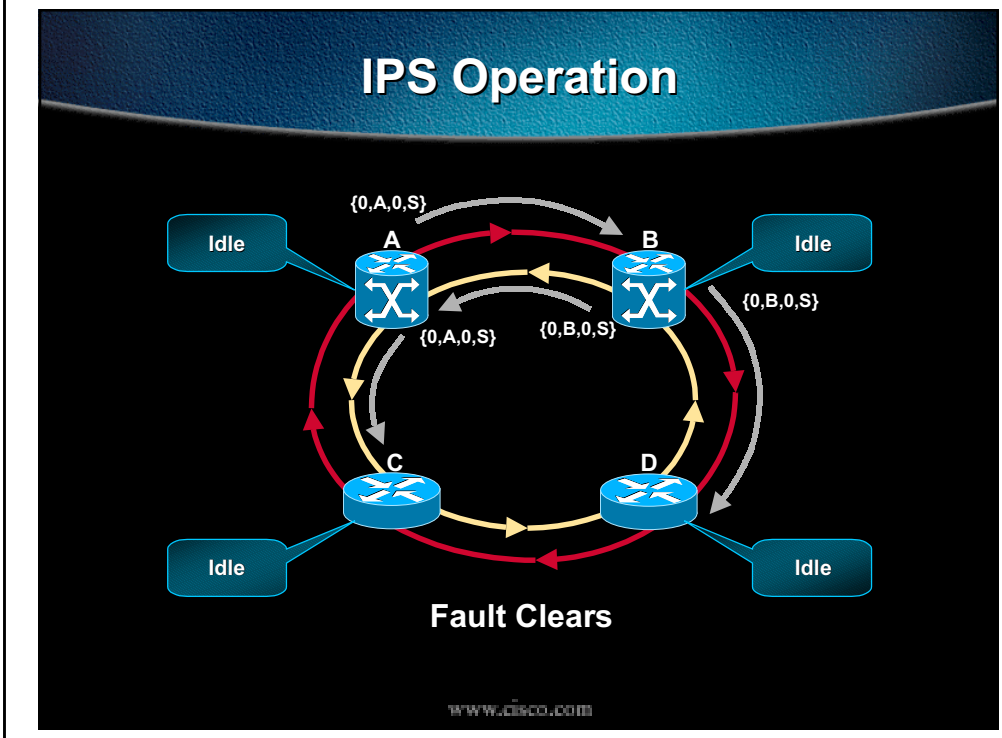
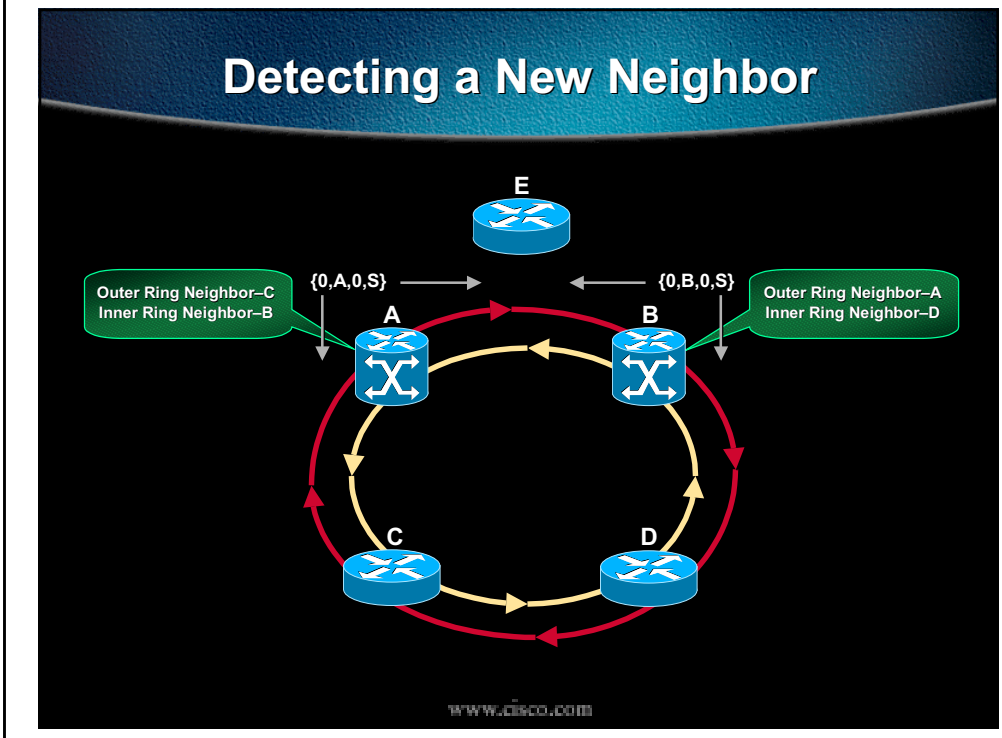
