A large, faint, light blue watermark of the Cisco logo is visible in the background of the slide.

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Service Integrity for PacketCable

Redundancy & Availability

John J. Downey

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Big Picture for Availability

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- **RF Plant**
Nodes and power supplies
- **Upstream (Advanced Spectrum Management)**
Frequency hopping, channel width and modulation profile changes
- **CMTS**
HCCP (Hot Standby CMTS-to-CMTS Protocol)
RF-Switch
- **WAN**
HSRP (Hot Standby Routing Protocol)

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Agenda


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- **Advanced Spectrum Management**
Upstream Availability
- **CMTS Availability**
RF-Switch
uBR10012
- **Future Products**
- **Summary**

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Advanced Spectrum Management

Upstream Availability

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Spectrum Management Implementations

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- **CNR**
 - Real-time spectrum analysis
 - Impulse noise tracking
 - Look Ahead
- **SNR**
 - Broadcom chip
 - Estimate
 - Averaging over time with data traffic
- **What are we trying achieve?**
 - HFC plant integrity via frequency hopping, ...
 - Increase availability / service “up-time”
 - Proactive vs reactive

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Frequency Hopping Pros

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- **Great way to increase availability of upstream plant**
- **Run modems 3 dB hotter**
 - If you base your levels off of power/Hz
 - Some of the spectrum is allocated just for redundancy
- **Hop based on time of day and day of week**
- **Assign a different power based on the hop freq. or range of frequencies (32 ranges)**
- **Increase availability even more**
 - Change modulation and/or bandwidth in addition to frequency hopping
 - Use spectrum areas previously avoided because of potential ingress (CB @ 27 MHz, Ham @ 28 MHz, etc.)

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Frequency Hopping Cons

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- **Some people will rely on this for availability instead of cleaning their plant**
- **Ingress at 15 MHz will still affect modems at 30 MHz**
 - Laser clipping, harmonics,...
- **More bandwidth must be allocated for redundancy/hopping**
- **If blind hop, you could spend more time hopping than actually transmitting data**

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MC16/5x20S Spectrum Management Card

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- **First DOCSIS line card to offer an integrated spectrum analyzer**
- **Reduces the reliance on costly spectrum analyzers at every headend or hub**
- **Quickly provides spectrum views without the complicated setup time of a spectrum analyzer**



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S Card Advantage

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- **Hardware-assist frequency hopping with software enhancements:**
 - Shift upstream (US) channel center frequency
 - Hop to new center frequency in clear spectrum
 - Change modulation
 - Reduce upstream channel bandwidth
- **Flexible configuration choices for pro-active channel management**
 - Default priority is frequency, modulation, channel width
- **Programmable thresholds**
 - CNR, FEC, station maintenance, hop time

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MC16/5x20S Benefits

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- Improves response time to ingress and noise impairments
- Eliminates “blind” and unnecessary frequency hops
- Saves time and effort by MSO staff when troubleshooting cable plant impairments
- Increases cable plant availability
- Improves % of modems on-line
- Maximizes spectrum utilization

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Spectrum Management Enhancements

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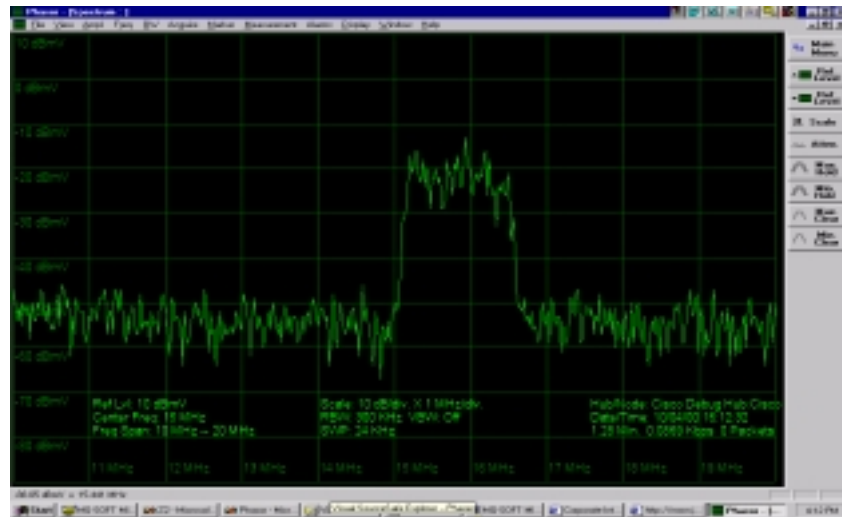
- Hopping criteria based on C/N ratio
- User-configurable criteria maintains highest
Channel width & modulation rate
Bit rate
- Dynamic modulation selection
- Revert to original channel settings when available
- Interface for real-time spectrum display

