Timing & Synchronization in Wireless Infrastructure
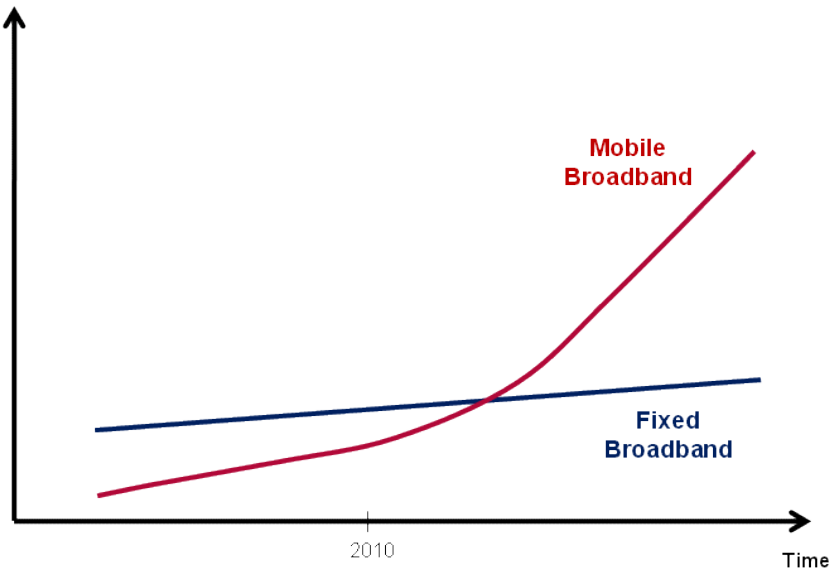
Harpinder Singh Matharu
Senior Product Manager, Comms Division, Xilinx

11/4/2010

Topics

- **Wireless Infrastructure Market Trends**

- **Timing & Synchronization in Base stations**

- **Challenges & Opportunities**
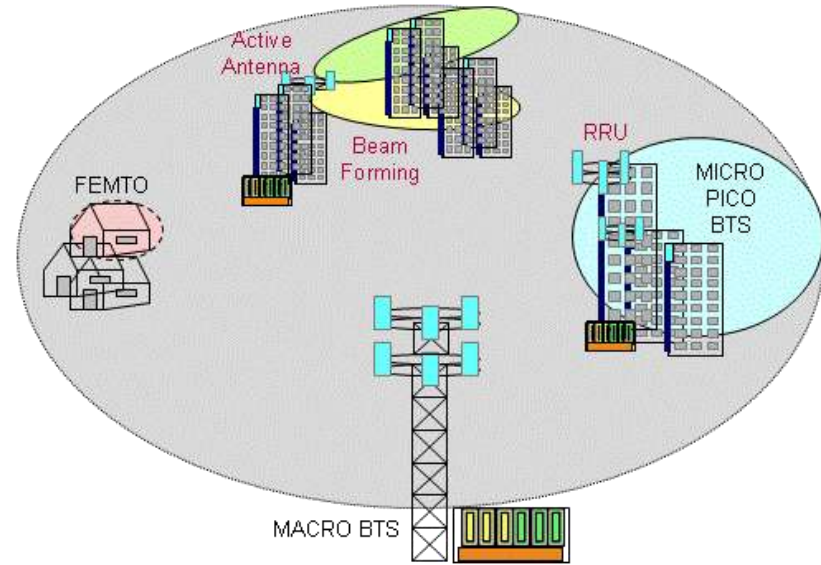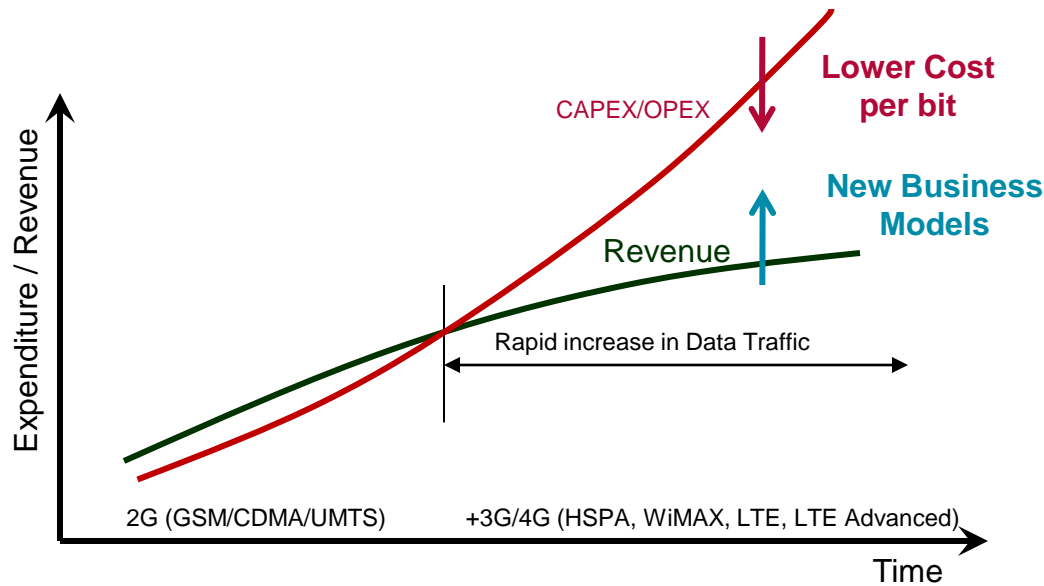
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Mobile Network witnessing rapid growth

