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elektronické měřicí přístroje

CPRI / OBSAI

Měření na základnových stanicích s RRH

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Agenda

Radio Access Network Evolution

CPRI/OBSAI Technologies

Detailed Look at the CPRI Protocol

RAN Testing Challenges

Unframed CPRI/OBSAI Testing with TX300S/320S – User guide

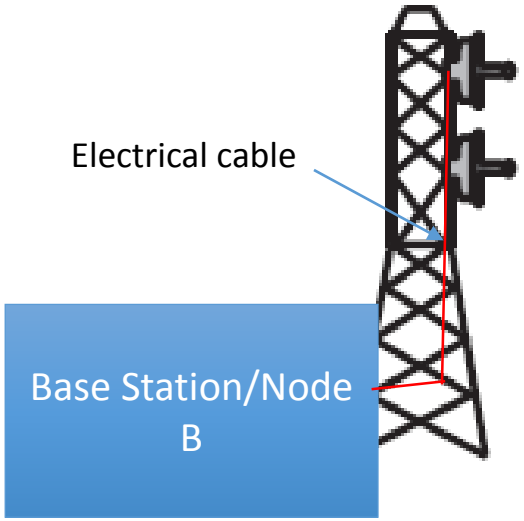
Layer 1 Framed CPRI Testing with TX300S/320S – User guide

Layer 2 CPRI Testing with TX300S/320S – User guide

Layer 2 CPRI Monitoring with TX320S – User guide

Tradiční RAN architektura

BTS a RF část v kolokaci



In traditional deployments, the base station functions are co-located with the radio tower at the base of the antenna or basement of a tall building.

Drawbacks of co-location:

RF transceiver and power amplifier needed to drive the radio functions are co-located with the other functions of the base station such as backhaul transport, control and baseband processing.

Needs to be physically located very close to the antenna because they are driven over very lossy electrical cables.

High power dissipation requires that require costly special enclosures with climate control and power redundancy

Makes it difficult to install and find a location that can host the enclosure and/or increase lease price due to additional space needed

Distribuované anténní systémy

Radio Equipment = Remote Radio Heads

RRH

RRH

RRH

Radio Equipment Controller

REC

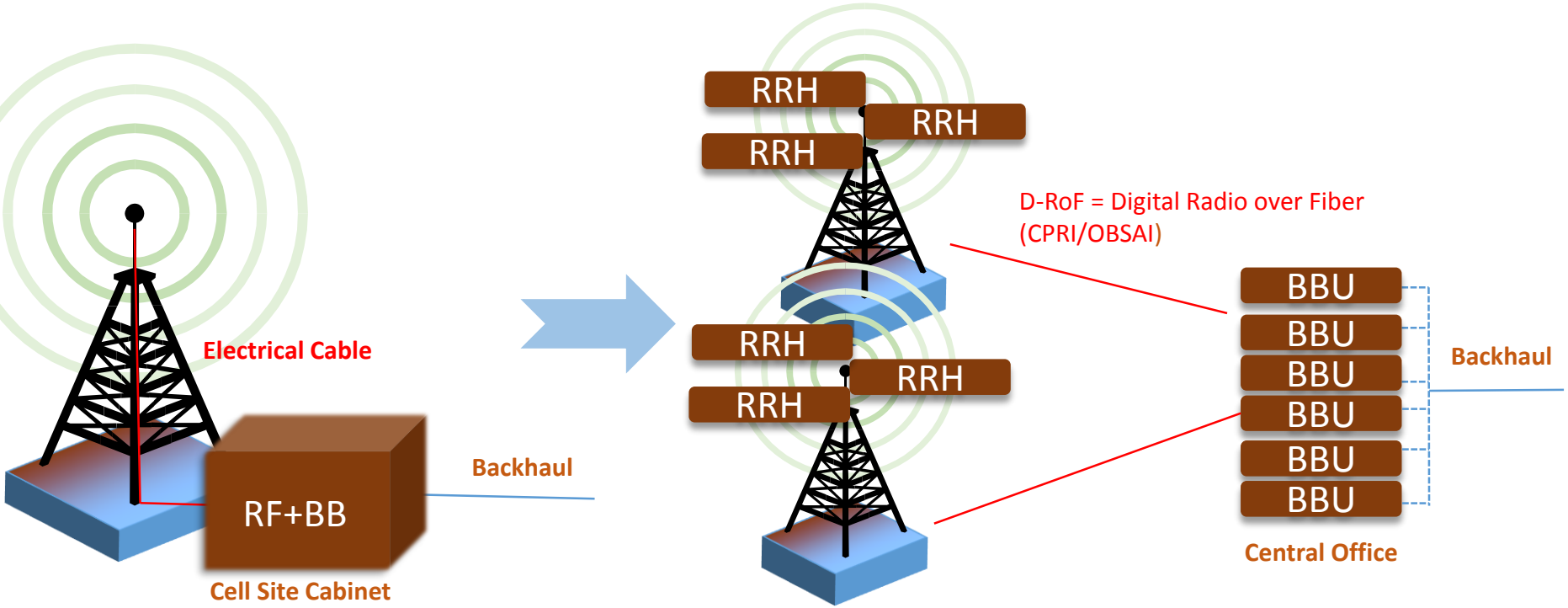
Fronthaul:
CPRI/OBSAI over Fiber

REC handles:
•Network Interface transport
• Radio base station control and management
•Digital baseband processing

Base Station Hotel
in CO or Colocation

C-RAN
= The Cloud RAN
CWDM/DWDM or
micro-wave

Migrace k C-RAN



Benefits:

Separation of RF and Baseband processing. Simplified function makes it more compact, easier to install and therefore increases the number of possible sites

Fiber Link replaces COAX, less power required at the cell site

Optimized X2 interface allows for LTE-A features support

CPRI vers. OBSAI

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CPRI and OBSAI are two competing standards

CPRI stands for Common Public Radio Interface, this protocol has been developed by Ericsson AB, Huawei Technologies Co. Ltd, NEC Corporation, Alcatel Lucent and Nokia Siemens

