



Wireless Seminar Fiber to the Antenna (FTTA)

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Agenda

Fiber to the Antenna (FTTA)

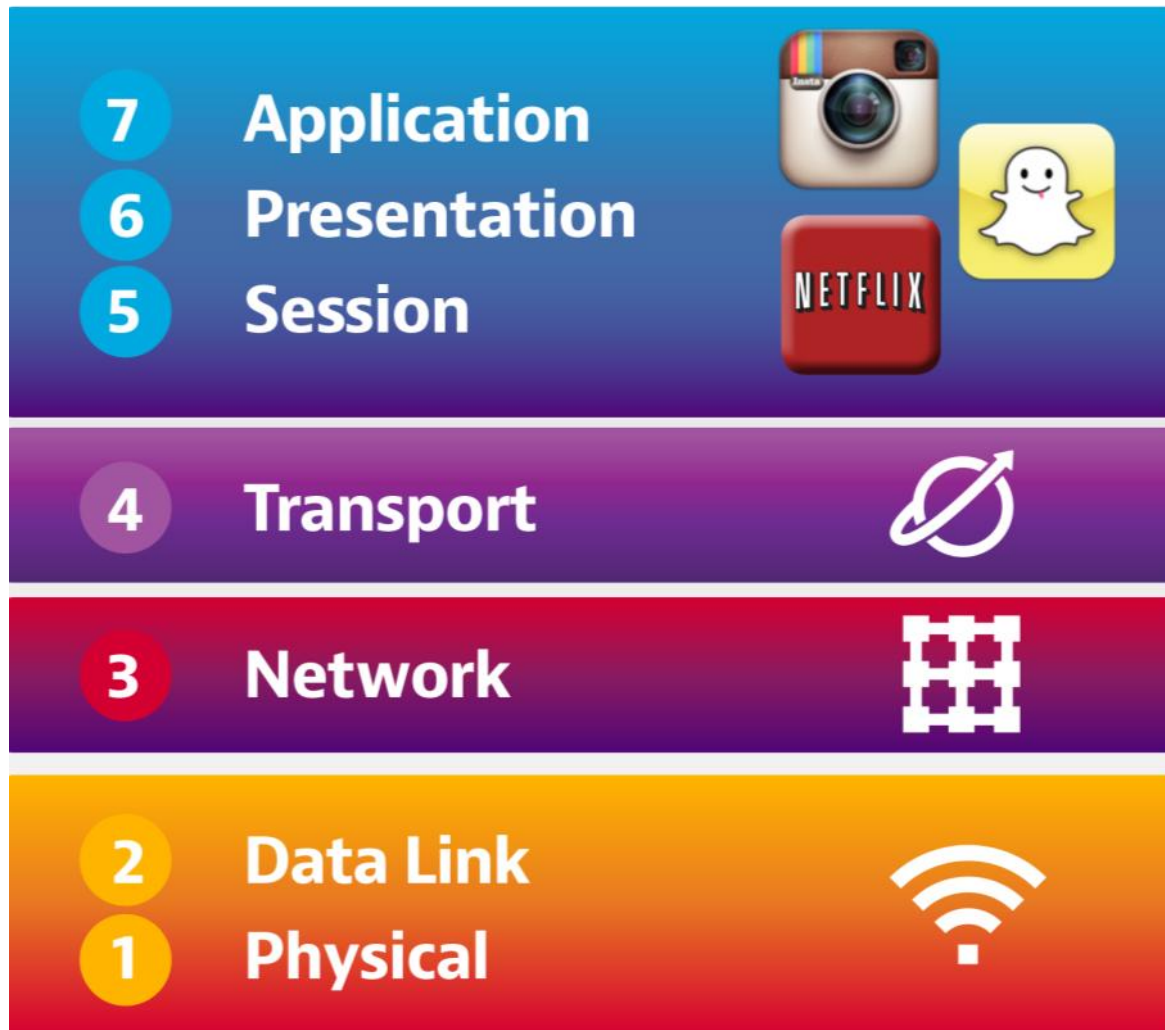
- Introduction and challenges
- Base station installation - FTTA
- Base station maintenance - FTTA
- RF Interference detection over fiber



Introduction and challenges



Network Layers: Bottom to Top



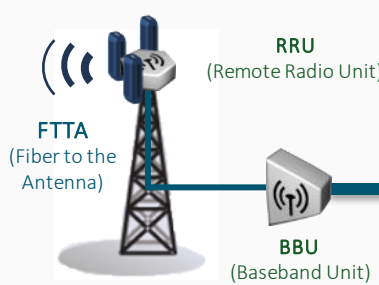
Evolution of Wireless Networks and Outdoor Mobile Deployments

Cell Site

Core Site

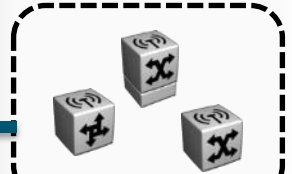
Central Site

MACROCELL



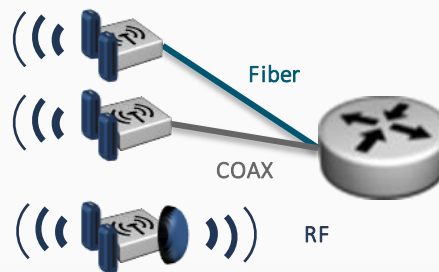
Backhaul

Mobile Switching Center



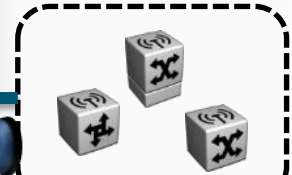
BSC/RNC SGW/MME

SMALL CELLS



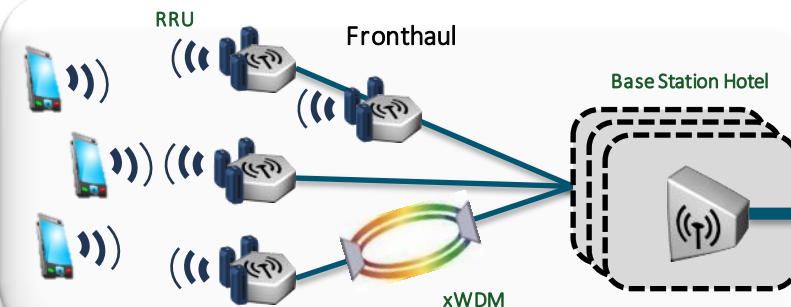
Backhaul

Mobile Switching Center



BSC/RNC SGW/MME

DISTRIBUTED ANTENNA SYSTEMS



Backhaul

Mobile Switching Center



BSC/RNC SGW/MME

Fiber Up the Tower – Interconnects

RRU



RRU Jumper



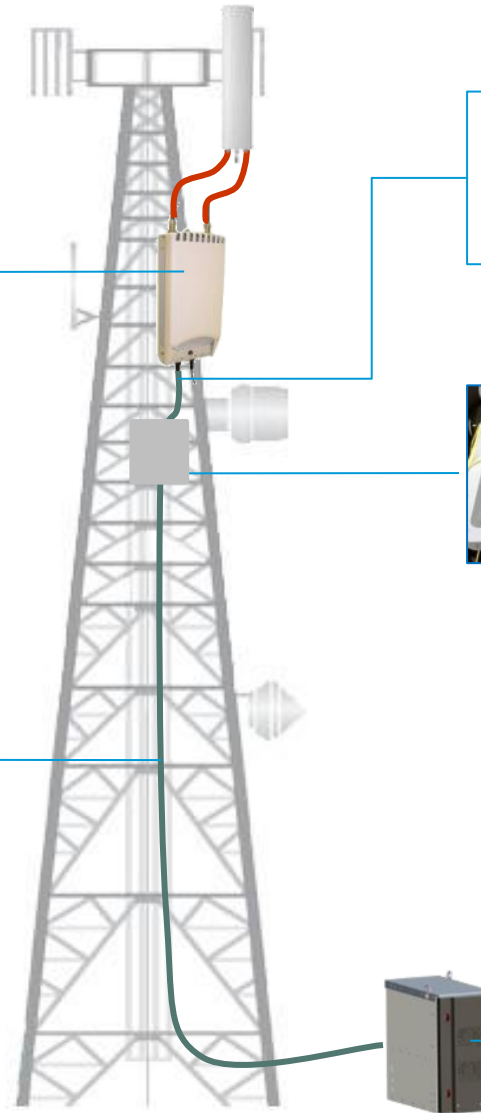
Junction Box



Trunk Cable



BBU and Fiber Patch Panel



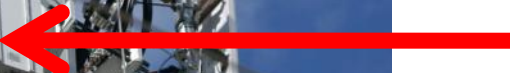
Remote Radio Site (at least 3dB Gain)