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Real Time Spectrum Display



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CNR-Based Hopping Criteria

- **Dual hop criteria in addition to station maintenance**
 - Modem performance**
 - Corr/Uncorr Forward Error Correction (FEC)**
 - CNR**
- **User-configurable CNR threshold criteria for both modulation schemes**
- **Active channel measurements**
- **View spectrum band around single modem transmit**

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DOCSIS Cable Modem Test Analyzer (DCMTA)

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- Acterna software
- Interactive CD with Cisco S card purchases
- 30 day free trial w/ Acterna license for all CMTSs
- Real-time spectrum analysis from 5-42 MHz
- Software resides on any pc w/ a link to uBR
- Supports MC16S cards: uBR7223, 7246, VXR

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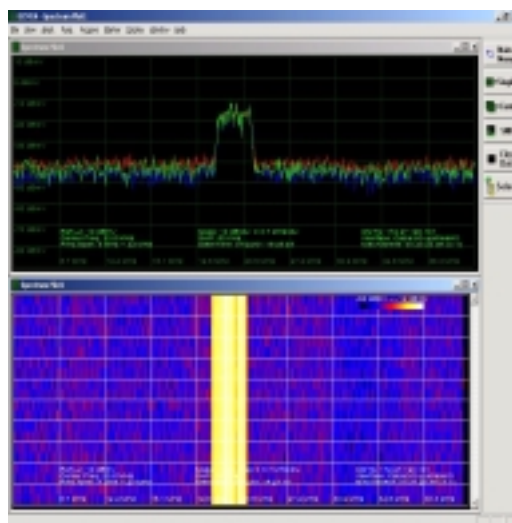
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3 Modes of Operation

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- Spectrum Analyzer
 - Single
 - Continuous
- Amplitude vs Time
 - Similar to zero-span
- Spectrogram
 - Color coded interpretation of time vs freq vs amplitude



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Modem & Port Analysis

- Quick and simple way to gauge the noise on an individual US
- Select US port in the tree, immediately taken to spectrum view of that US port
Can see ingress under the carrier



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Test Analyzer Benefits

- Automatically populated network tree ensures you're always viewing accurate data from the CMTS
Newly provisioned modems
Even self installs!
- Easily and quickly choose the US port or modem to analyze and launch the spectrum analyzer view immediately
Live troubleshooting of an US port or single modem
- Proactively address ingress before affecting customers
- Measure ingress on the uBR port (under the carrier!)
- Easily troubleshoot cable modems in real-time
Identify low/high modem transmit signal levels
- No re-cabling or test points required to support diagnostics

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Advanced Spectrum Management Summary

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- **Proactive maintenance**
- **Increased availability**
Practically a necessity for 3.2 MHz channel at 16-QAM
- **Efficient troubleshooting**
Time and money savings
- **Not meant to replace return path monitoring equipment or spectrum analyzers but;**
Great for troubleshooting and seeing noise right at the upstream port input and under the carrier
Convenient and less setup issues
Needed for advanced spectrum management

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CMTS Availability

RF-Switch & uBR100012

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Typical Redundancy Options

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- **P/S**
- **WAN**
- **1:1 and N:1**
- **Upconverter**
- **Hot-standby N+1 (HCCP)**
Without an RF-Switch
With an RF-Switch

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Components

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- **Wavecom Upconverter w/ SNMP**
HD4040
Dual4040D & MA4040D
- **RF-Switch**
3 DS x 10 US
- **uBR 10012**
MC28C linecards

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RF-Switch


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RF-Switch Views



Front Panel



Rear Panel

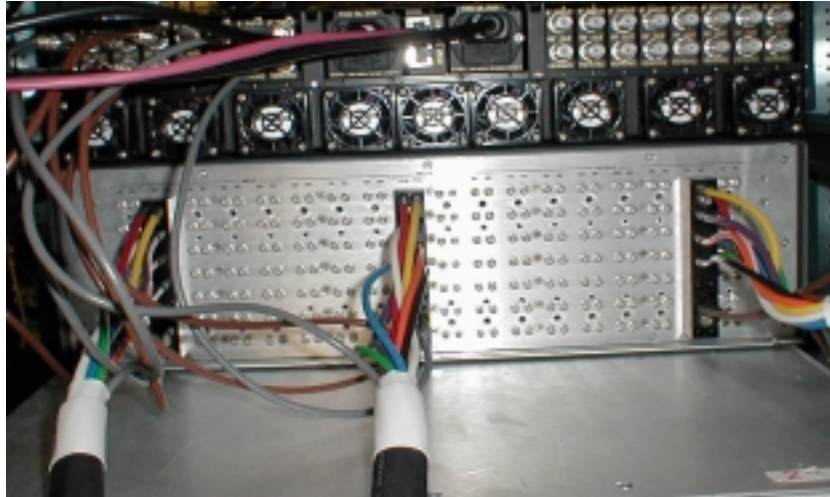
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RF-Switch Header & Wiring