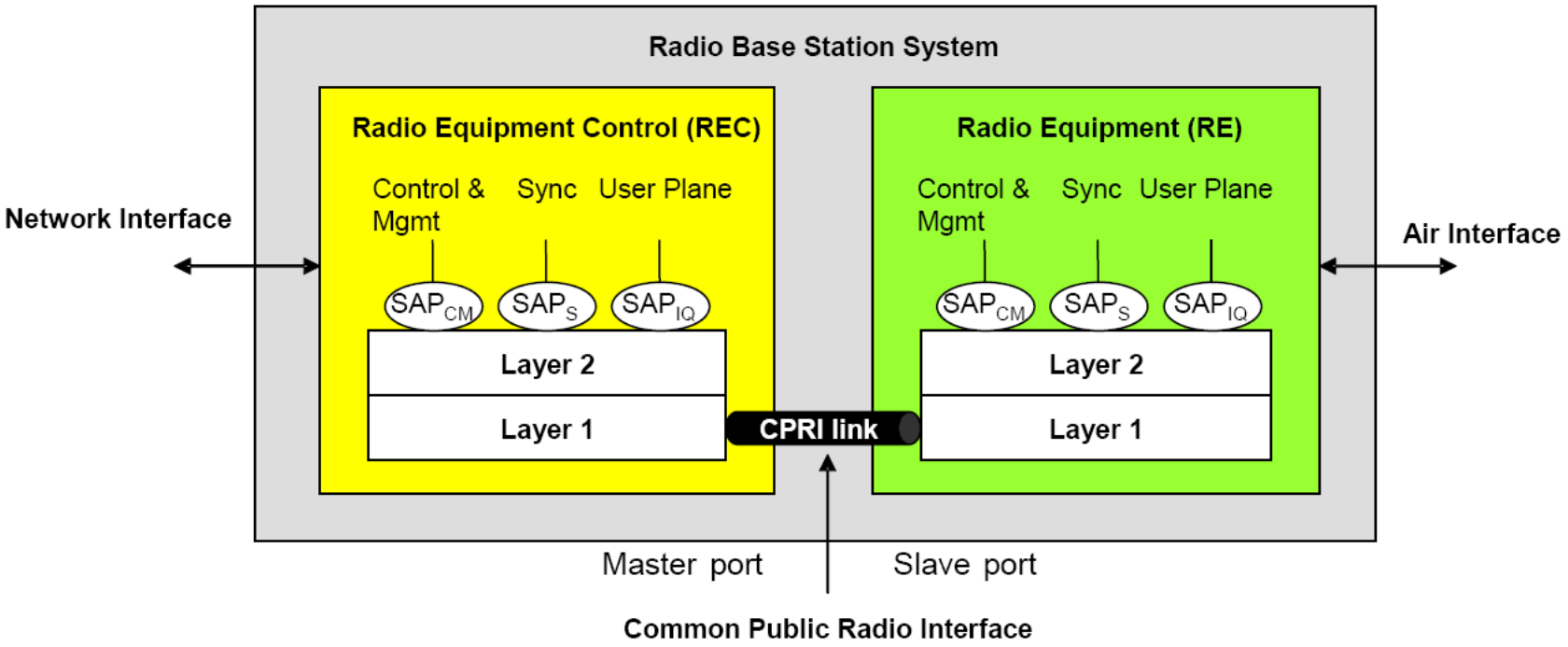
OBSAI stands for Open Base Station Architecture Initiative, this protocol has been developed by Hyundai, LGE, Nokia, Samsung and ZTE

CPRI Rates range from 614 Mbps to 10.137 Gbps

OBSAI Rates range from 728 Mbps to 6.8 Gbps

CPRI has higher market penetration rate than OBSAI

CPRI- specifikace



- Specification written with the goal to be generic enough to support scalable rates, physical access medium type and air interfaceCPRI specification defines only Layer 1 and Layer 2 technologies

CPRI- bitové rychlosti

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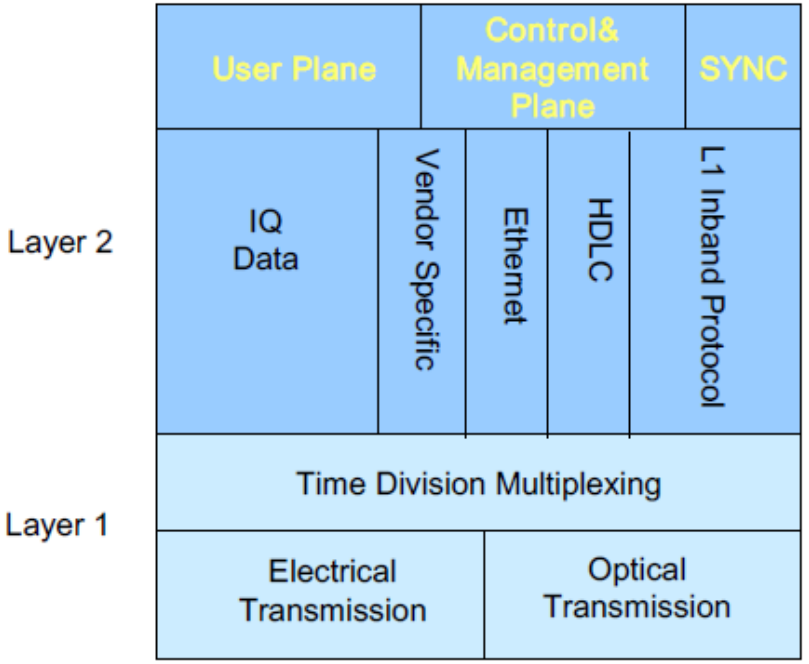
The following Line bit rates are defined in the standard:

- CPRI line bit rate option 1: 614.4 Mbit/s
- CPRI line bit rate option 2: 1228.8 Mbit/s (2 x 614.4 Mbit/s)
- CPRI line bit rate option 3: 2457.6 Mbit/s (4 x 614.4 Mbit/s)
- CPRI line bit rate option 4: 3072.0 Mbit/s (5 x 614.4 Mbit/s)
- CPRI line bit rate option 5: 4915.2 Mbit/s (8 x 614.4 Mbit/s)
- CPRI line bit rate option 6: 6144.0 Mbit/s (10 x 614.4 Mbit/s)
- CPRI line bit rate option 7: 9830.4 Mbit/s (16 x 614.4 Mbit/s)
- CPRI line bit rate option 8: 10137.6 Mbit/s, 64B/66B line coding (20 x 491.52 x 66/64 Mbit/s)

Rates chosen to be integer multiples of UMTS chip rate at 3.84 M

CPRI- protokol



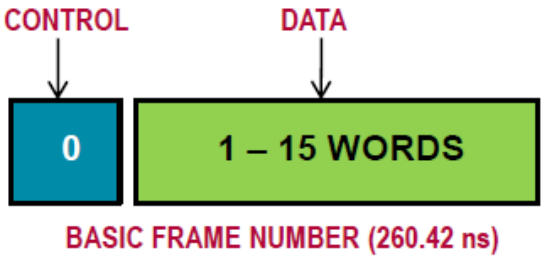
I/Q data: User plane information in the form of in-phase and quadrature modulation data (digital baseband signals)

L1 inband protocol: Signalling information that is related to the link and is directly transported by the physical layer.

C&M data: Control and management information exchanged between the C&M entities within the REC and the RE. This information flow is given to the higher protocol layers. Two different layer 2 protocols for C&M data are supported: subset of High level Data Link Control (HDLC) and Ethernet.