Mobile Broadband

Fixed Broadband

2010

Time

Trend

Traditional Network Investment – 80%	Mobile Network– 20%

Active Antenna

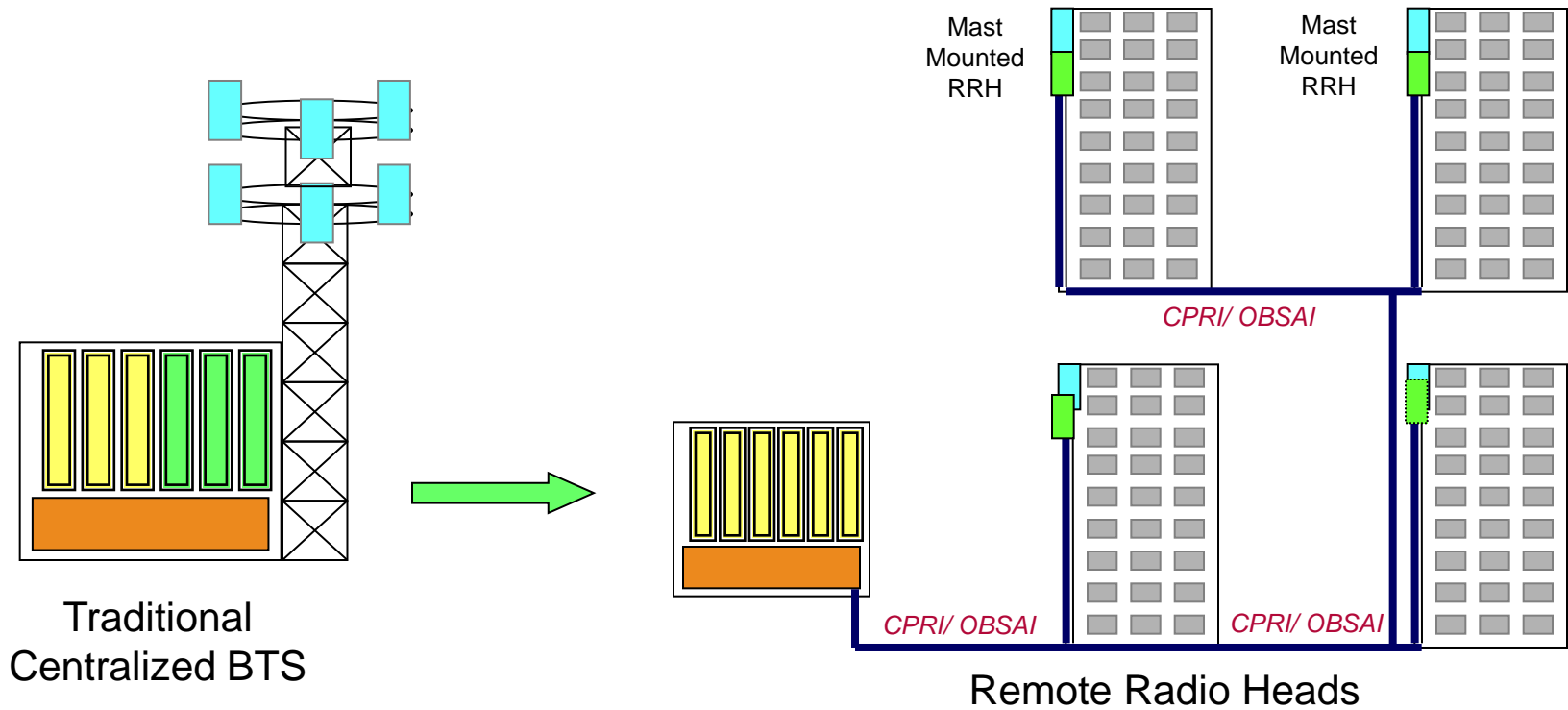Beam Forming

FEMTO

RRU

MICRO PICO BTS