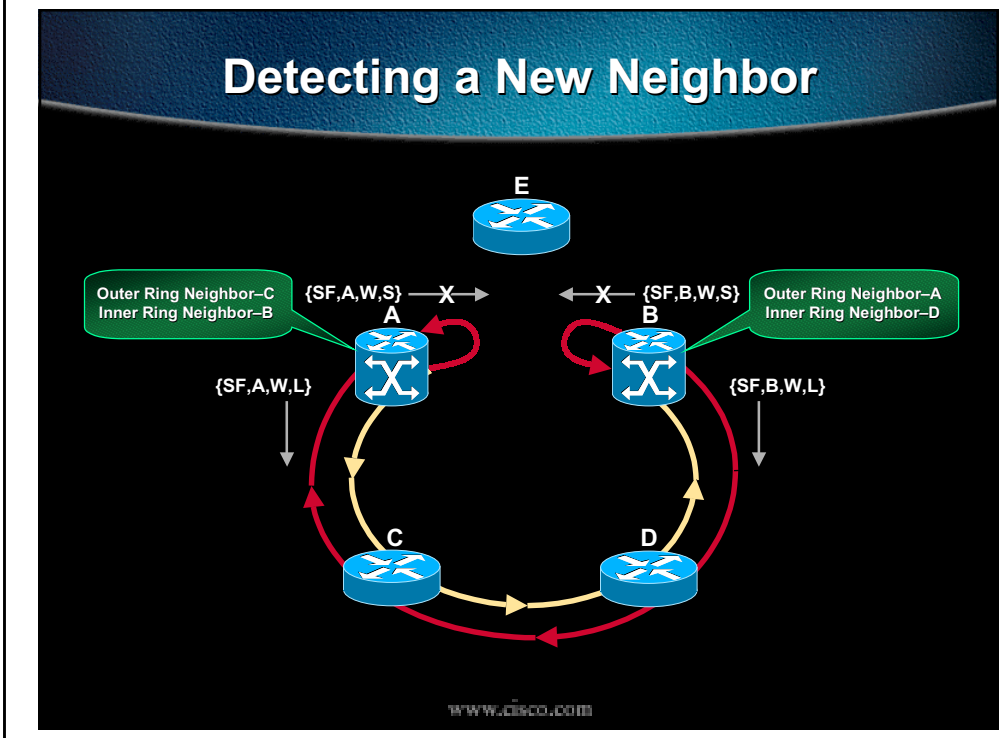
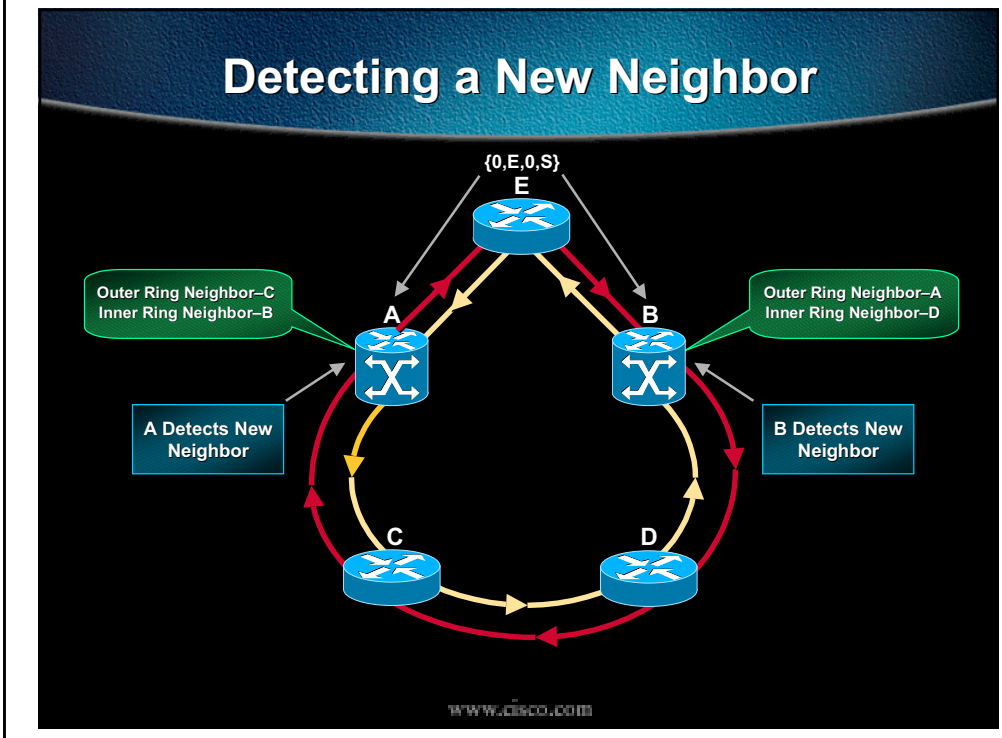