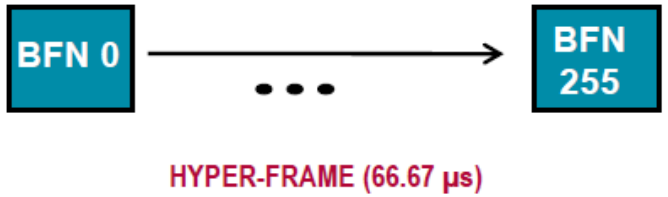
CPRI- struktura rámce

Basic Frame = 512 bits

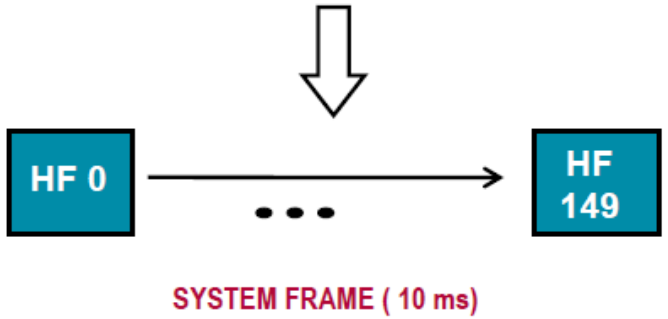


Control = L1 in band and C&M channels
Data = Antenna I/Q samples
Called AxC

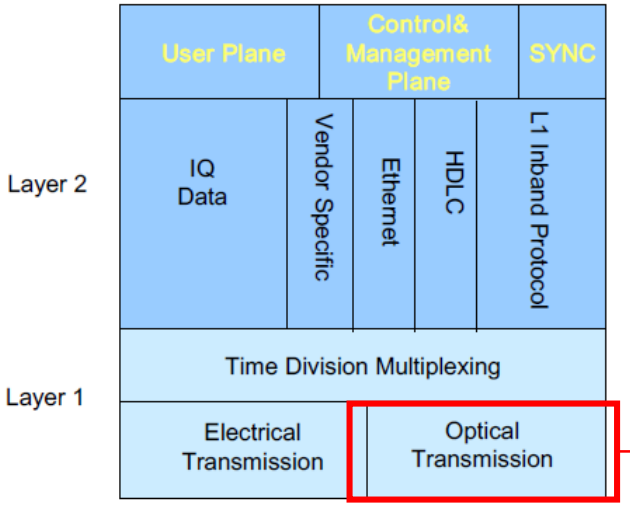
Hyper Frame = 256 Basic Frames



Radio Frame (NodeB Frame) = 150 Hyper Frames

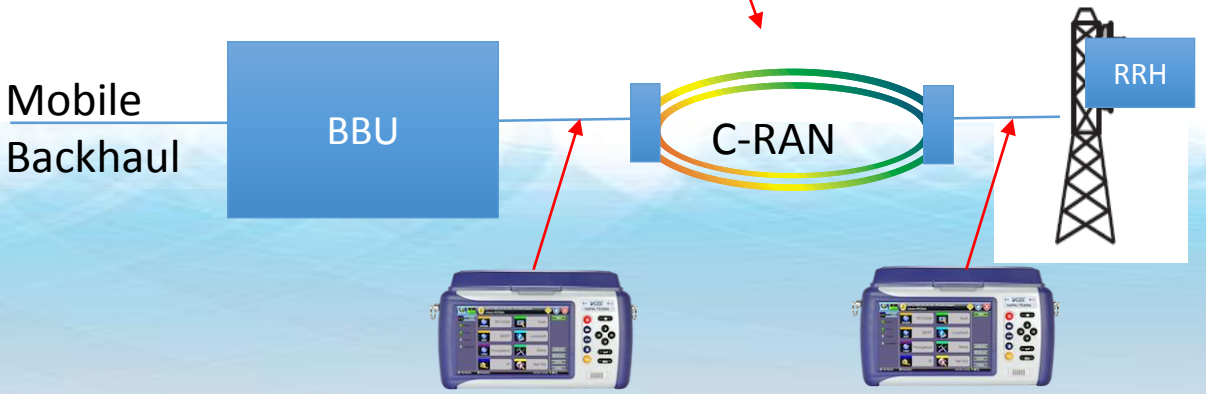


CPRI- měřicí úlohy

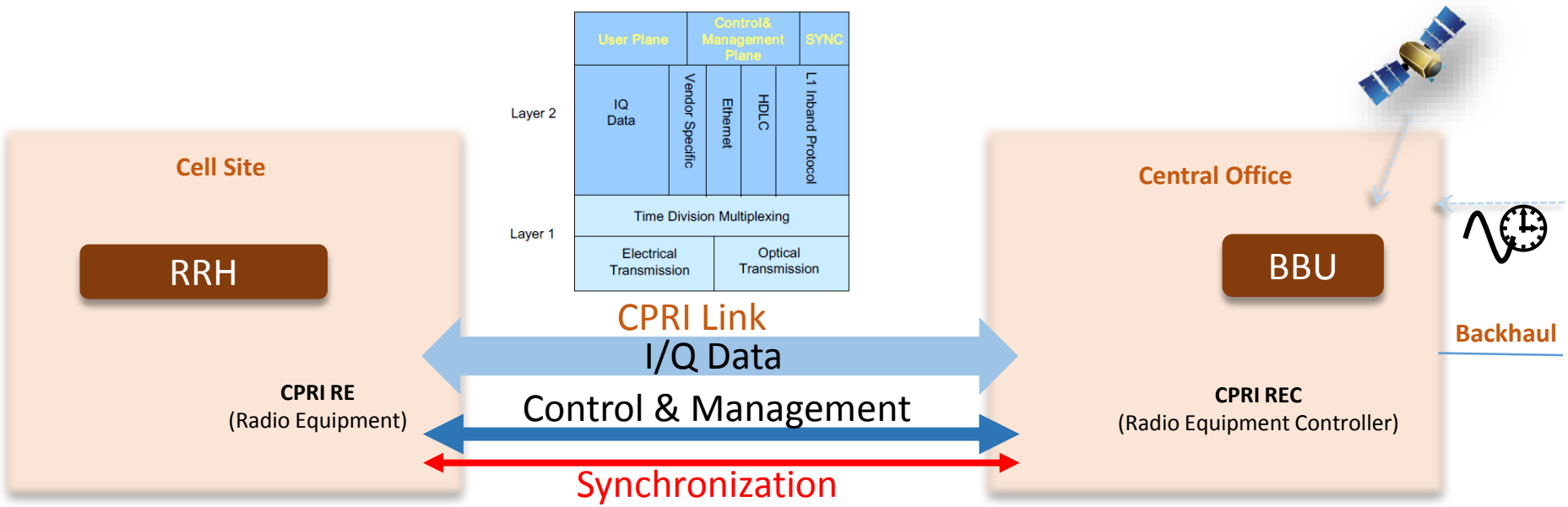


The Cloud RAN (C-RAN) can be dark fiber, DWDM/CWDM, micro-wave or
CPRI over OTN with Fronthaul distance up to 40km.
Transport should be tested for error free CPRI transmission, the TX300S validates:

- Optical power
- BERT with PRBS pattern – CPRI standard requirement of 10^{-12} BER
- Accurate Round trip delay measurement



Fronthaul a synchronizace



CPRI delivers synchronization to the RRH. No GPS antenna or other sync solution needed at the RRH

RRH extracts its clock from the CPRI bit stream

BBU centrally located has available choices to get sync including 1588 PTP delivered via backhaul or GPS signal

Synchronizace a zpoždění

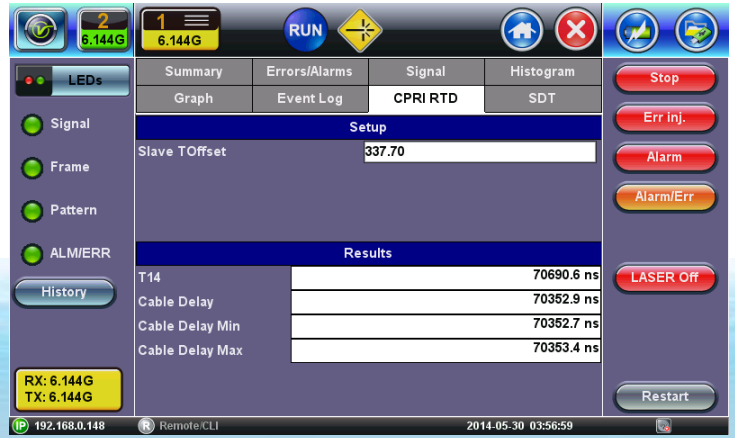
CPRI is a Synchronous technology, similar to SyncE in Clock recovery. The CPRI Slave (RE/RRH) recovers clock from CPRI link.