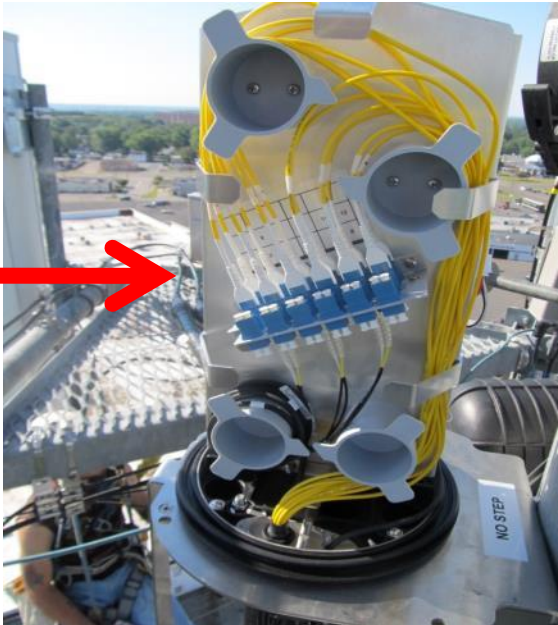
Fiber Junction Box



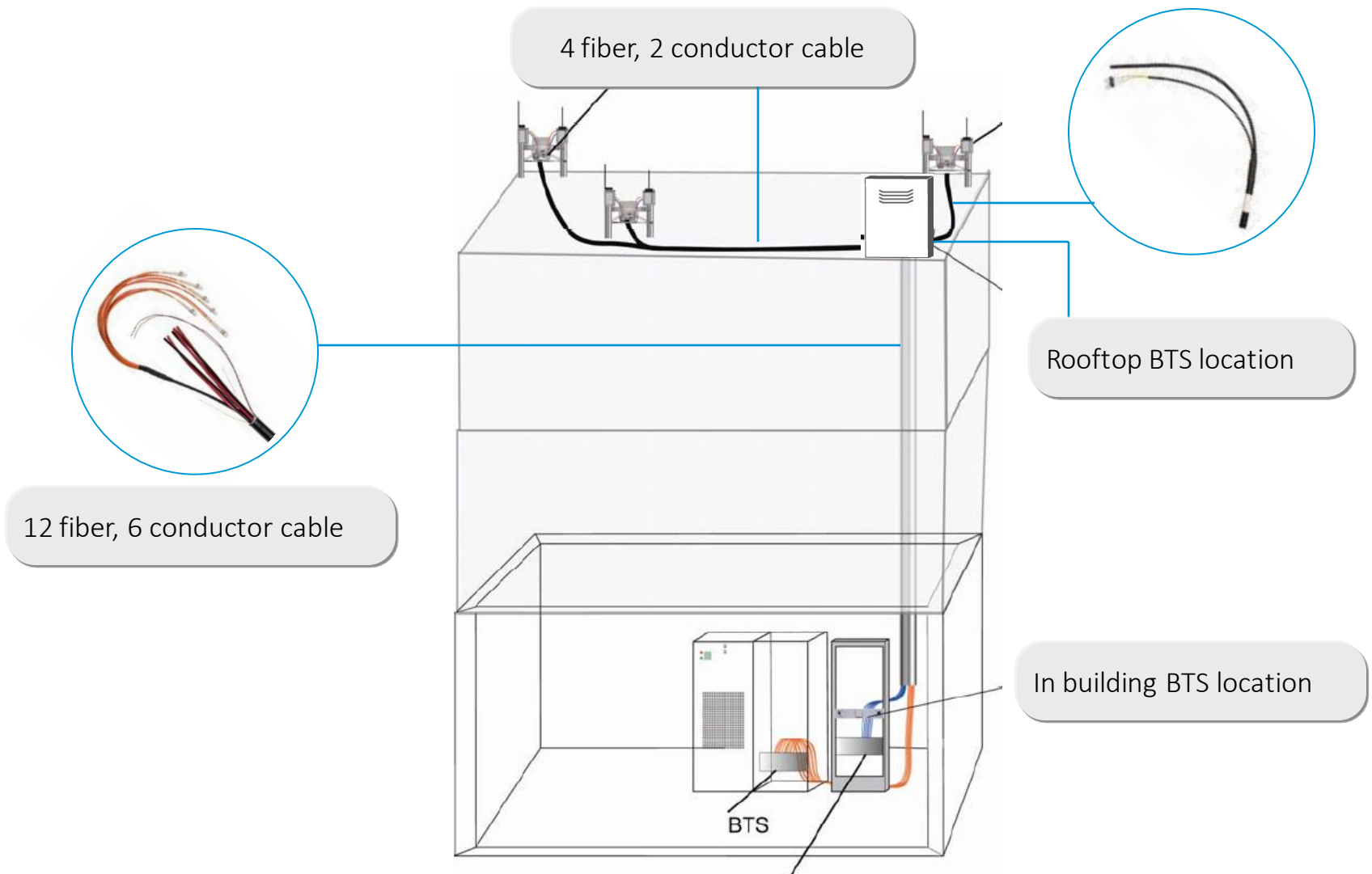
4T4R RRH



4T4R Antenna



RFF Standard Sector Solution Set



Fiber Testing – Why it's needed

- The BBU/RRU Green Light shows it's working.
 - This does not guarantee system performance.
 - Signal levels could be marginal or on threshold.
 - Need to ensure the network is ready to survive environmental effects network ageing
- The dust caps keep the connectors clean
 - This does not guarantee the connection is clean.
 - Vendors are unable to warrant cleanliness.
 - Small particles can still migrate onto the surface.
 - Contamination can occur during build/staging
- If the cable does not work we replace it.
 - Where is the fault? (macro bend, bad or dirty connector, break, polarity...)
 - How long does this add to the job?
 - What if it's the trunk cable, cross over issue..
- Large optical budget head room is not a license for bad habits.
- Ignoring best practices is costly
- Protect yourself from reruns

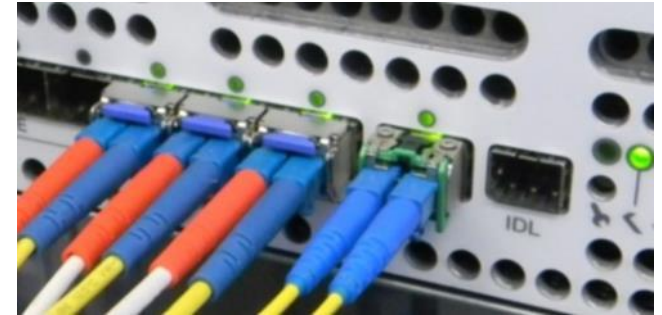
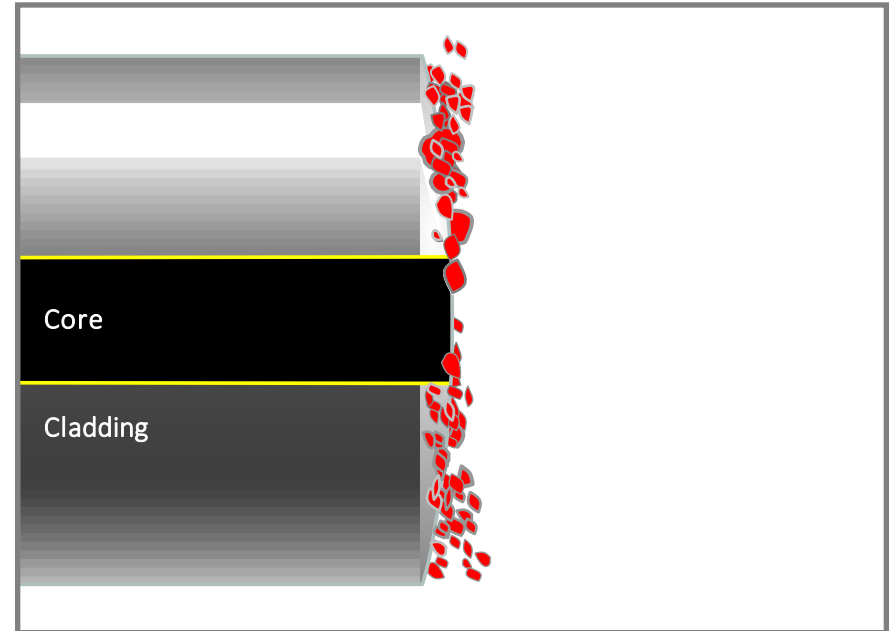
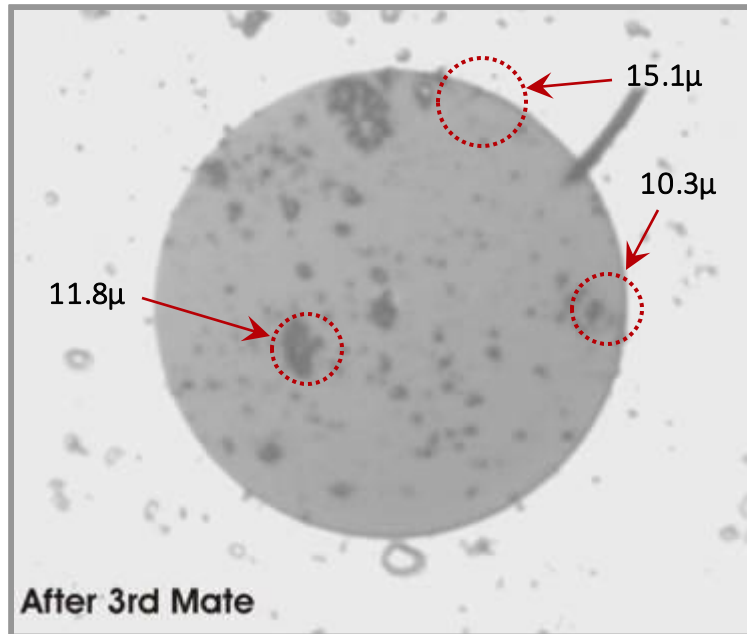