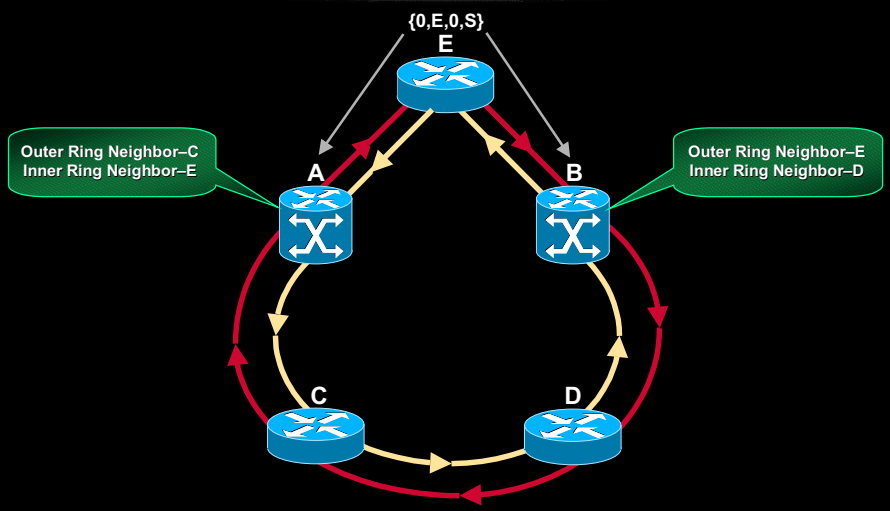








Detecting a New Neighbor



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DPT Management

- RFC 2558 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
- SRP MIB
- SRP MAC statistics

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SRP Agenda

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

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Clocking and Synchronization

- Three scenarios
  - ADM
  - WDM
  - Direct to fiber

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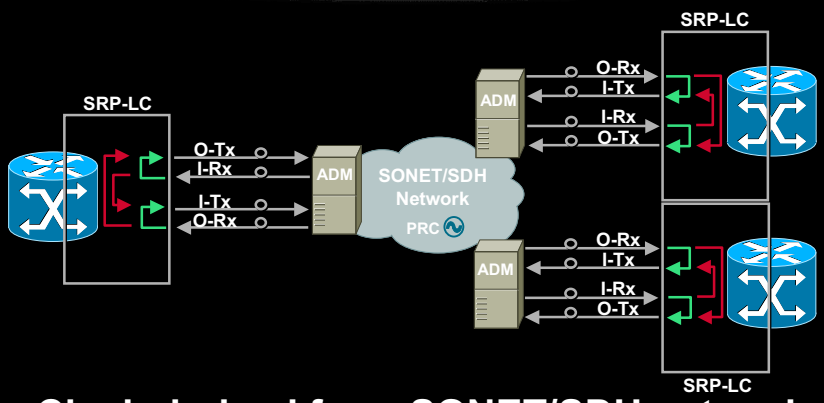
ADM



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

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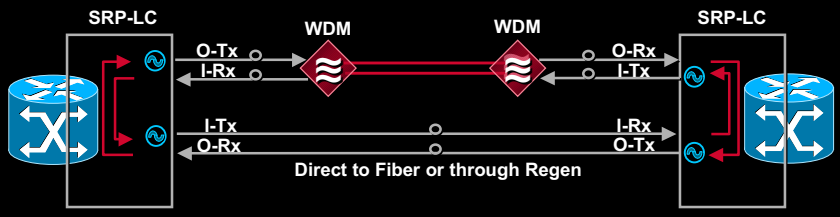
WDM or Direct to Fiber



- Clock derived from internal oscillator
- Internal oscillator has an accuracy of ± 20ppm
- Internal clocking

  Similar to doing POS back to back

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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