- TX300S Master or REC provides stable clock traceable to PRC external ref clock. TX300S Slave or RE recovers clock and verifies timing recovery

CPRI has strict timing requirements, Remote Radio Heads have to be synchronized to Controller in order to avoid dropped calls.

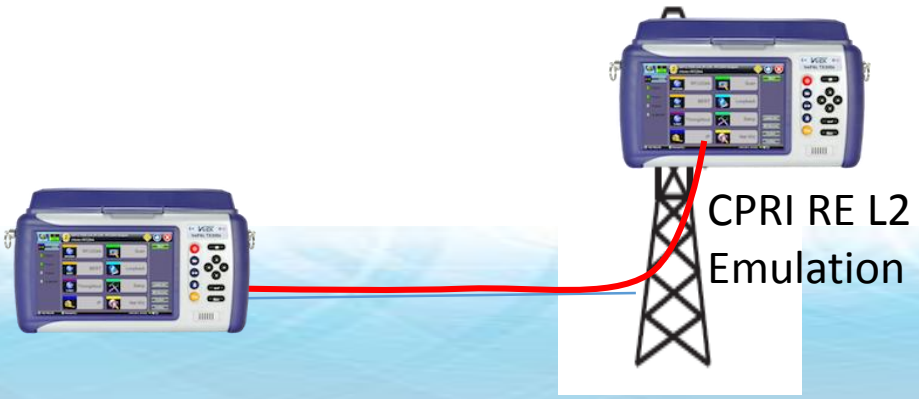
- TX300S supports CPRI standard compliant Round trip delay measurement mechanism at Layer 2

CPRI Master with
external Reference clock

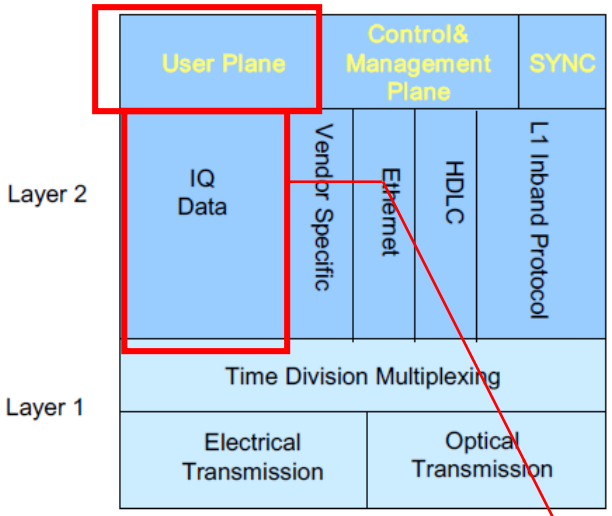


Emulace provozu na L2

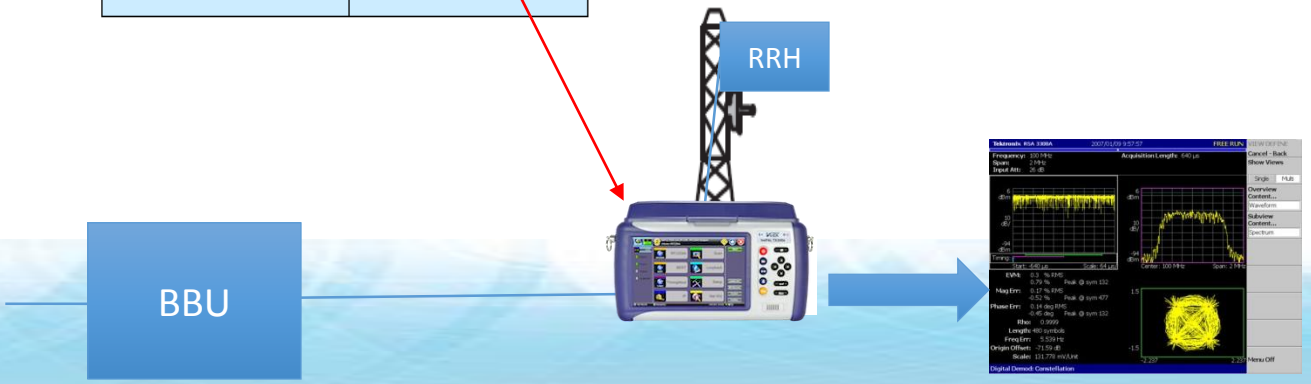
- Test Network with Performance Statistics with TX300S REC/BBU Master Emulation to TX300S RE/RRH Slave Emulation.
- View Alarms: LOS,LOF, RAI, SDI
- Code violations, BER Statistics
- Service Disruption Testing (SDT)
- Frame Counters (HFN and BFN)



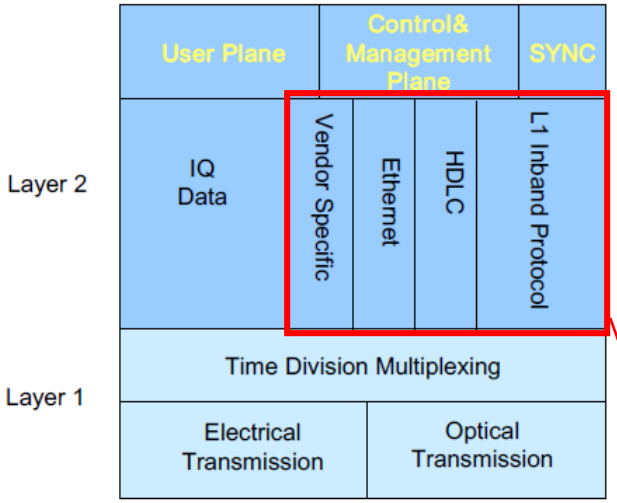
Analýza RF parametrů



No RF signal availability at the bottom of the tower – RF troubleshooting becomes difficult. Only digital RF signal carried in CPRI frame.
TX300S monitoring between BBU and RRH via optical splitter
Capture CPRI frames I/Q data and export them in csv format to VSA software for RF analysis



C&M parametry



Troubleshoot interoperability issues with Control Words Protocol Decode.