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Switch & Upconverter – Front View

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RF-Switch Design

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- Flexible, scalable external design
- 252 connections in 3RU of rack space
- Fully passive “Working” path = high MTBF
If Switch relay goes bad or powered off, Working isn’t affected
- Active modules only in “Protect” path, serviceable with no disruption
- Latching relays increase reliability
Self-testing relays for offline testing
- Enables RF cabling migration with no downtime (e.g. MC28C to MC520S)

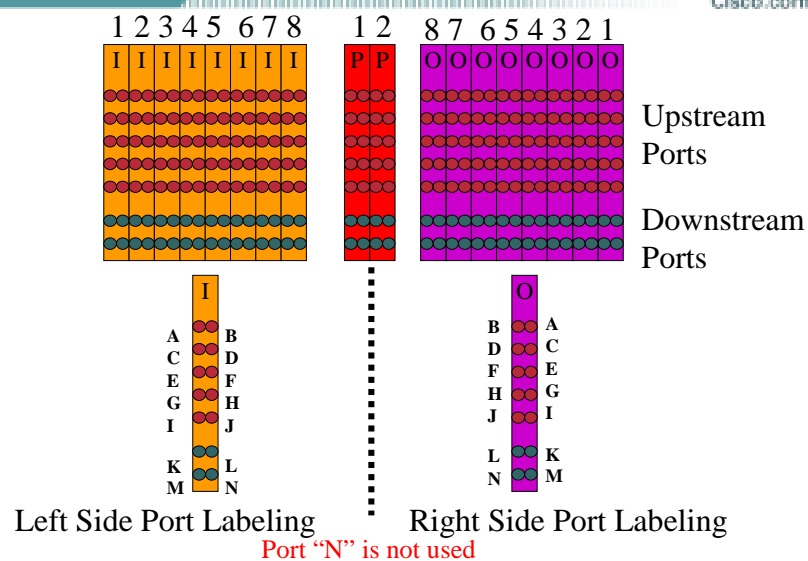
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RF-Switch Labeling

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Switch Operation

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- **Two modes of operation**

Mode 1 = 8 + 1

All 8 input cards protected by 1st Protect

Mode 2 = 4 + 1

Input cards 5 to 8 protected by 1st Protect

Input cards 1 to 4 protected by 2nd Protect

- **Programmed through CLI**

- **Fail-over times about 3-5 seconds**

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RF-Switch Operation

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- **Maintains normal operation even with no power**

- **Modules in front are hot-swappable**

Removal doesn't affect normal operation

- **Only supports 3x10 DS-to-US configuration, but RF-Switch "may" be user configurable**

- **Configurable times**

- **Debug and test commands**

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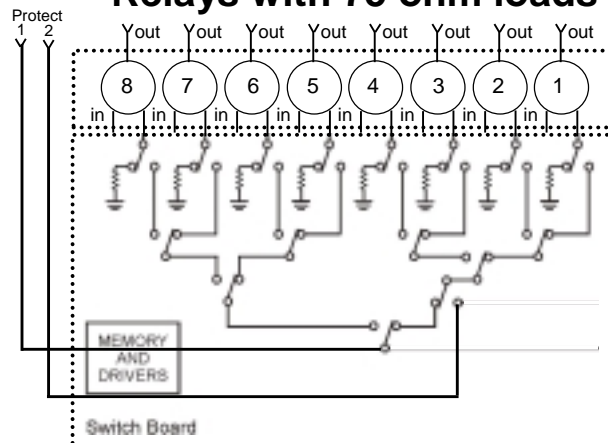
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Block Diagram

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- **Relays with 75 ohm loads**