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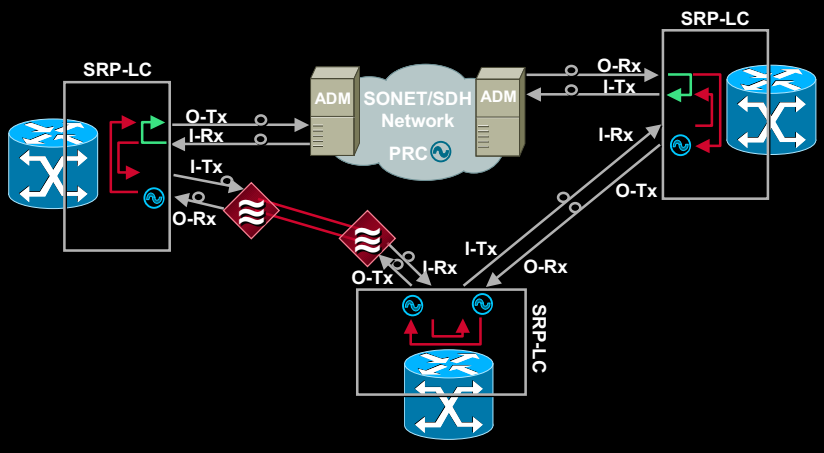
Mix



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SRP Agenda

- Overview
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Configuration Commands

```
GSR-core-1(config-if)#int srp 6/0
GSR-core-1(config-if)#ip addr 10.0.0.1 255.255.255.0
GSR-core-1(config-if)#no shut
```

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Configuration Commands

```
GSR-core-1(config)#int srp 6/0
GSR-core-1(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
  loopback        Configure (framer) loopback. WARNING: breaks connectivity
  reject          Reject packets based on source mac address
  report          Enable reporting of selected alarms
  shutdown        Shutdown request, shorthand for 'ips request forced-switch'
  threshold       Set BER threshold values
  topology-timer  Specify topology timer
```


Configuration Commands (Clocking)

```
GSR-core-1(config-if)#srp clock-source ?
  internal  Use internal clock (default)
  line      Recover clock from line

GSR-core-1(config-if)#srp clock-source line
GSR-core-1(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>

GSR-core-1(config-if)#srp clock-source line a ?
  <cr>
```

Configuration Commands (Framing)

```
GSR-core-1(config-if)#srp framing ?
  sdh    Select SDH framing and s1s0=2
  sonet  Select SONET framing and s1s0=0 (default)

GSR-core-1(config-if)#srp framing sdh ?
  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>

GSR-core-1(config-if)#srp flag ?
  c2  Path Signal Label byte (default 0x16)
  j0  Section Trace byte (default 0xCC)
```

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Configuration Commands (IPS)

```
GSR-core-1(config-if)#srp ips request ?
  forced-switch  Forced Switch request
  manual-switch  Manual Switch request

GSR-core-1(config-if)#srp ips request forced-switch ?
  a  Specify IPS request on side A
  b  Specify IPS request on side B

GSR-core-1(config-if)#srp ips request forced-switch a ?
  <cr>

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

GSR-core-1(config-if)#srp ips wtr-timer ?
  <10-600>  value in seconds
```

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Configuration Commands (Topology Discovery)

```
GSR-core-1(config-if)#srp topology-timer ?
  <1-600>  value in seconds
```

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Configuration Commands (Misc)

```
GSR-core-1(config-if)#srp count ?
  H.H.H  48-bit source address

GSR-core-1(config-if)#srp reject ?
  H.H.H  48-bit source address
```

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Configuration Commands (Diagnostic)

```
GSR-core-1(config-if)#srp loopback ?
  internal  Internal (framer) loopback
  line      Loopback line data

GSR-core-1(config-if)#srp loopback internal ?
  a  Loopback the A side of the interface (inner tx, outer rx)
  b  Loopback the B side of the interface (outer tx, inner rx)

GSR-core-1(config-if)#srp report ?
  b1-tca  B1 BER threshold crossing alarm
  b2-tca  B2 BER threshold crossing alarm
  b3-tca  B3 BER threshold crossing alarm
  lais    Line Alarm Indication Signal
  lrdi    Line Remote Defect Indication
  pais    Path Alarm Indication Signal
  plop    Path Loss of Pointer
  prdi    Path Remote Defect Indication
  sd-ber  LBIP BER in excess of SD threshold
  sf-ber  LBIP BER in excess of SF threshold
  slof    Section Loss of Frame
  slos    Section Loss of Signal
```


Configuration Commands (Diagnostic)

```
GSR-core-1(config-if)#srp report b1-tca ?
  a  Specify alarm report on side A
  b  Specify alarm report on side B
  <cr>

GSR-core-1(config-if)#srp shutdown ?
  a  Specify shutdown request on side A
  b  Specify shutdown request on side B
```