- Decode Sync and Timing Bytes
- Verify proper incrementing of BFN and HFN frame counters
- L1 Inband Protocol decode
- HDLC and Ethernet C&M Bytes decode
- Bi-directional dual port in-service monitoring

	0-15					16-31					32-47					48-63				
0	Sync & timing	SYN BC	HFN 55	BFN E8	BFN 09	8	Reserved	RES 00	RES 00	RES 00	RES 00									
1	Slow C&M	C&M 7E	C&M 7E	C&M 7E	C&M 7E	9	Reserved	RES 00	RES 00	RES 00	RES 00									
2	L1 inband prot.	VER 01	STR 04	L1 00	Ptr 14	10	Reserved	RES 00	RES 00	RES 00	RES 00									
3	Reserved	RES 00	RES 00	RES 00	RES 00	11	Reserved	RES 00	RES 00	RES 00	RES 00									
4	Ctrl_AxC low Byte	Ctl 00	Ctl 00	Ctl 00	Ctl 00	12	Reserved	RES 00	RES 00	RES 00	RES 00									
5	Ctrl_AxC low Byte	Ctl 00	Ctl 00	Ctl 00	Ctl 00	13	Reserved	RES 00	RES 00	RES 00	RES 00									
6	Ctrl_AxC high Byte	Ctl 00	Ctl 00	Ctl 00	Ctl 00	14	Reserved	RES 00	RES 00	RES 00	RES 00									
7	Ctrl_AxC high Byte	Ctl 00	Ctl 00	Ctl 00	Ctl 00	15	Reserved	RES 00	RES 00	RES 00	RES 00									

Měření pomocí TX300S

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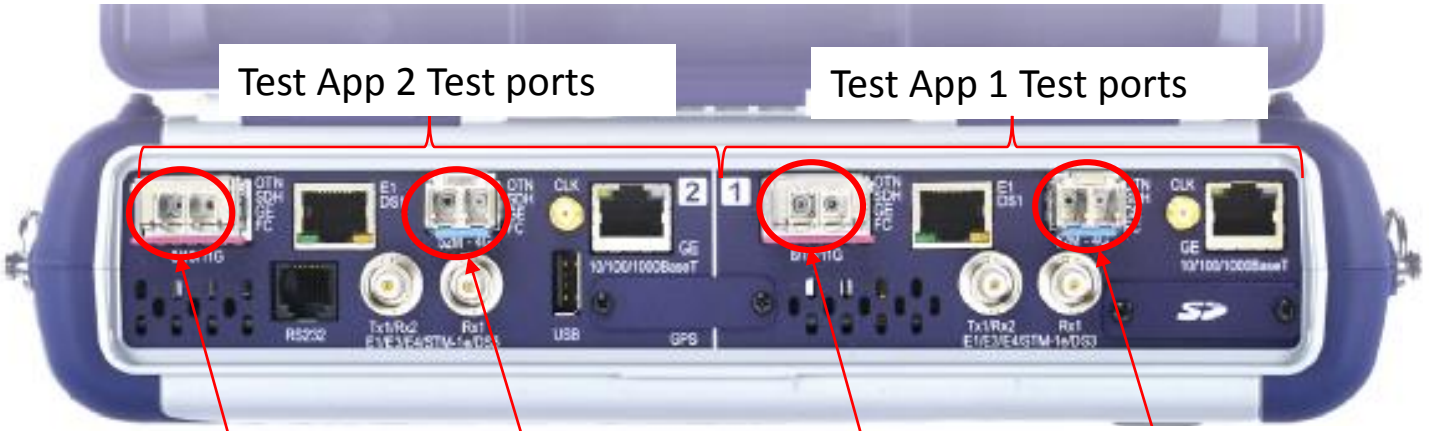
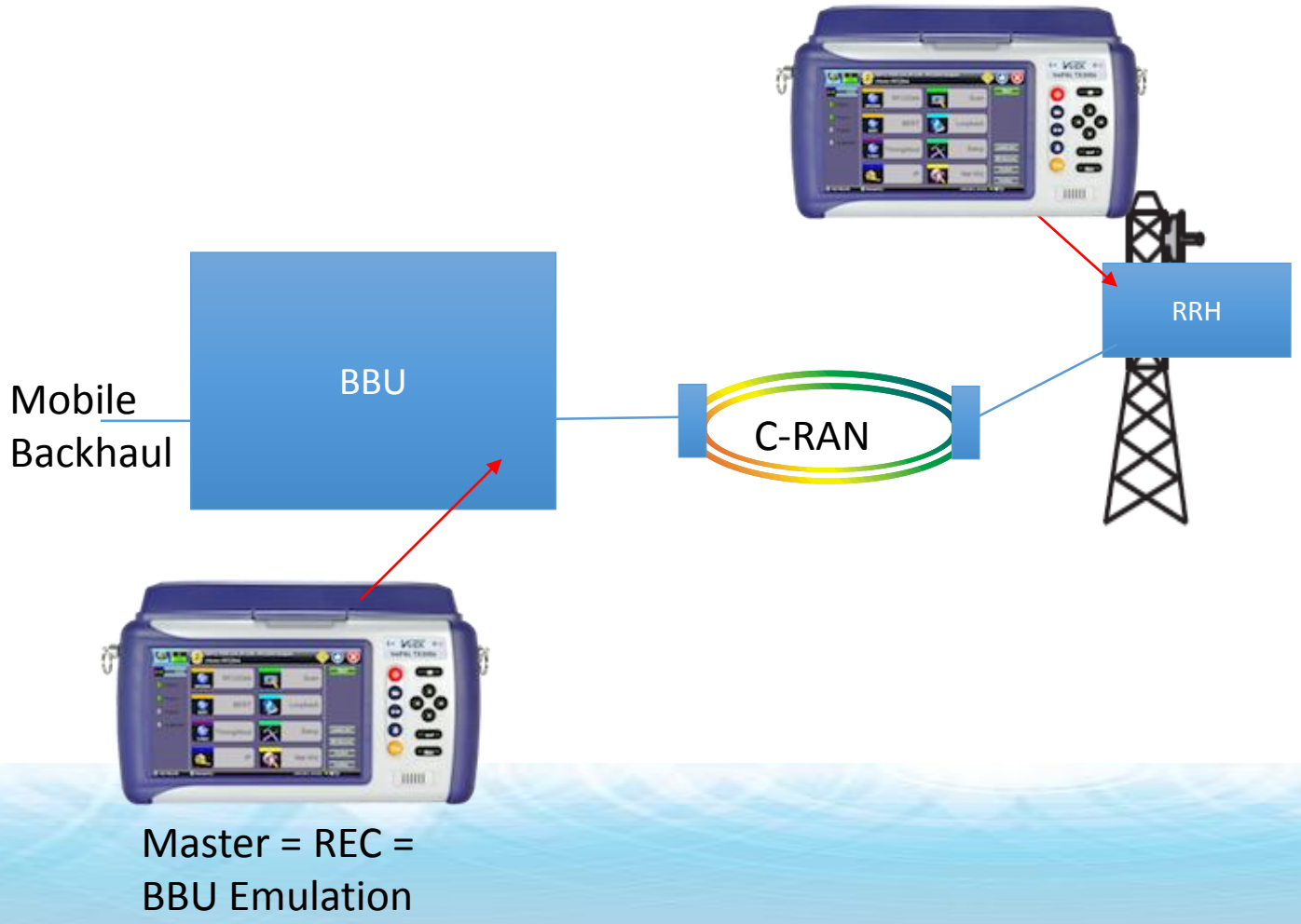
Note: For CPRI and OBSAI rates of 4.9152 and 6.144 Gbps an SFP+ should be used.