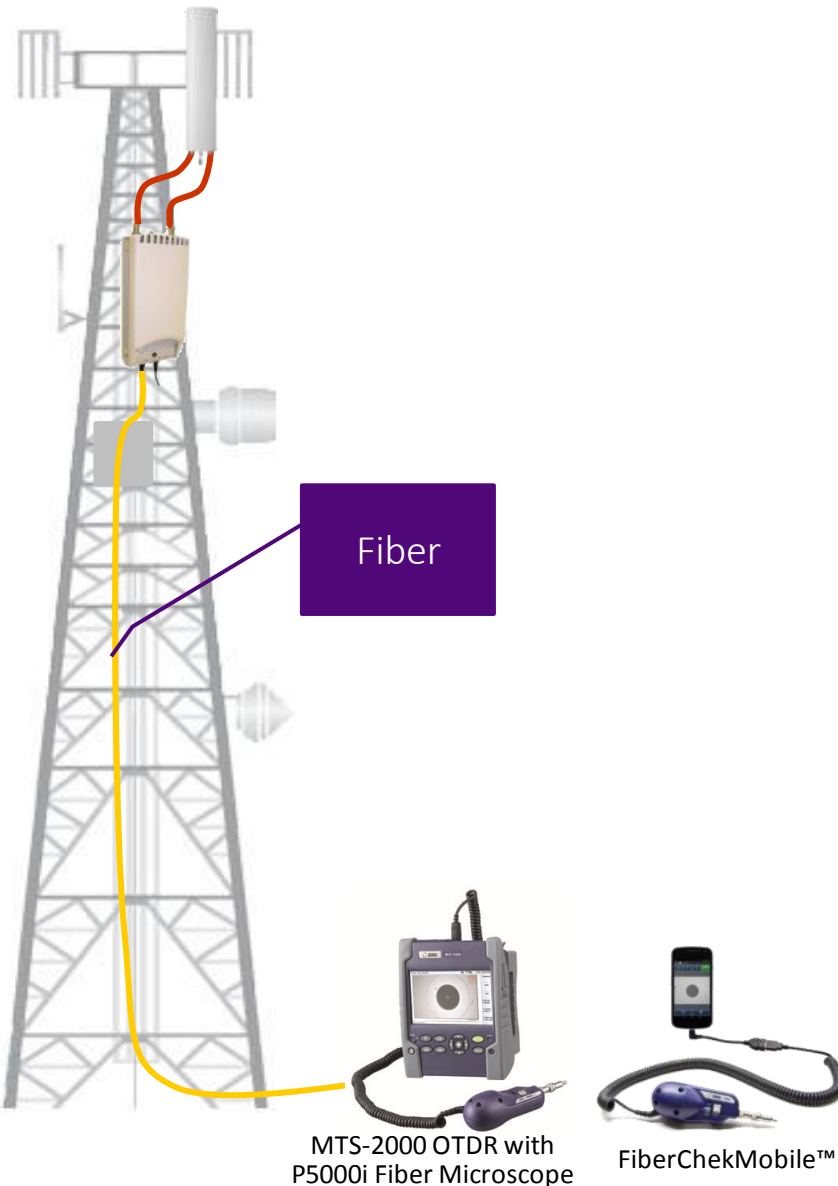
Illustration of Particle Migration



Actual fiber end face images of particle migration

- Each time the connectors are mated, particles around the core are displaced, causing them to migrate and spread across the fiber surface.
- Particles larger than 5 μm usually explode and multiply upon mating.
- Large particles can create barriers ("air gaps") that prevent physical contact.
- Particles less than 5 μm tend to embed into the fiber surface, creating pits and chips.

Installation of Fiber and Connectors



Challenges

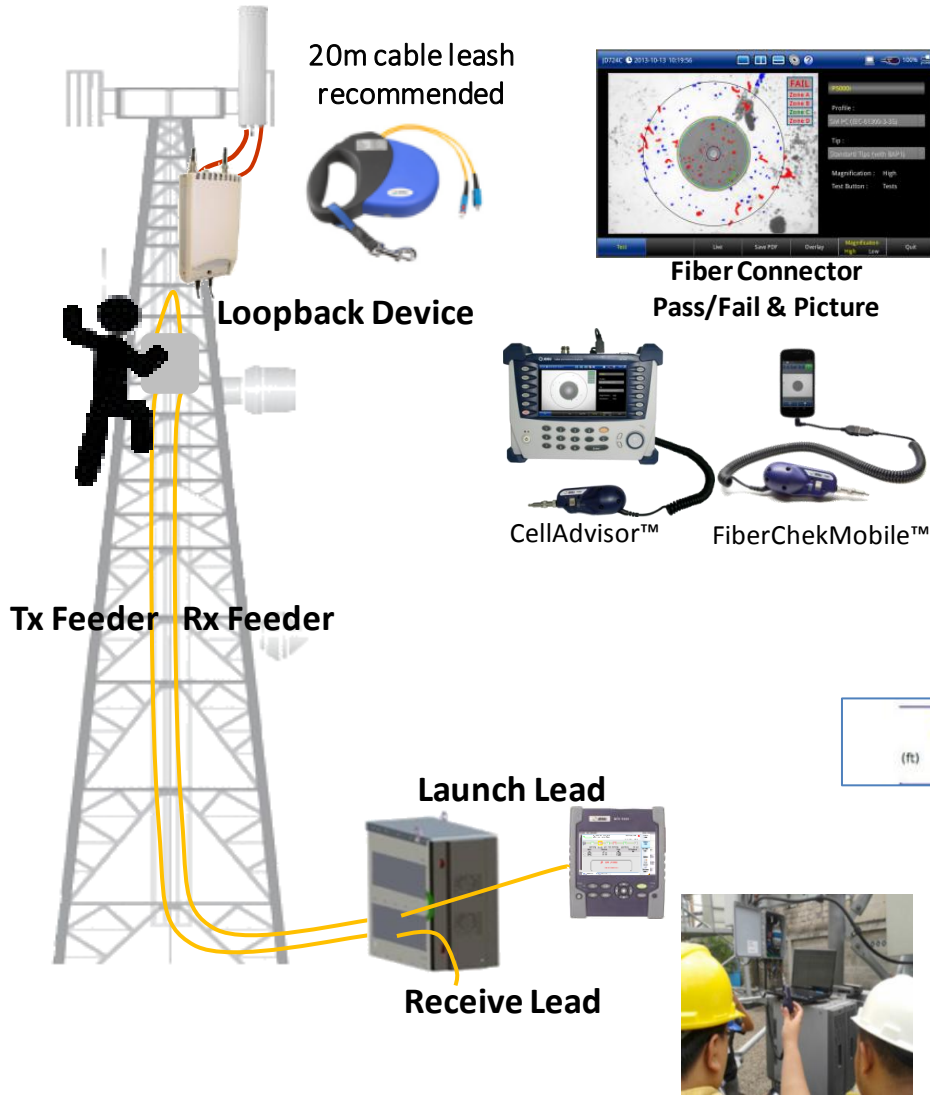
- a) Fiber continuity, bends
- b) Connector issues (dirt,...)