Show Commands

```
GSR-core-1#sh ver
Cisco Internetwork Operating System Software
IOS (tm) GS Software (GSR-P-M), Experimental Version 12.0(6.5)S1 [soma-v120_7_s_
throttle.build1 135]

[snip]

cisco 12008/GRP (R5000) processor (revision 0x01) with 131072K bytes of memory.
R5000 CPU at 200Mhz, Implementation 35, Rev 2.1, 512KB L2 Cache
Last reset from power-on

2 Route Processor Cards
2 Clock Scheduler Cards
3 Switch Fabric Cards
2 four-port OC3 POS controllers (8 POS).
1 OC12 POS controller (1 POS).
1 one-port OC12 SONET based SRP controller (1 SRP)
1 Ethernet/IEEE 802.3 interface(s)
9 Packet over SONET network interface(s)
1 SRP network interface(s)
507K bytes of non-volatile configuration memory.

[snip]
```


Show Commands

```
GSR-core-1#sh int srp 6/0
SRP6/0 is up, line protocol is up
  Hardware is SRP over SONET, address is 0010.1f41.28c0 (bia 0010.1f41.28c0)
  Internet address is 10.0.0.3/24
  MTU 4470 bytes, BW 622000 Kbit, DLY 100 usec, rely 255/255, load 1/255
  Encapsulation SRP,       Side A loopback not set   Side B loopback not set
     4 nodes on the ring   MAC passthrough not set
     Side A: not wrapped   IPS local: IDLE           IPS remote: IDLE
     Side B: not wrapped   IPS local: IDLE           IPS remote: IDLE
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of "show interface" counters 00:23:09
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 1 packets/sec
  5 minute output rate 2000 bits/sec, 3 packets/sec
     2998 packets input, 133047 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     5445 packets output, 442694 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     Side A received errors:
     0 input errors, 0 CRC, 0 runts, 0 giants, 0 ignored, 0 abort
     Side B received errors:
     0 input errors, 0 CRC, 0 runts, 0 giants, 0 ignored, 0 abort
```

Show Commands

```
GSR-core-1#sh srp

 IPS Information for Interface SRP6/0
 MAC Addresses
   Side A (Outer ring RX) neighbor 0010.1f41.2cc0
   Side B (Inner ring RX) neighbor 0010.f60e.d0c0
   Node MAC address 0010.1f41.28c0
 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     IPS Remote Requests
   Side A IDLE                    Side A IDLE
   Side B IDLE                    Side B IDLE
 IPS messages received
   Side A (Outer ring RX) {0010.1f41.2cc0,IDLE,S}, TTL 128
   Side B (Inner ring RX) {0010.f60e.d0c0,IDLE,S}, TTL 128
 IPS messages transmitted
   Side A (Inner ring TX) {0010.1f41.28c0,IDLE,S}, TTL 128
   Side B (Outer ring TX) {0010.1f41.28c0,IDLE,S}, TTL 128
```


Show Commands

```
    Source Address Information for Interface SRP6/0
        0010.f60e.d0c0, index 1, pkt. count 331
        0010.1f41.38c0, index 2, pkt. count 511458
        0010.1f41.2cc0, index 3, pkt. count 593484

     Topology Map for Interface SRP6/0
      Topology pkt. sent every 5 sec. (next pkt. after 3 sec.)
      Last received topology pkt. 00:00:01
      Nodes on the ring: 4
      Hops (outer ring)      MAC       IP Address      Wrapped Name
          0             0010.1f41.28c0 10.0.0.3          No    GSR-core-1
          1             0010.f60e.d0c0 10.0.0.4          No    GSR-core-2
          2             0010.1f41.38c0 10.0.0.1          No    GSR-core-3
          3             0010.1f41.2cc0 10.0.0.2          No    GSR-core-4
```

Show Commands

```
GSR-core-1#sh cont srp
SRP6/0
SRP6/0 - Side A (Outer RX, Inner TX)
SECTION
  LOF = 0          LOS    = 0                          BIP(B1) = 0
LINE
  AIS = 0          RDI    = 0          FEBE = 0        BIP(B2) = 0
PATH
  AIS = 0          RDI    = 0          FEBE = 0        BIP(B3) = 0
  LOP = 0          NEWPTR = 0          PSE  = 0        NSE     = 0
Active Defects: None
Active Alarms:  None
Alarm reporting enabled for: SLOS SLOF PLOP
Framing           : SONET
Rx SONET/SDH bytes: (K1/K2) = 0/0        S1S0 = 0  C2 = 0x16
Tx SONET/SDH bytes: (K1/K2) = 0/0        S1S0 = 0  C2 = 0x16  J0 = 0xCC
Clock source      : Internal
Framer loopback   : None
Path trace buffer : Stable
  Remote hostname : GSR-core-4
  Remote interface: SRP6/0
  Remote IP addr  : 10.0.0.2
  Remote side id  : B
BER thresholds:  SF = 10e-3  SD = 10e-6
TCA thresholds:  B1 = 10e-6  B2 = 10e-6  B3 = 10e-6
```