RRC / RE L2 měření



CPRI konfigurace pro L2 měření

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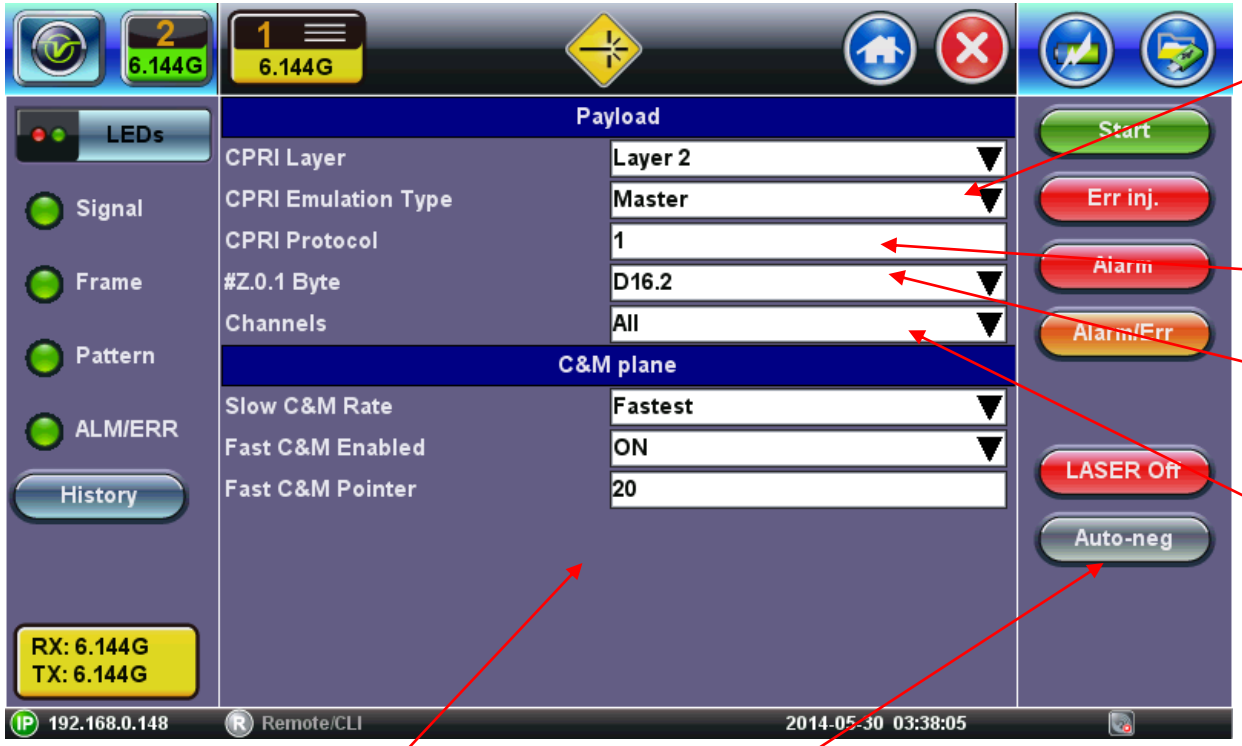


Master = REC/BBU
Slave = RE/RRH
Master is responsible for CPRI Start up sequence and Synchronization

CPRI Protocol Version 1 supported

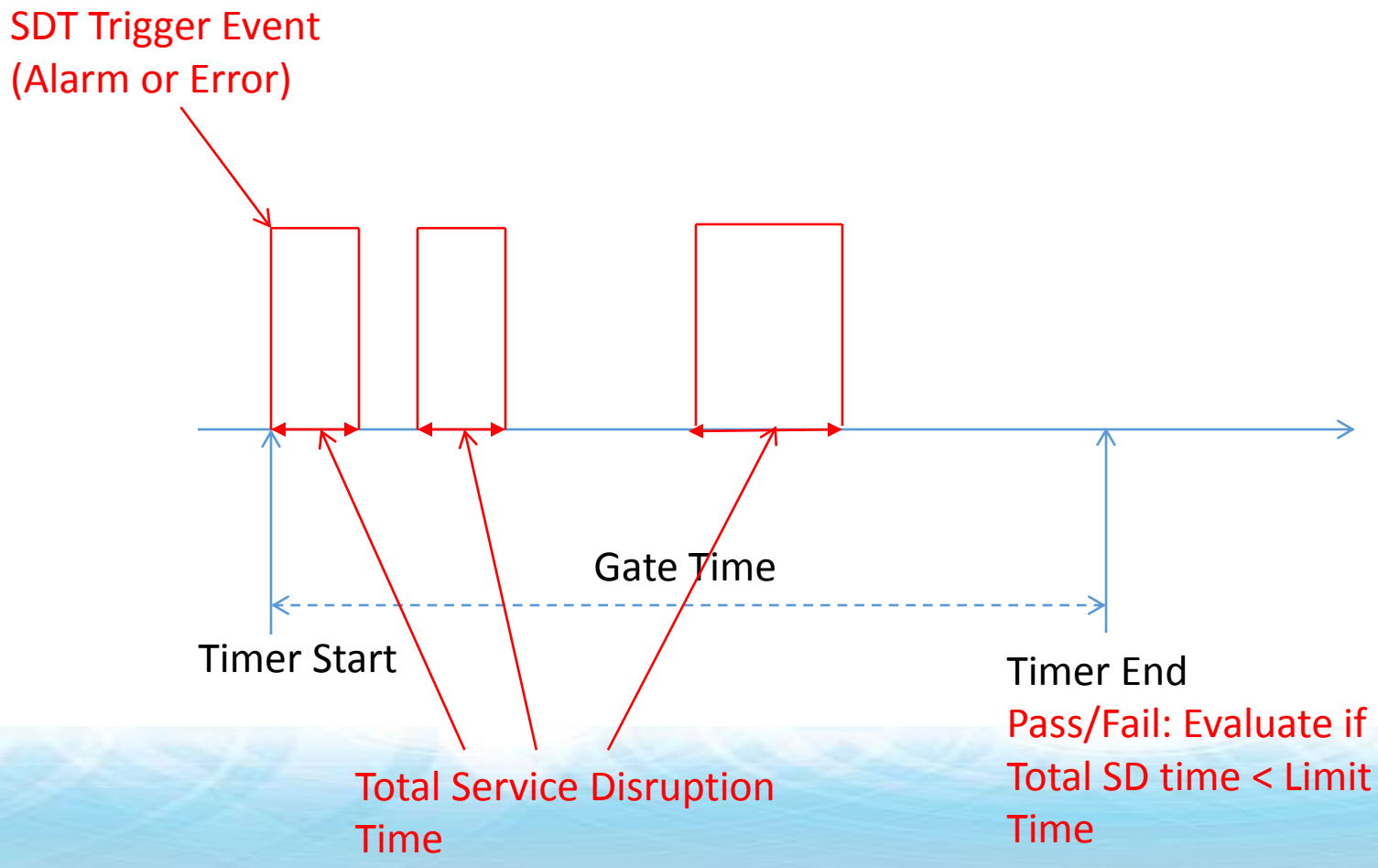
Sync Control word Z.0.1 set to D16.2 or D5.6

PRBS set to 1 AxC or All AxCs

Control and Management channel configuration
Slow C&M = HDLC channel, configurable rate or disable channel
Fast C&M = Ethernet channel, configurable start of Ethernet channel pointer in Control word or channel disabled.