Fiber Test

- a) Fiber inspection
- b) Return Loss
- c) OTDR



Fiber Cell Site Acceptance and Qualification



Certification Report Example



JDSU FTTA-SLM:

- Measures and displays total fiber link loss
- Measures and displays connector loss and reflectance
- Detects installation issues (bends / kinks, bad or dirty connections) and provide a clear diagnostic

Maintenance and Troubleshooting

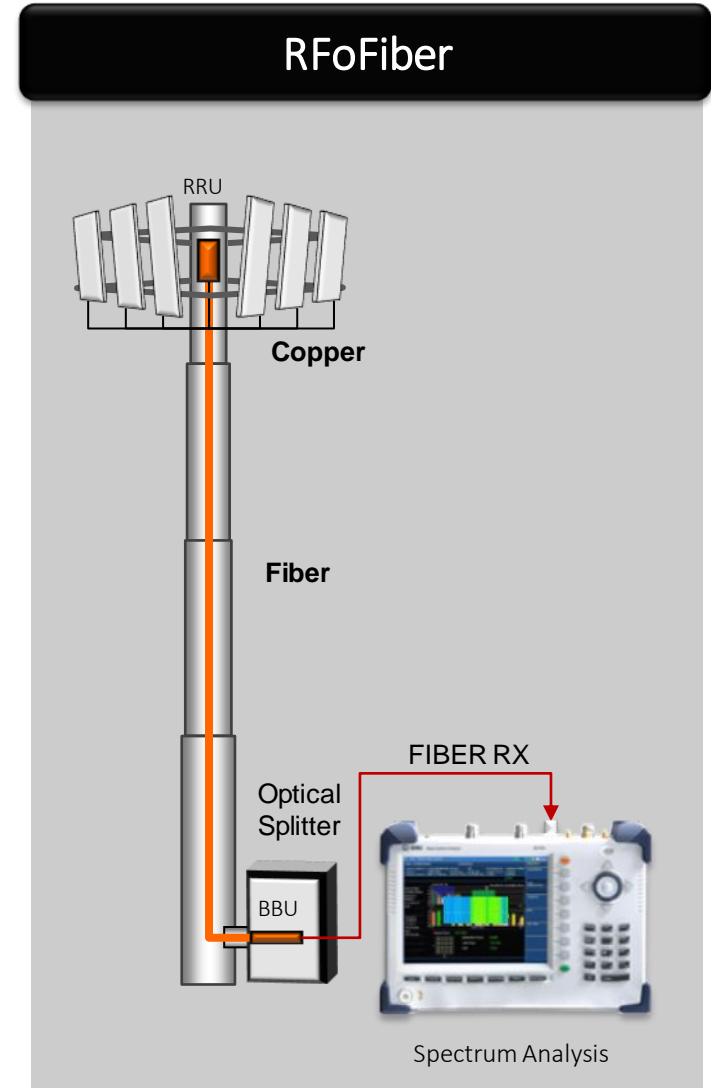
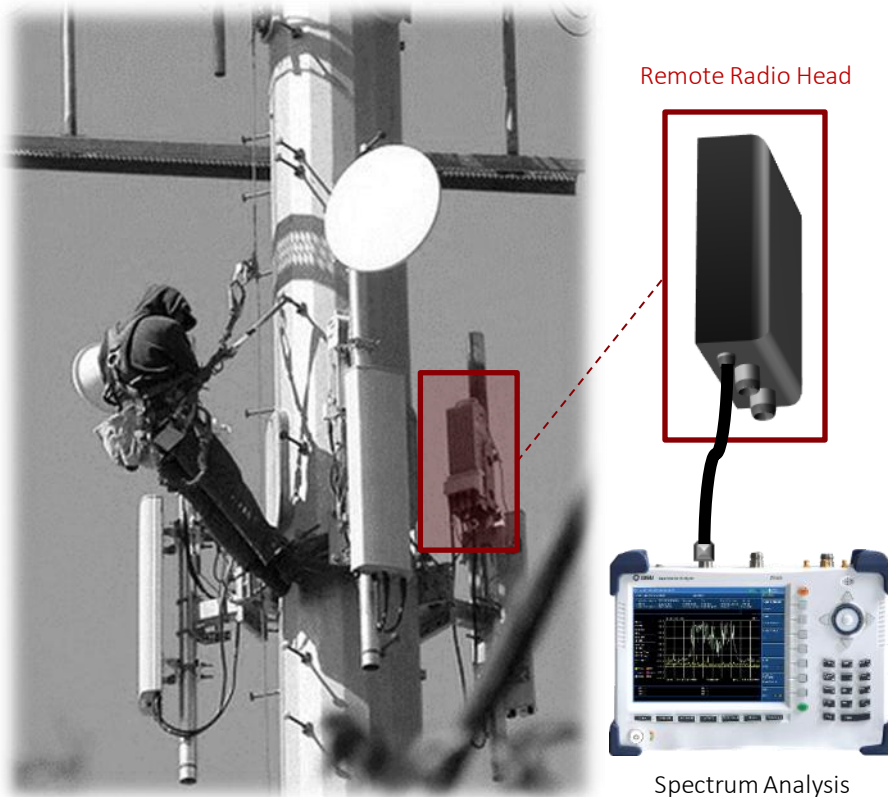


Cell Site Maintenance

RFoFiber Interference Analysis

RF access at Remote Radio Heads

- Long Resolution Time (Tower Climb)
- High Maintenance Cost
- Safety Concerns



RFoCPRI Technology Overview

▪ Common Public Radio Interface (CPRI)

- Industry cooperation for distributed cell sites defined by:



- Additional information at: www.cpri.info

▪ Open Base Station Architecture Initiative (OBSAI)

- Industry initiative creating an open interface specifications related to key parts of the base station subsystem.
- NEM members include:



- Additional information at www.obsai.com

▪ Open Radio equipment Interface (ORI)

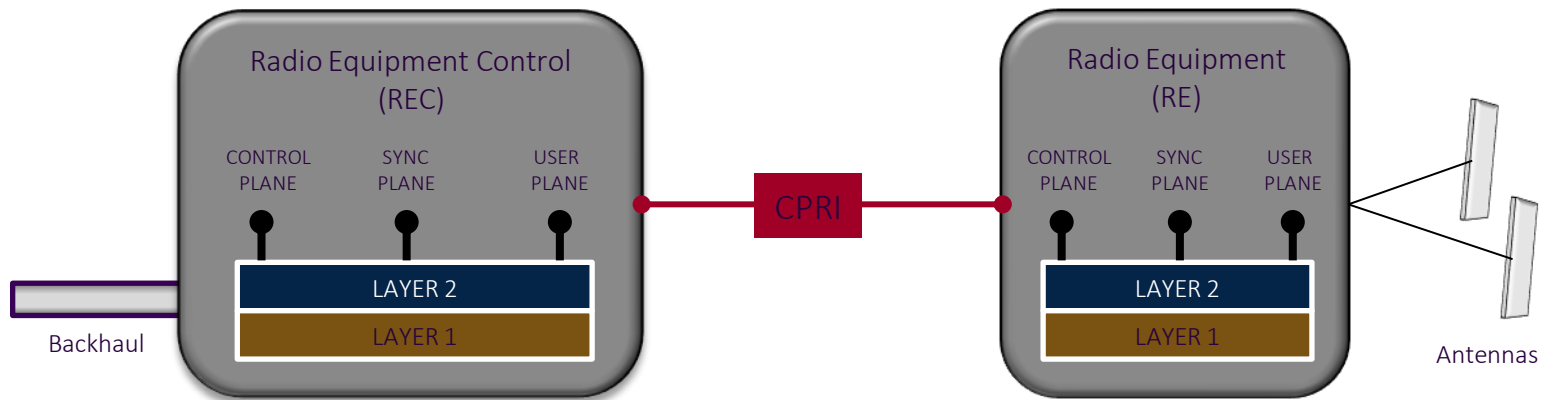
- CPRI is the baseline for ORI low layers specifications
- Additional information at www.etsi.org



RFoCPRI™ and RFoOBSAI™ Technology

Introduction to CPRI and OBSAI

- CPRI and OBSAI are an industry cooperation defining a specification for the interface between the Radio Equipment Control (REC / BBU) and the Radio Equipment (RE / RRH).
 - Three different information flows (User Plane data, Control and Management Plane data, and Synchronization Plane data) are multiplexed over the interface.



- **Data Plane:** IQ data flow of one antenna and one carrier (AxC).
- **Control Plane:** Information related the operation, administration and maintenance of the CPRI link. The actual content of the control data bytes are not defined in CPRI but are vendor specific.
- **Synchronization Plane:** Data flow which transfers frame and time alignment information between nodes.