Show Commands

```
SRP6/0 - Side B (Inner RX, Outer TX)
SECTION
  LOF = 0          LOS    = 0                          BIP(B1) = 0
LINE
  AIS = 0          RDI    = 0          FEBE = 0        BIP(B2) = 0
PATH
  AIS = 0          RDI    = 0          FEBE = 0        BIP(B3) = 0
  LOP = 0          NEWPTR = 0          PSE  = 0        NSE     = 0
Active Defects: None
Active Alarms:  None
Alarm reporting enabled for: SLOS SLOF PLOP
Framing           : SONET
Rx SONET/SDH bytes: (K1/K2) = 0/0        S1S0 = 0  C2 = 0x16
Tx SONET/SDH bytes: (K1/K2) = 0/0        S1S0 = 0  C2 = 0x16  J0 = 0xCC
Clock source      : Internal
Framer loopback   : None
Path trace buffer : Stable
  Remote hostname : GSR-core-2
  Remote interface: SRP6/0
  Remote IP addr  : 10.0.0.4
  Remote side id  : A
BER thresholds:  SF = 10e-3  SD = 10e-6
TCA thresholds:  B1 = 10e-6  B2 = 10e-6  B3 = 10e-6
```

Debug Commands

```
GSR-core-1#debug srp ?
  cam        SRP CAM
  error      SRP protocol errors
  ips        SRP IPS
  packet     SRP packets
  periodic   SRP periodic activity
  topology   SRP topology
```

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SRP Agenda

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

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Application

- POP interconnect
- Campus ring
- Metro/city ring
- Hierarchical ring

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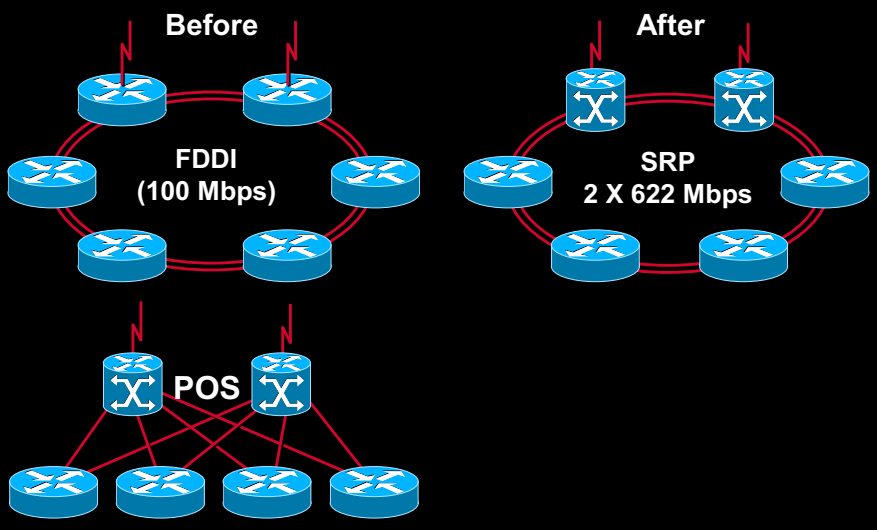
POP Interconnect



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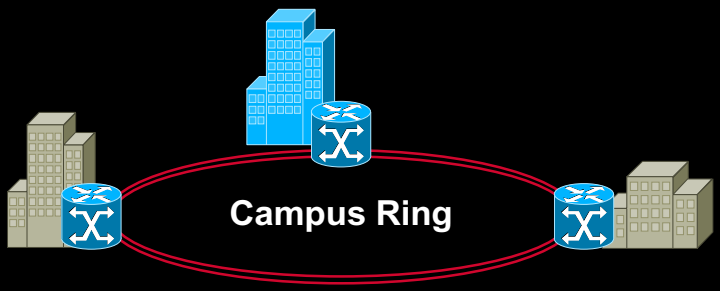
Campus Ring