Auto-negotiation can be used for Master/Slave to negotiate their maximum C&M channels capabilities

Mechanismus SDT měření



Výsledky SDT měření

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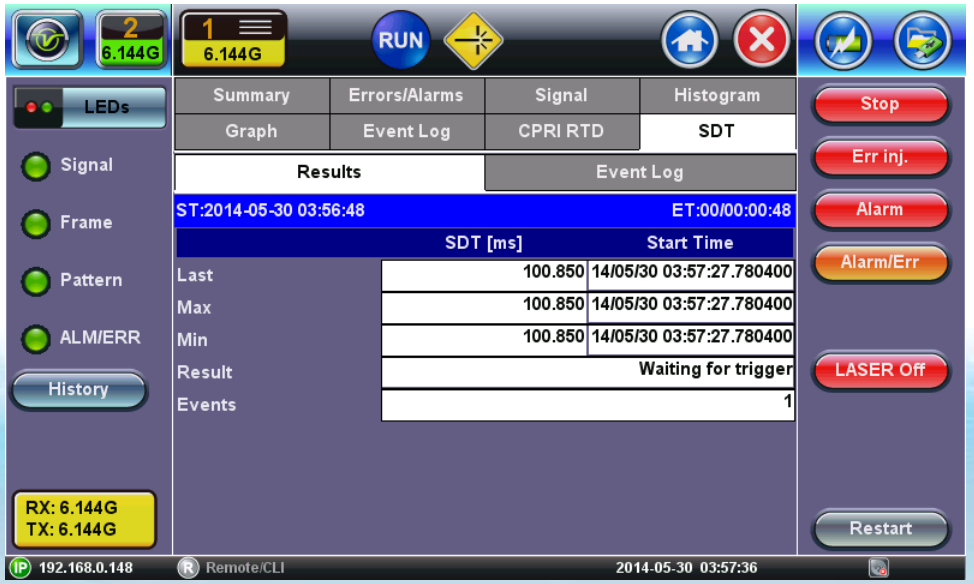
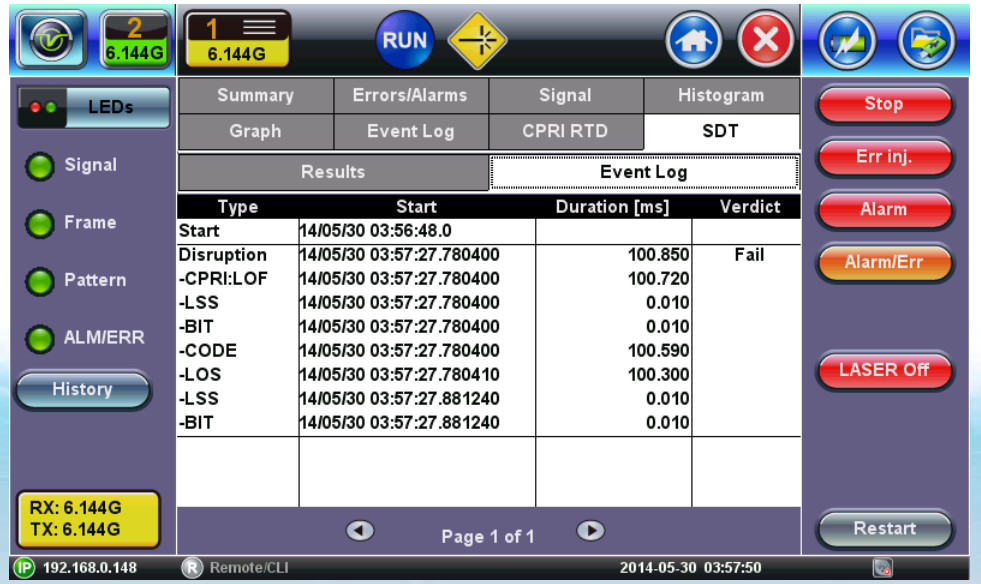
Limit and Gate Time counters begin at the onset of the first valid event.
SDT Measurement ends after the Gate time is elapsed, to allow the capture of multiple smaller events.
The total time from the beginning of the first event to the end of the last event (within the Gate Time) is the reported SD time.
The measurement process is immediately restarted in search for the next trigger. Results are presented in tabular form (Events table) indicating SD start time (1 ms resolution or better), disruption time, and Pass/Fail evaluation. This table gets populated as new disruptions are detected and measured.





Měření zpoždění

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CPRI Standard Cable Delay Measurement reference points:
Toffset = Frame offset delay between Slave RX and Slave TX
T 1,4 = Frame delay between Master TX and Master RX
Cable Delay (round trip) = T 1,4 – Toffset