Power splitter card/Switch card

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Testing Switch Relays

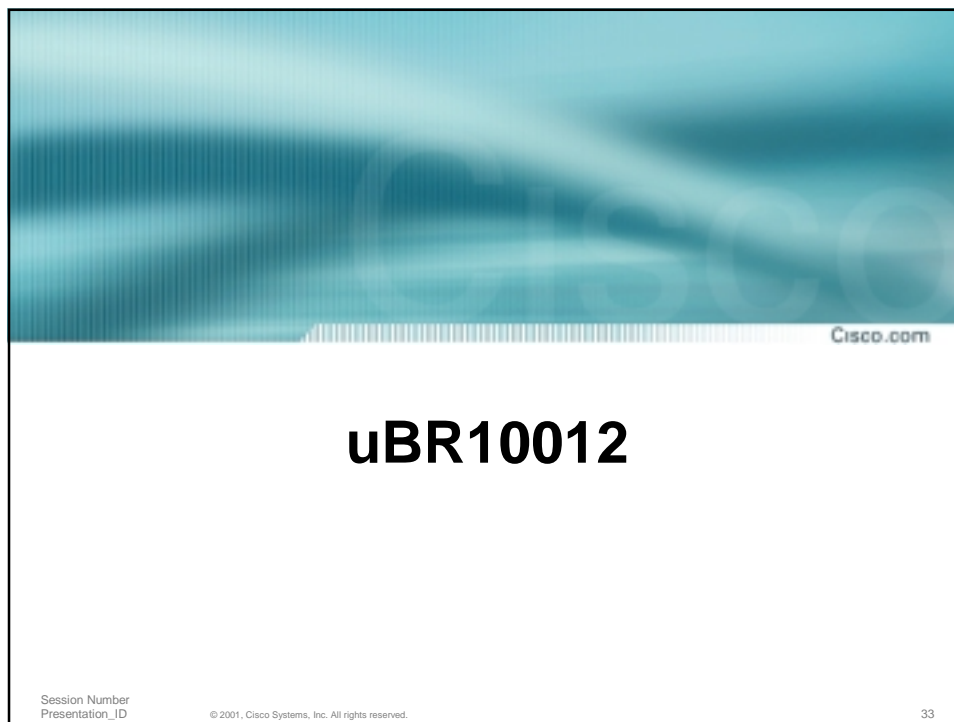
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- **Can toggle Switch relays without affecting upx or CMs**
Important if testing relays without actually failing over
Recommend testing relays once a month / once a week
- **Can do an entire bitmap group, individual ports, or whole Switch**
Don't toggle whole Switch while in Protect mode
- **Corresponding module LEDs turn green to amber**

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What Initiates a Switch-Over

- Shut down the active cable interface
- On-line insertion removal (OIR) of active line card
- CLI entered commands
- Software crash of the active line card
- Third party initiated failures (like upx failures)
- DS cabling failure via "KeepAlive" feature
- Resetting the line card

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Smart Switching Capability

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- **Protect Group x protects all MAC domains assigned to Group x**
- **Can switch specific cards or MAC domains**
Switch groups can be defined within a card
- **Switch-over activates “Protect” upx and de-activates “Working/Active” upx**

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uBR 10K Setup

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- **Always review config when updating IOS to latest code**
- **Configure Working interfaces before Protect interface(s)**
- **10K interfaces are “no shut” by default, unlike other uBRs**
- **DS mod and interleaving not synced over**
Must be the same on all members of a group and related Protect to keep modems on-line
- **DS freq. has to be set in 10K config for “Working” interfaces**
Protect upconverter module could change its frequency to a potentially wrong frequency
- **Current IOS version, which supports N+1 on the schooner, is ubr10k-k8p6-mz.12.2(4)BC1b image**

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2x8 Card Mini-Coax Wiring

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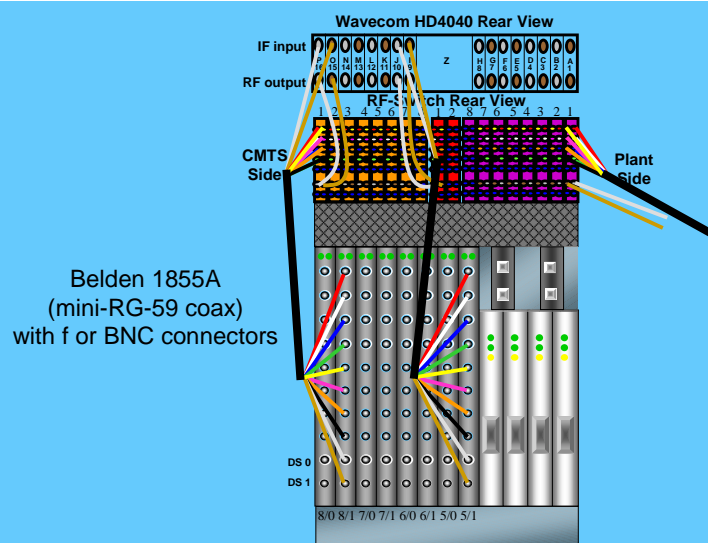
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Example Layout