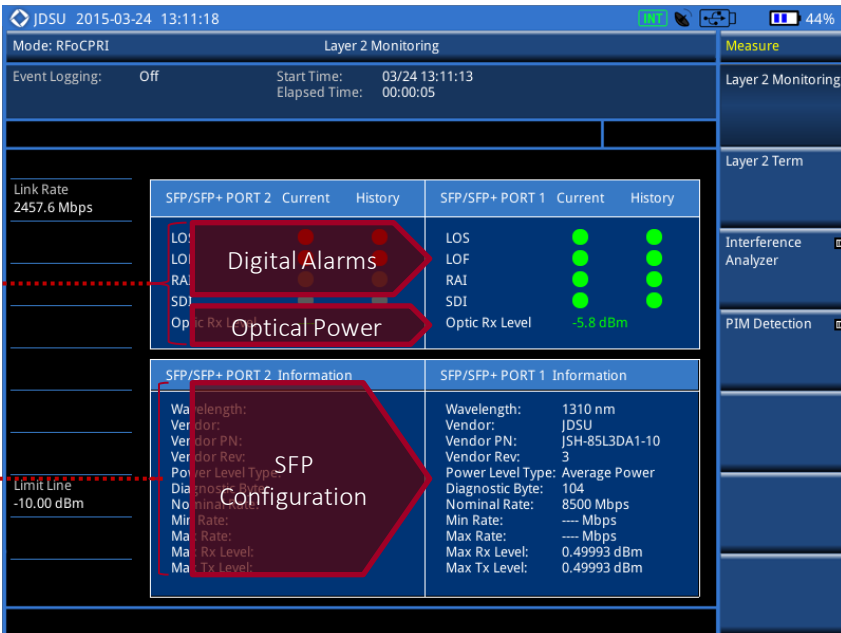
RFoFiber™ Link Test

Layer 2 Measurement – Link Status

■ CPRI Link

- Digital alarms
 - Loss of signal (LOS): code violation or low optical power
 - Loss of frame (LOF): frame synchronization or alignment
 - Remote alarm indication (RAI): any error including LOS, LOF
 - SAP defect indication (SDI): link not to be used for service access points
 - BER ≤ 10-12

- Optical power level
 - Maximum, Minimum Tx Power
 - Maximum, Minimum Rx Power
 - Wavelength
 - Maximum, Minimum Nominal Transmission Rate



RFoCPRI™ Layer 2 Measurements

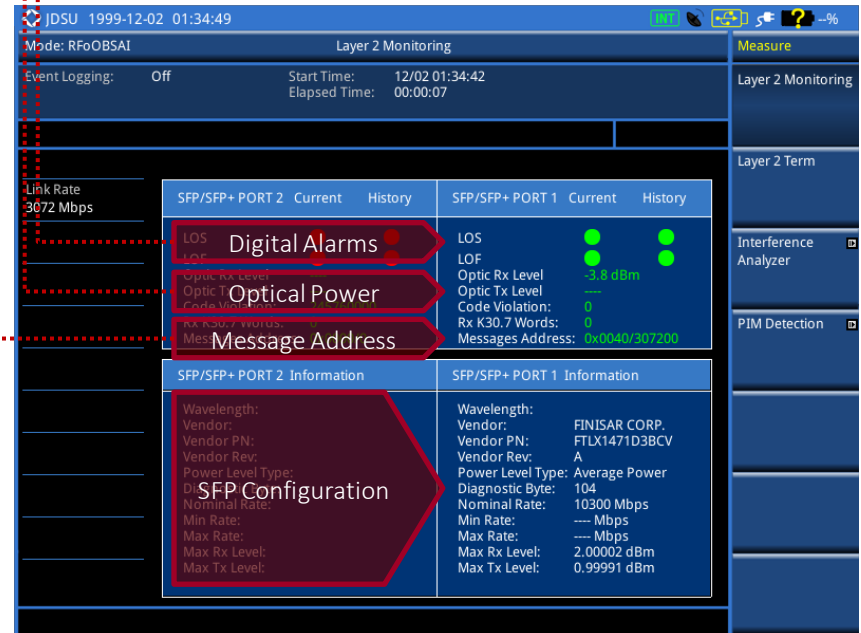


■ OBSAI Link

- Digital alarms
 - Loss of signal (LOS): code violation or low optical power
 - Loss of frame (LOF): frame synchronization or alignment
 - BER ≤ 10-12

- Optical power level
 - Maximum, Minimum Tx Power
 - Maximum, Minimum Rx Power
 - Wavelength
 - Maximum, Minimum Nominal Transmission Rate

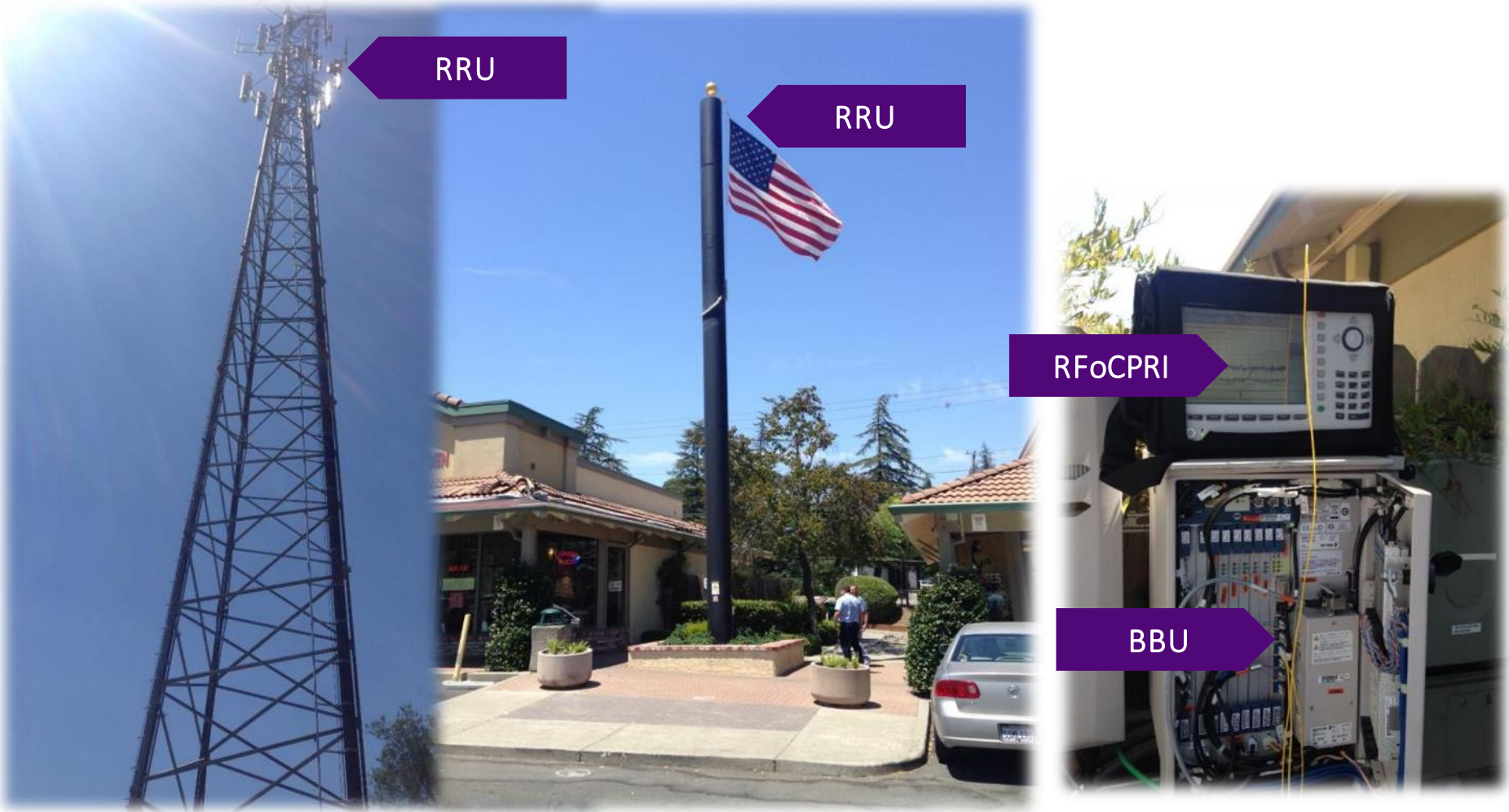
- Message address: RP3 address / Msg per frame