MACRO BTS

- Heterogeneous Network
- Backhauling & Synchronization a challenge

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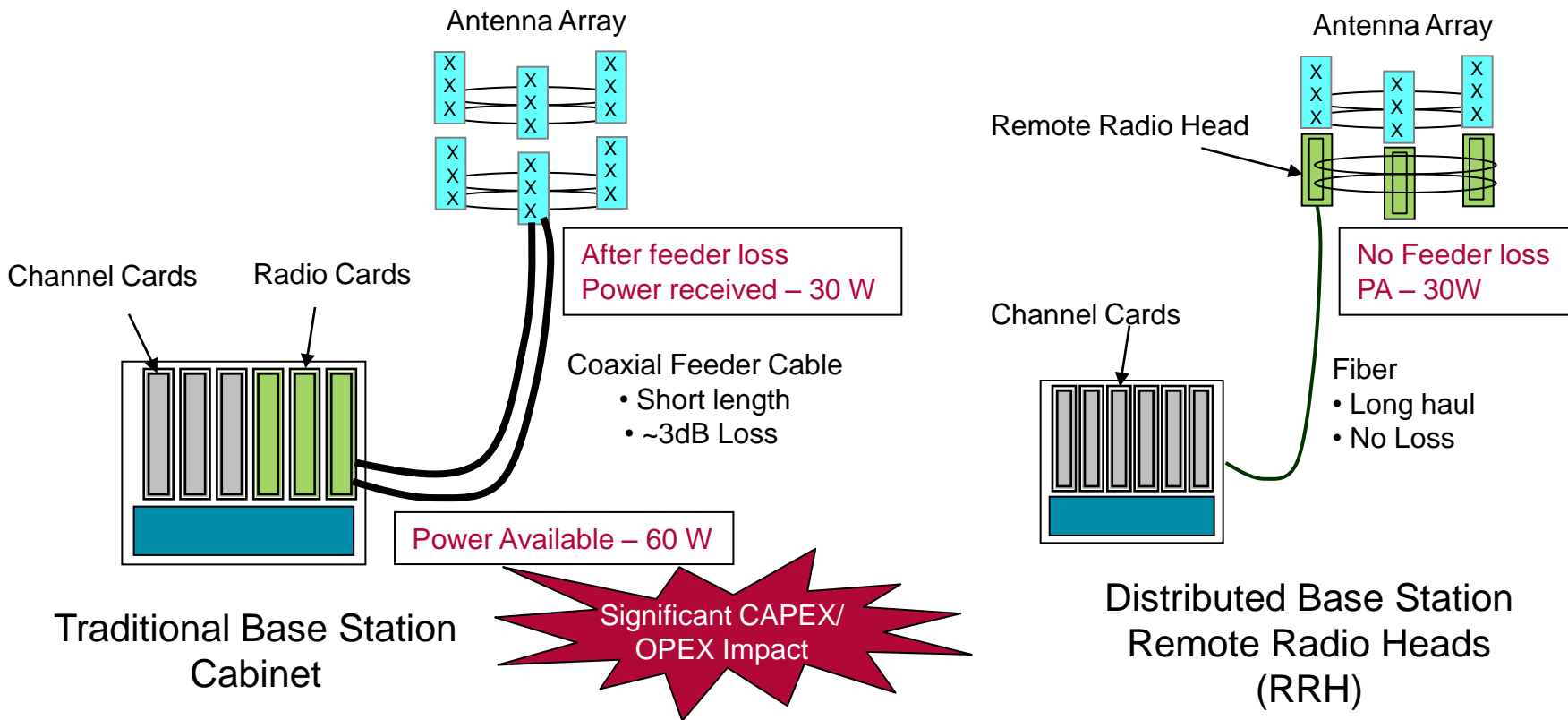# Revenue & CAPEX/ OPEX disparity