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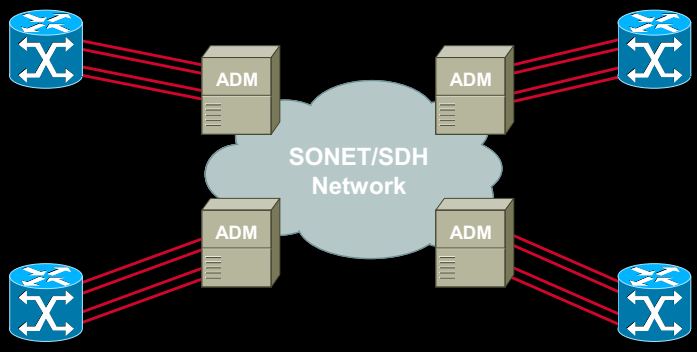
Metro/City Ring—SONET/SDH



Requires Concatenated Interfaces on the ADM

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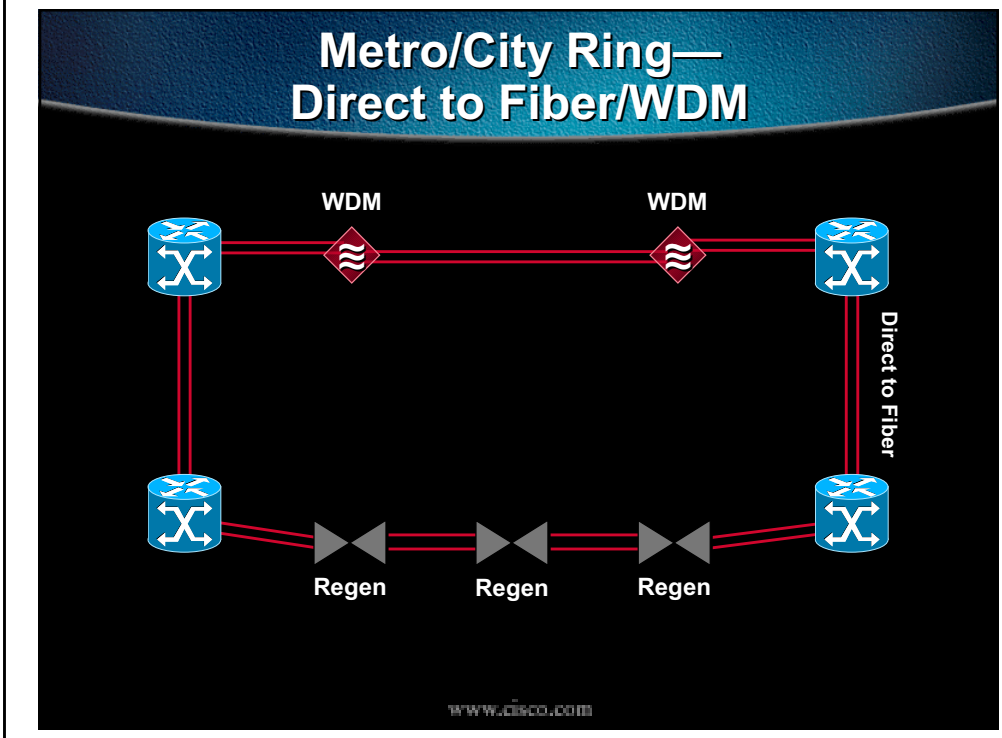