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7+1 Card-Level Redundancy

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- **10K and RF-Switch**
- **Slightly under utilized RF-Switch**
Spare RF-Switch slot for future wiring
- **2x8 cards with 2 Working groups**
2 domains per card
- **Cost efficient**
- **No protection if the whole chassis goes down**
Considered a “multiple catastrophic” failure
Not likely since 10K has a passive chassis, redundant PREs, TCC+, WAN, & Power Supplies

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10K w/ Mini-Coax and RF-Switch

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Future Products

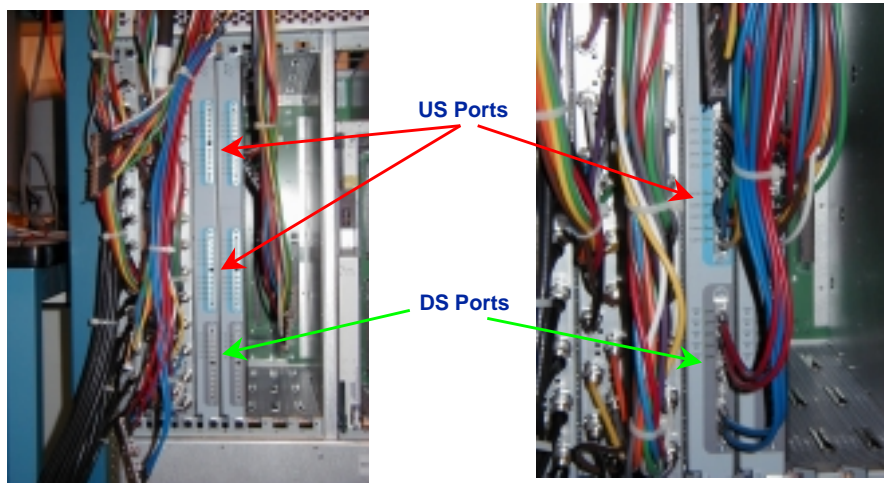
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uBR MC520S w/Dense Connector

- Easy to read port markings
Even with cabling installed



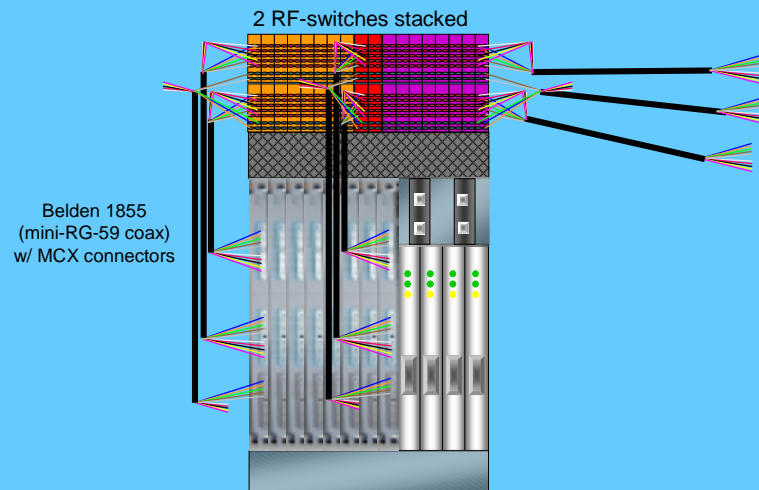
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7+1 Card-Level Redundancy

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7+1 Card-Level Redundancy


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- 10K and 2 RF-switches
- Slightly under utilized RF-switches
- 5x20 cards with dense connectors & 5 Working groups
- Spare RF-Switch slots for future wiring
- No protection if the whole chassis goes down
- Not sure of MAC domains at this point
- Most value for the investment

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Summary

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Single Points of Failure

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- **uBR10012 chassis**
Passive chassis has very high MTBF
- **RF-Switch**
Totally passive working path
- **Upstream port**
- **Protect card**
- **Protect upconverter**

Packetcable specification met with these elements

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Closing Points

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- **Cover US spectrum**
DS frequency is next on the roadmap
- **Cover hardware**
- **Cover the backhaul**
- **Single points of failure need to be assessed**
- **We can't cover every conceivable failure, but knowing which ones are more prevalent will help**
- **Happy customers!**
"Word of mouth" advertising
- **Load balancing is next**

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For More Information

Cisco.com

- **Supporting Docs, References**
www.cisco.com/univercd/cc/td/doc/product/cable/rfswitch/
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