- Maximizing spectrum utilization

- Ease of network deployment & management

- Leveraging value/ intelligence in the network

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Base station Architectural shift

Traditional Centralized BTS

Mast Mounted RRH

Mast Mounted RRH

CPRI/ OBSAI

Remote Radio Heads

CPRI/ OBSAI

CPRI/ OBSAI

Shift from co-located to distributed BTS Architecture

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Remote Radio Heads enable Power Savings

Antenna Array

Channel Cards   Radio Cards

After feeder loss
Power received – 30 W

Coaxial Feeder Cable
• Short length
• ~3dB Loss

Power Available – 60 W

Significant CAPEX/
OPEX Impact

Traditional Base Station
Cabinet

Antenna Array

Remote Radio Head

No Feeder loss
PA – 30W

Channel Cards

Fiber
• Long haul
• No Loss

Distributed Base Station
Remote Radio Heads
(RRH)

Fiber replaces Coaxial Cable for significant CAPEX/ OPEX Savings

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Standardization of Radio Interface
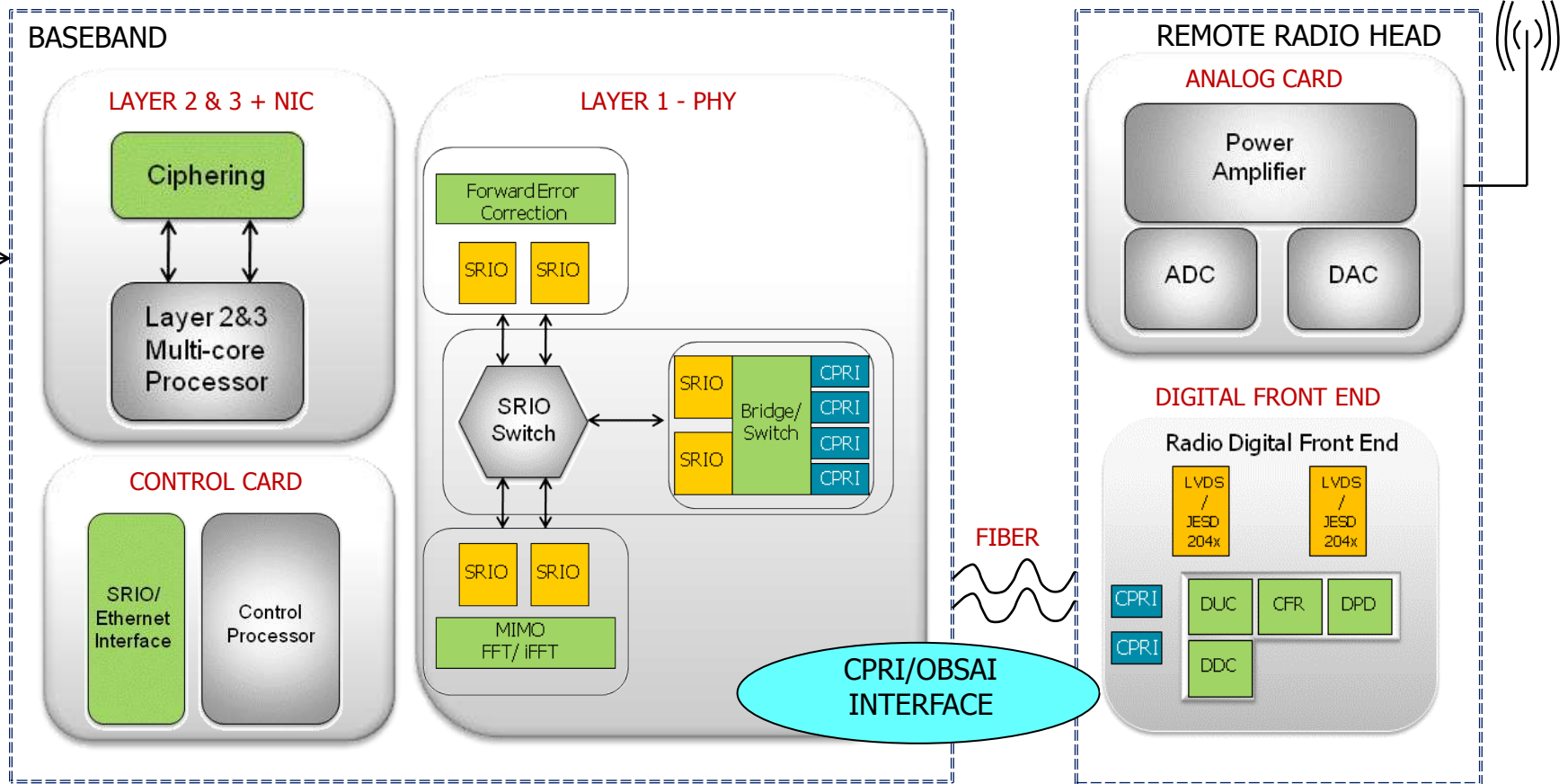
Radio Interface Standards – Drivers & Benefits