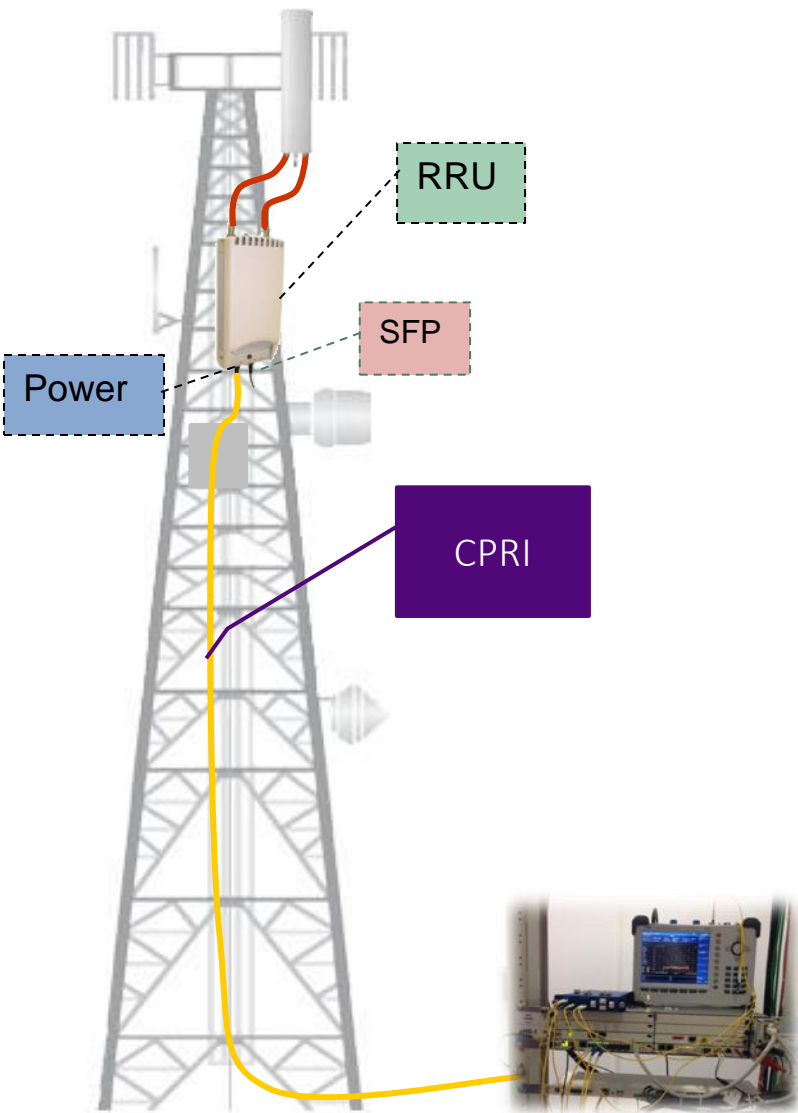
RFoOBSAI™ Layer 2 Measurements

RFoCPRI Technology Overview

Use Cases – Macro Cell and Small Cell



Troubleshooting wireless problems (RFoCPRI)



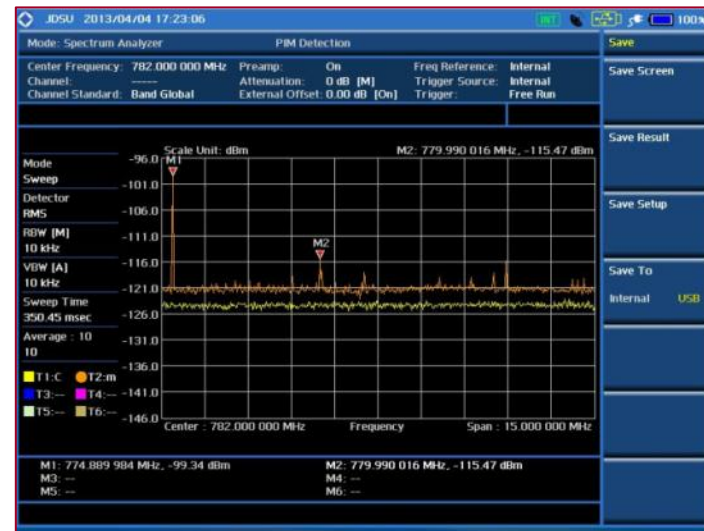
JD745/785

Challenges

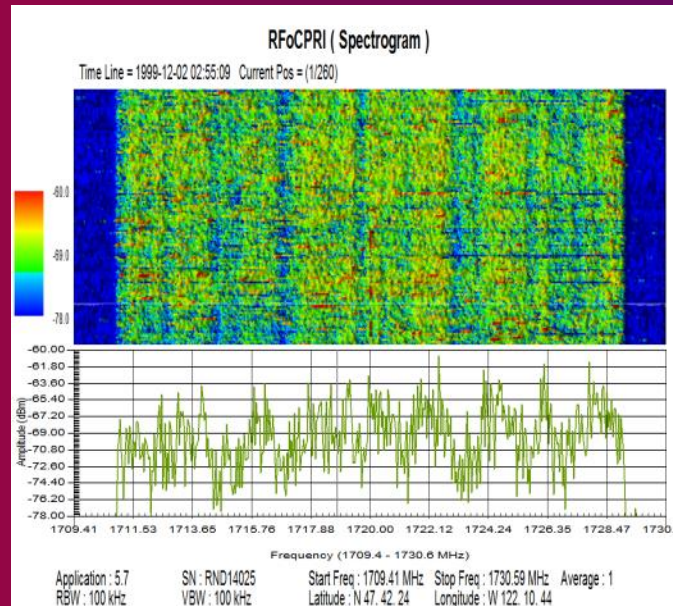
- Interference Problems
- Deterioration in cable/antenna systems
- Equipment failure (RRH/BBU)

RF/CPRI Test Suite

- PIM testing
- Spectrum analysis
- Signal analysis
- RFoCPRI allows measurements at CPRI interface



RF Interference detection over fiber

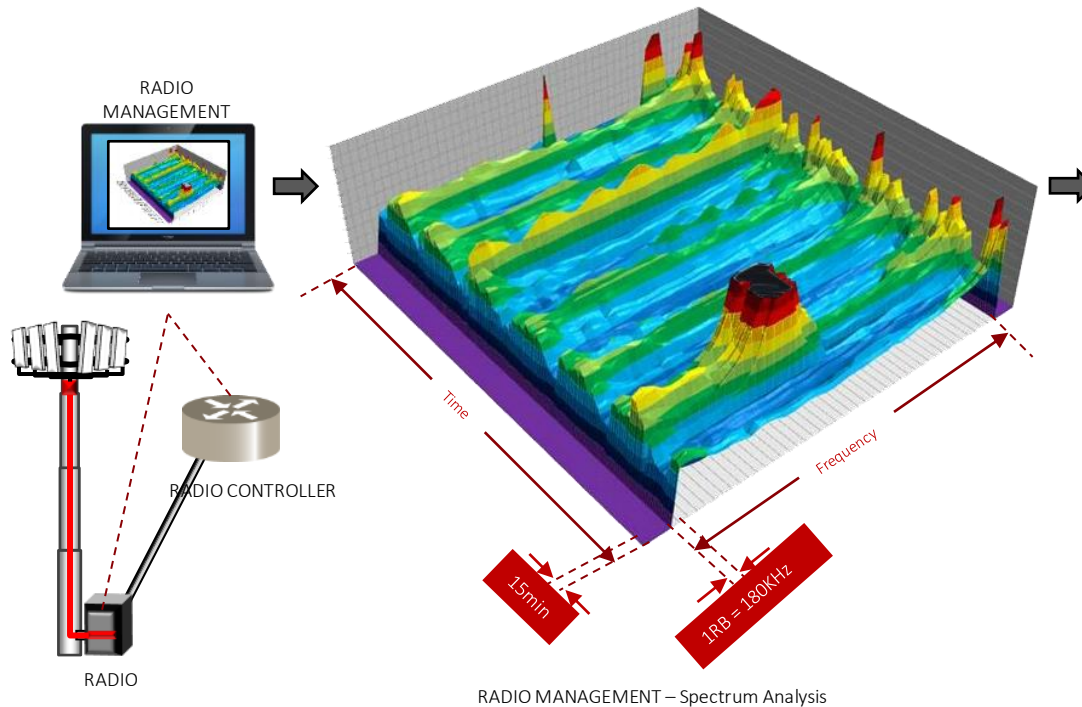


Interference Analysis

Detection and Mitigation

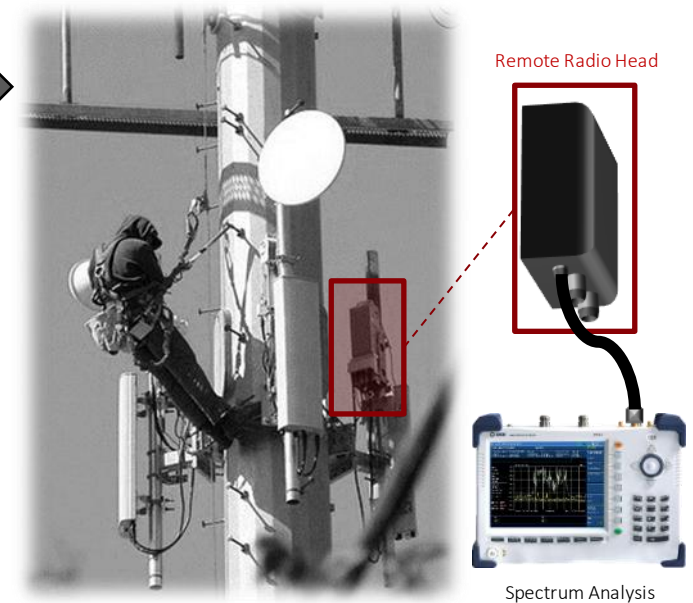
Interference Detection

- Radio Management System
 - Frequency resolution 180KHz (RB)
 - Time resolution (15 minutes)