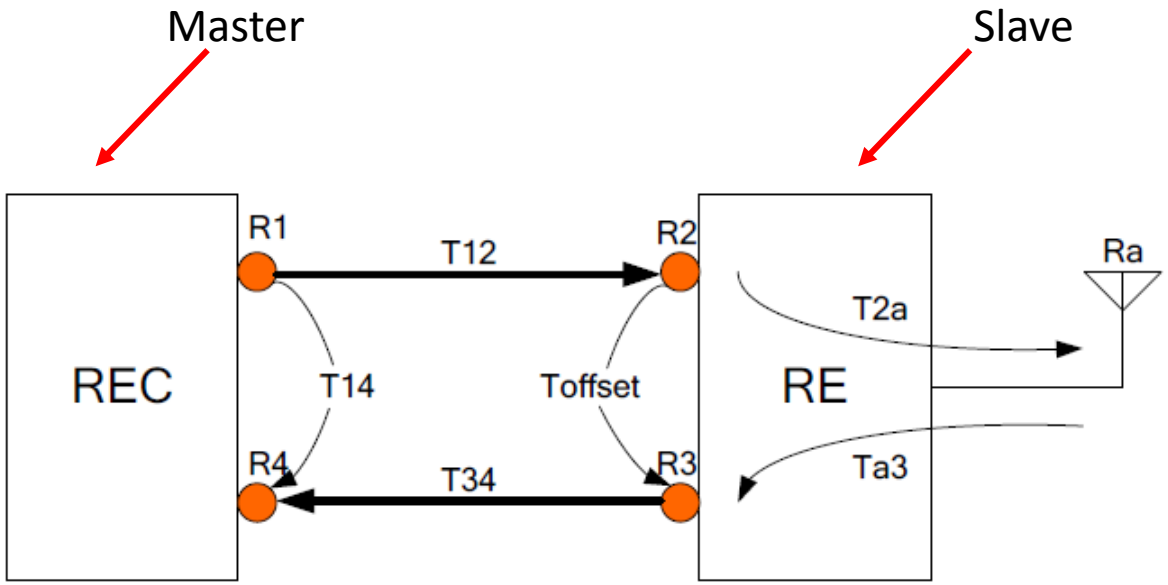
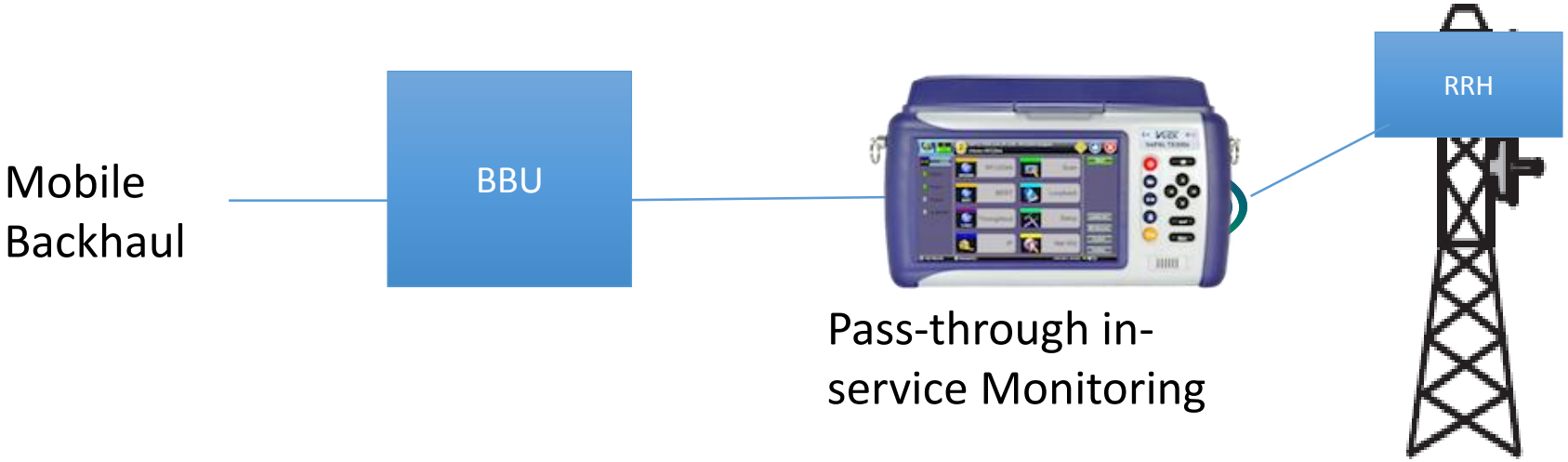


Figure 24: Definition of reference points for delay calibration (single-hop configuration)

Monitoring CPRI provozu



- Configured for dual port pass through monitoring or with optical splitters
- Troubleshoot protocol interop with Control words display
- Link status and alarm display
- Hyperframe capture

Analýza řídicího protokolu

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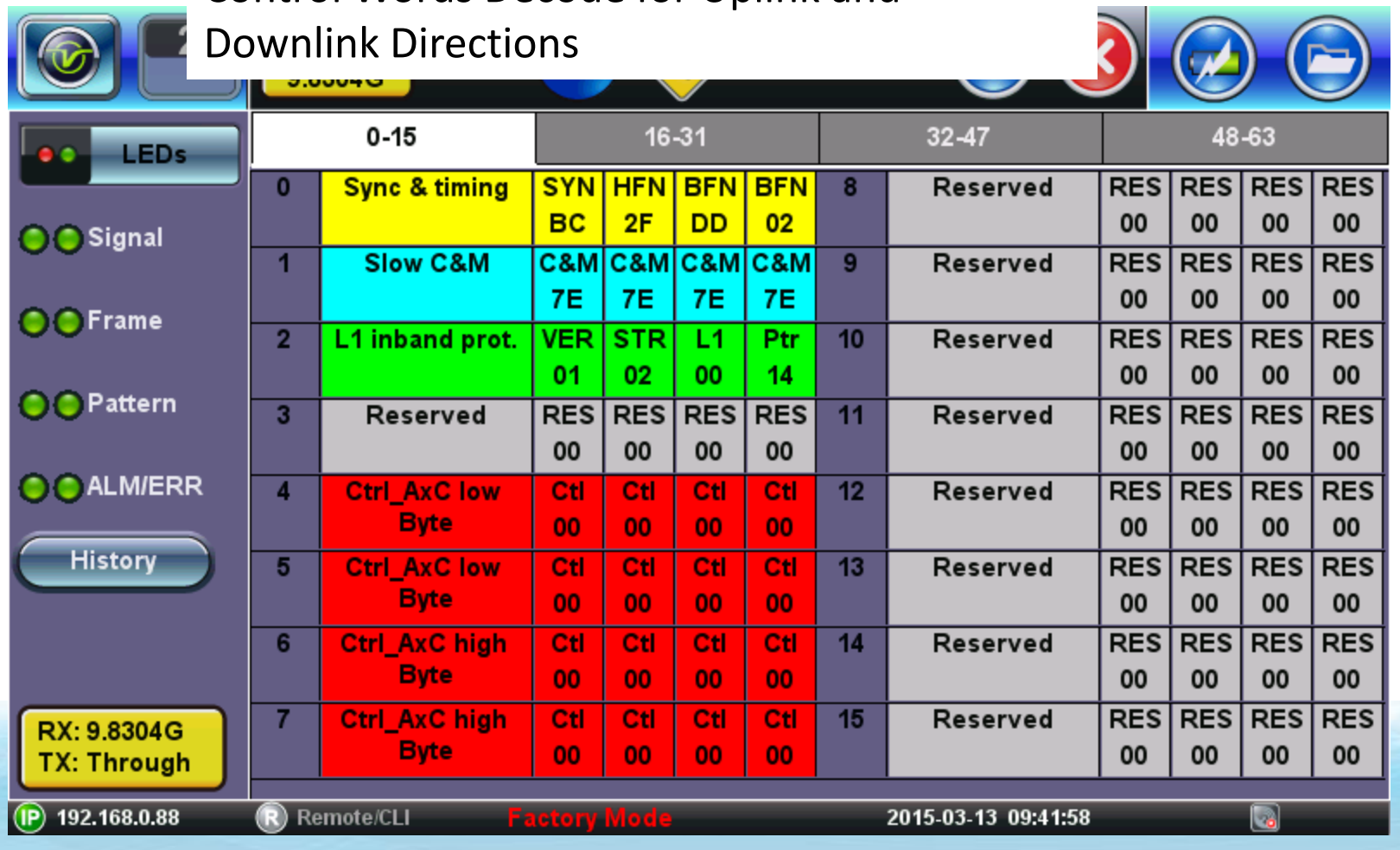
Control Words Decode for Uplink and Downlink Directions



	0-15					16-31					32-47					48-63			
0	Sync & timing	SYN BC	HFN 2F	BFN DD	BFN 02	8	Reserved	RES 00	RES 00	RES 00	RES 00								
1	Slow C&M	C&M 7E	C&M 7E	C&M 7E	C&M 7E	9	Reserved	RES 00	RES 00	RES 00	RES 00								
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7	Ctrl_AxC high Byte	Ctl 00	Ctl 00	Ctl 00	Ctl 00	15	Reserved	RES 00	RES 00	RES 00	RES 00								