- **Drivers:**
  - Reduce BTS cost, power, and complexity
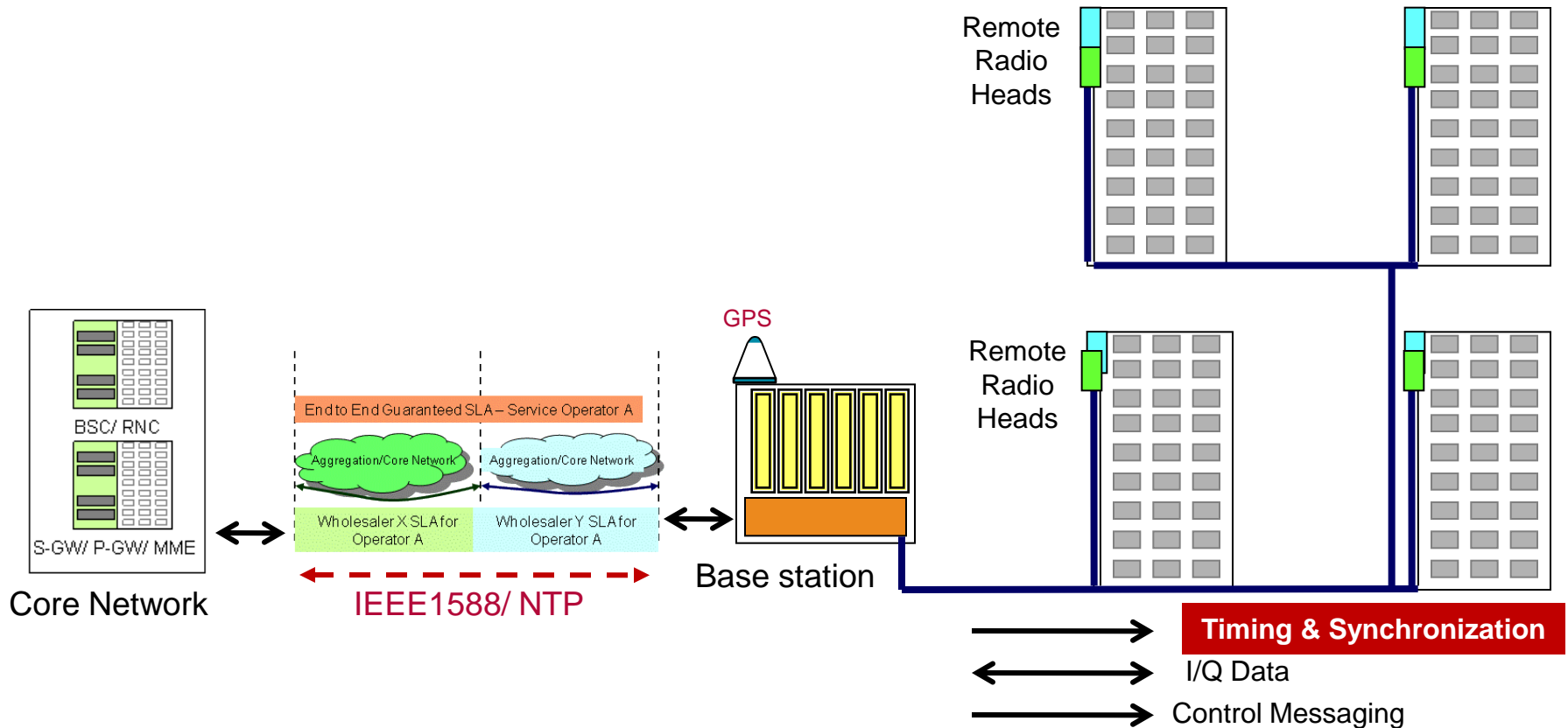 - Make module level expertise & ecosystem viable
- **Benefits:**
  - Off-the-shelf modules
  - Lower cost and shorter time to market
  - Faster technology / innovation adoption