Interference Mitigation

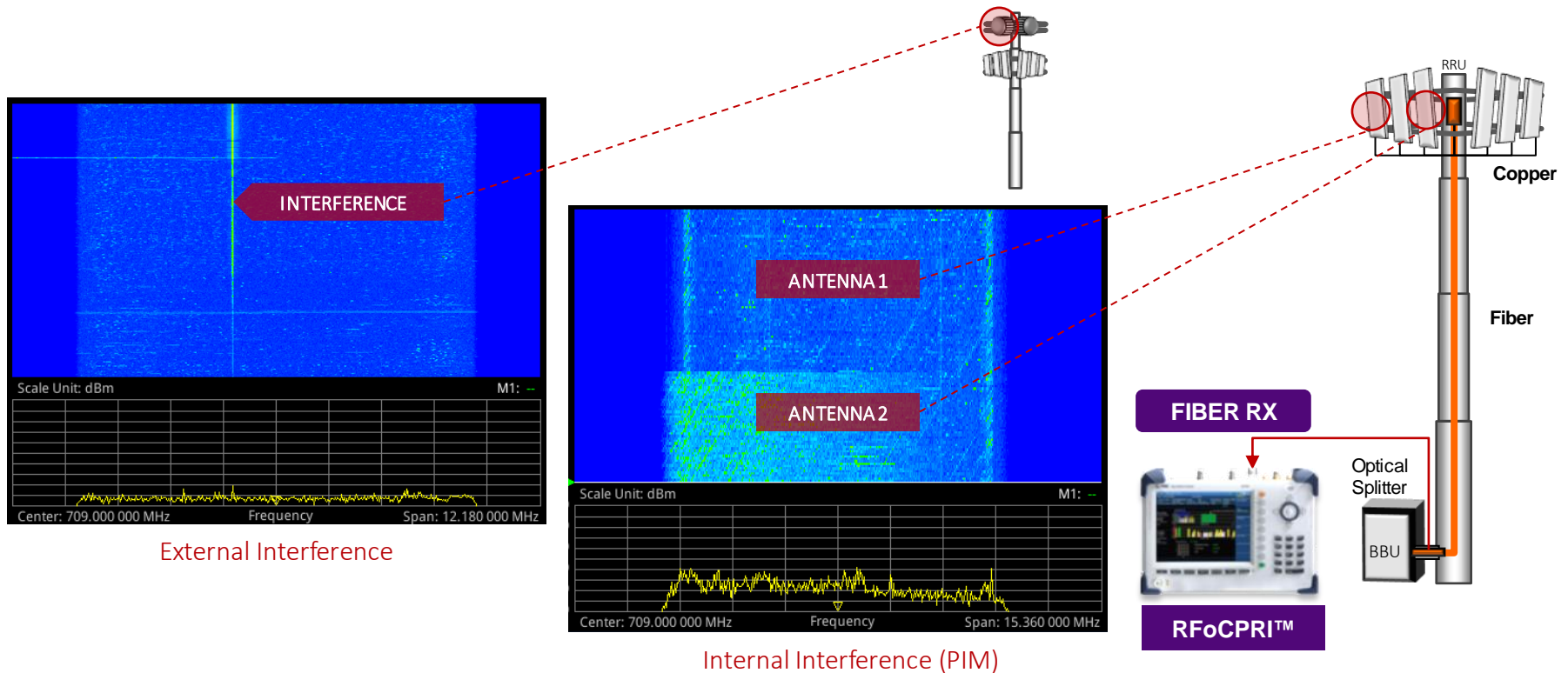
- Long Resolution Time (Tower Climb)
- High Maintenance Cost
- Safety Concerns



RFoCPRI™ / RFoBSAI™ Interference Analysis

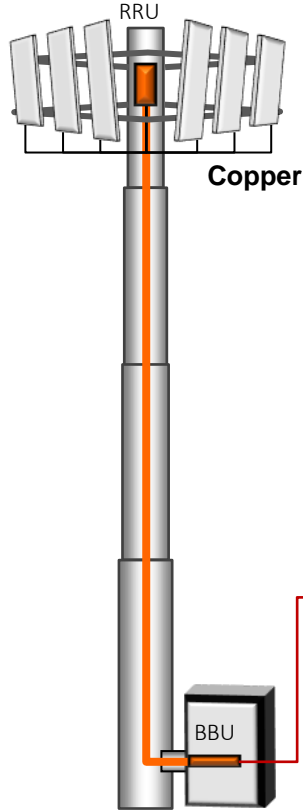
Overview

Perform **interference analysis** including **external interferes** and **internal PIM** on **fiber-based cell sites** (Macro-Cell, DAS, and Small-Cell).

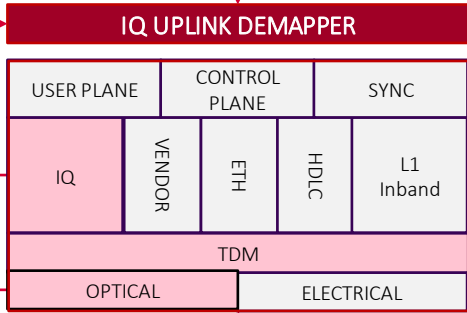


CellAdvisor RFoCPRI™

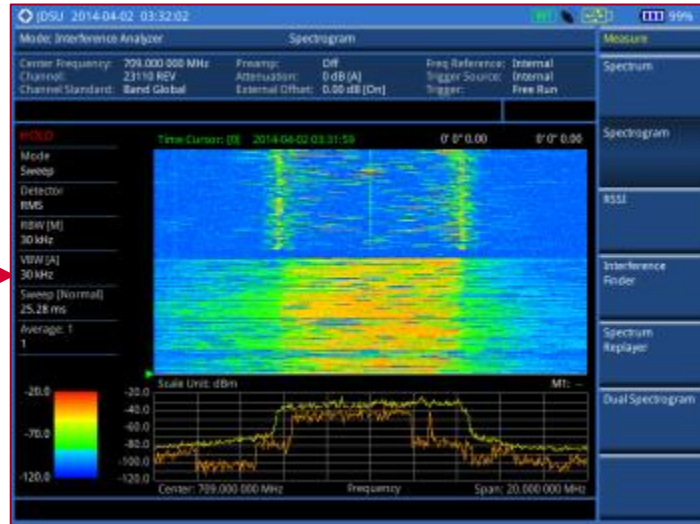
Uplink Analysis



Phase	Line Rate Mbps	Word Size bits	CPRI Frames
1	614.4	8	1
	1228.8	16	2
	2457.6	32	4
	3072.0	40	5
2	4915.2	64	8
	6144.0	80	10
3	9830.4	128	16

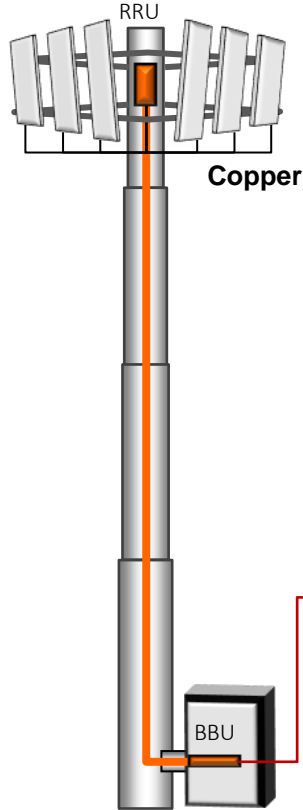


CellAdvisor JD785B RFoCPRI™

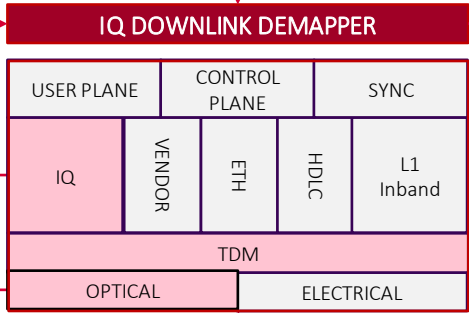


CellAdvisor RFoCPRI™

Downlink Analysis



Phase	Line Rate Mbps	Word Size bits	CPRI Frames
2	614.4	8	1
	1228.8	16	2
	2457.6	32	4
	3072.0	40	5
	4915.2	64	8
3	6144.0	80	10
	9830.4	128	16