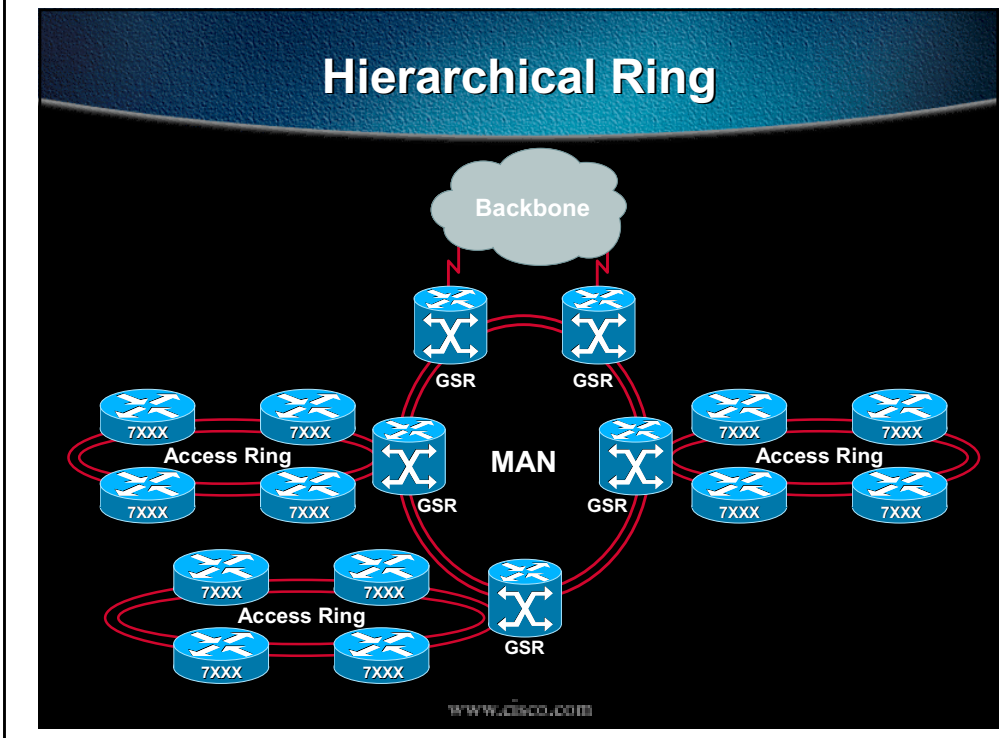

SRP Agenda

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

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DPT Product Highlights

- Cisco GSR linecard
- Cisco 7500 dual wide port adapter
- Multimode and single-mode
- IR, LR and XR
- 1310 nm and 1550 nm

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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

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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

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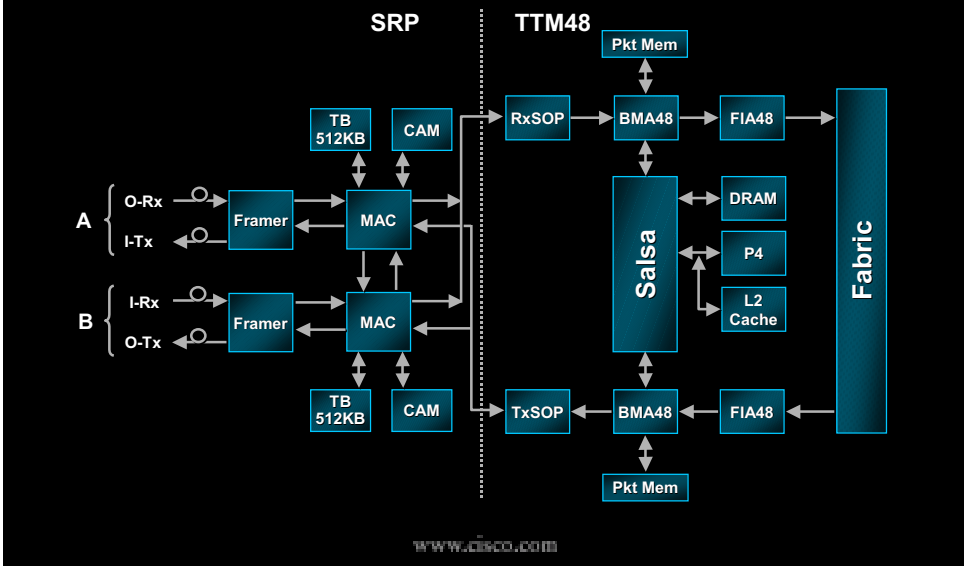
GSR DPT Linecard



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

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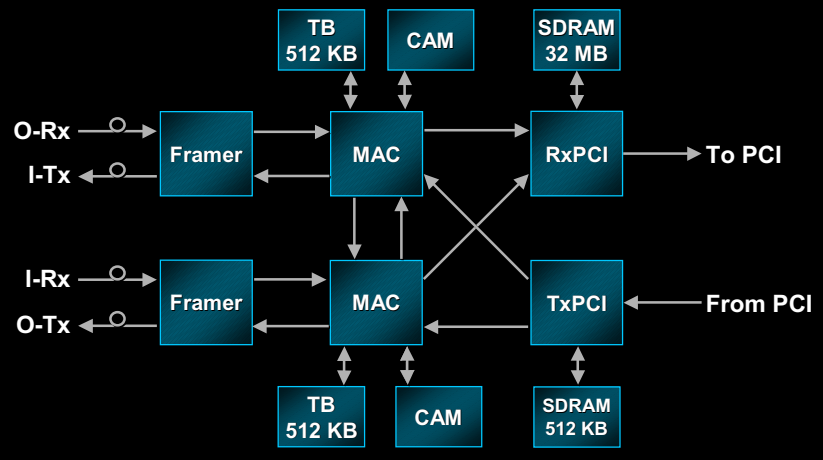
Cisco 7500 DPT PA



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Conclusions

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

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