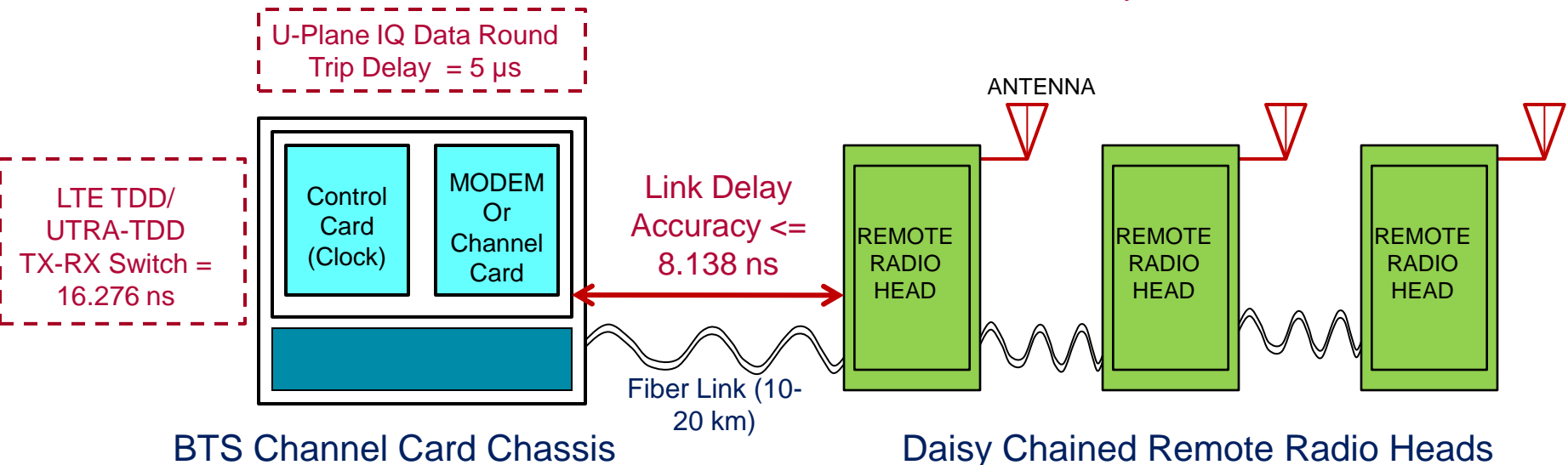XILINX.

Topics

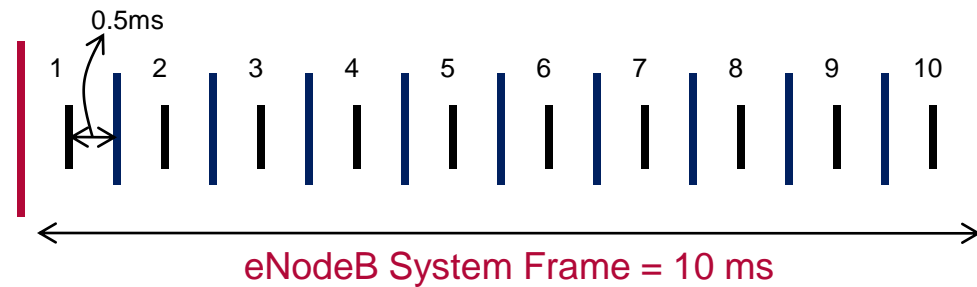- **Wireless Infrastructure Market Trends**

- **Timing & Synchronization in Base stations**

- **Challenges & Opportunities**

XILINX.