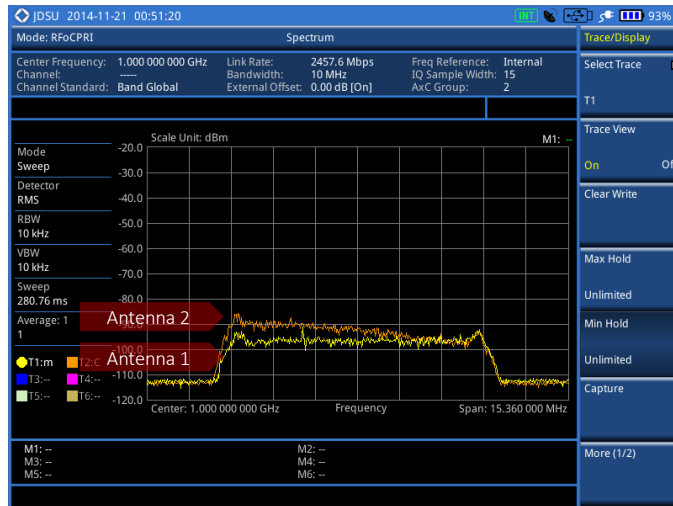


CellAdvisor JD785B RFoCPRI™

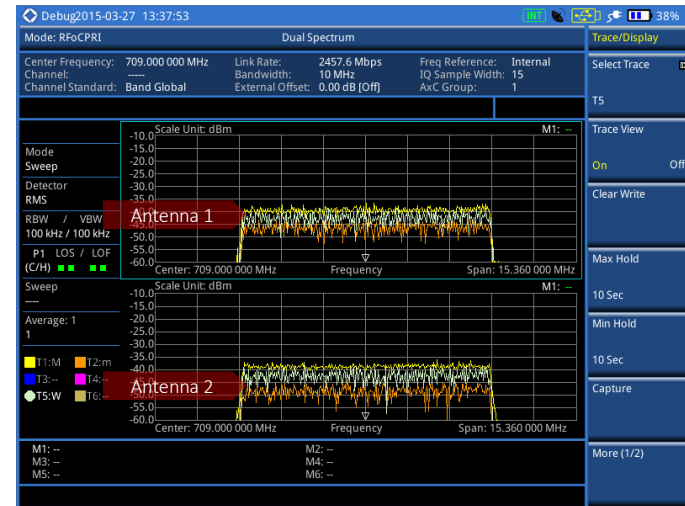


RFoCPRI Interference Analysis

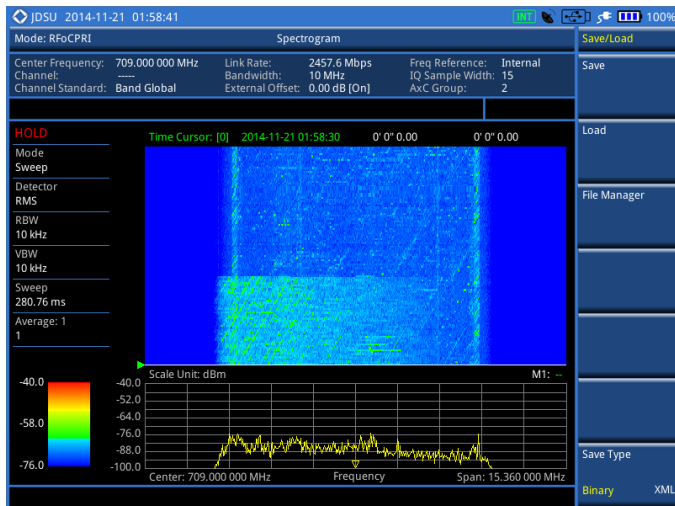
MIMO Test (Diversity Imbalance)



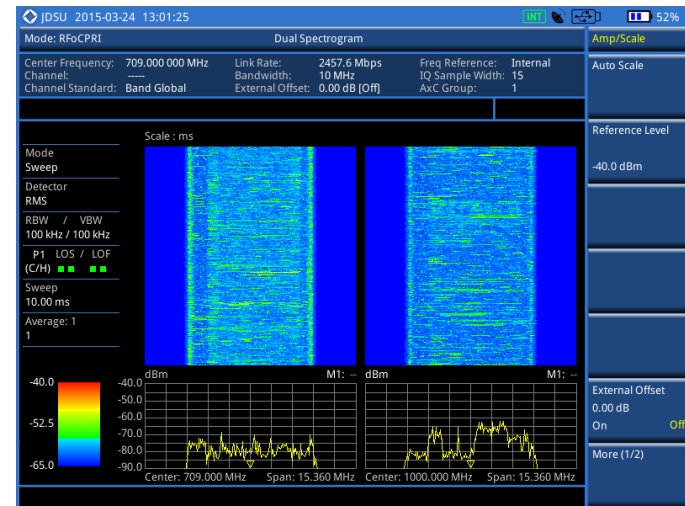
Spectrum Analysis – Antenna 1 (Captured) and Antenna 2 (Active)



Dual Spectrum Analysis – Antenna 1 (Active) and Antenna 2 (Active)



Spectrogram – Active Analysis of One Antenna



Dual Spectrogram – Active Analysis of Two Antennas

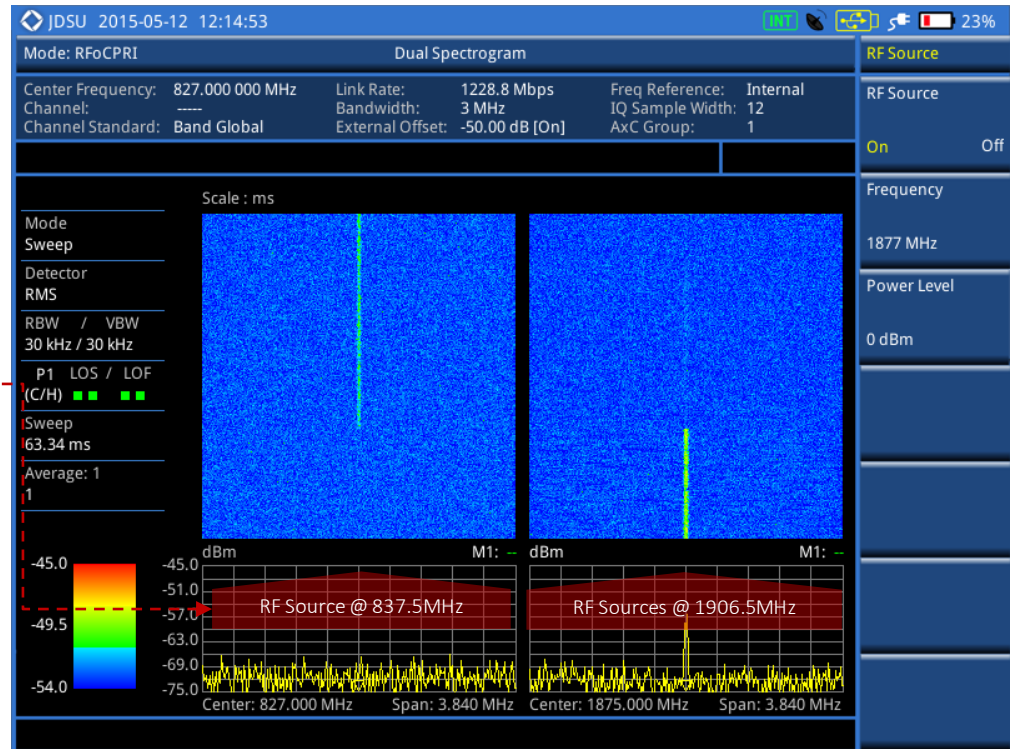
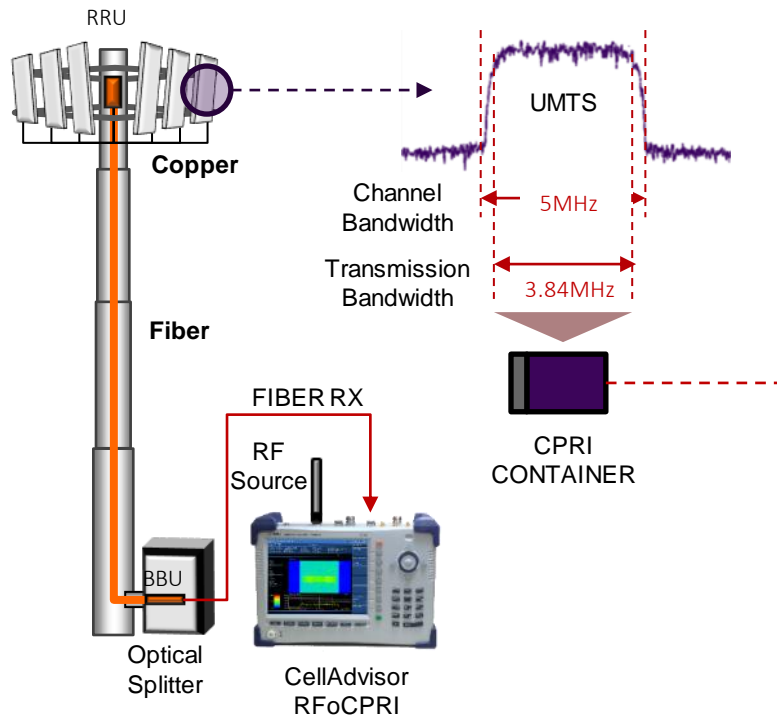
Active Spectrum Analysis of Dual Antenna or Dual Carrier

RFoCPRI Interference Analysis

RFoCPRI and RF-Source

RFoCPRI™ Interference Analysis

- Interference Analysis with RF Source (Multi-Carrier UMTS example)



Dual Spectrogram – Active Analysis of Two Carriers

UMTS Multi-Carrier Identification

Viavi Portfolio for FTTH

Product	Coax (single end)	RF	RFoFiber	Inspection	Fiber Tier 1	Fiber Tier 2
Smart Class Fiber				X	X	
MTS 2000				X	X	X
P5000i				X	X	
CellAdvisor™	X	X	X	X	X	



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