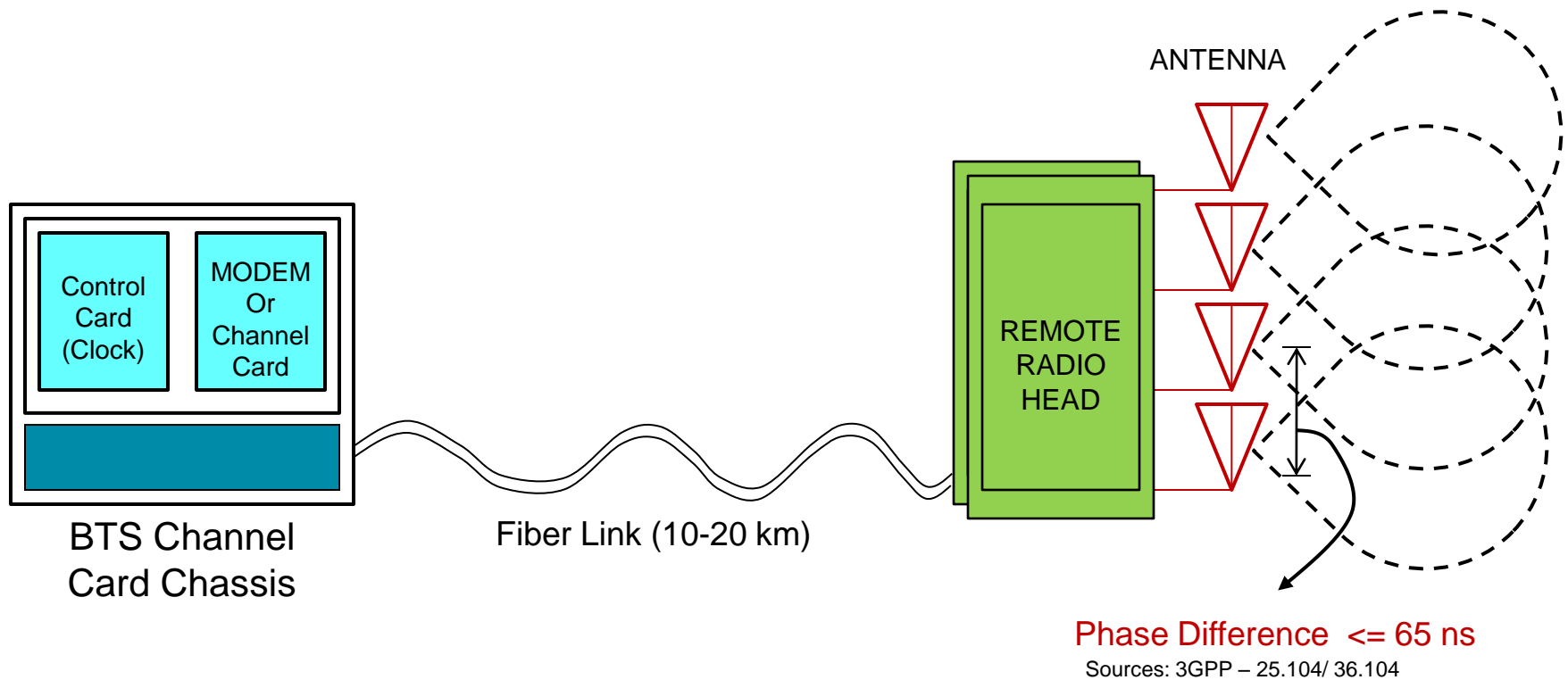# Timing & Synchronization Challenge in RRH

Tight timing & synchronization needs to enable Remote Radio Heads

System Timing Requirements

0.5ms

1 2 3 4 5 6 7 8 9 10

eNodeB System Frame = 10 ms

U-Plane IQ Data Round Trip Delay = 5 µs

LTE TDD/ UTRA-TDD TX-RX Switch = 16.276 ns

Control Card (Clock)

MODEM Or Channel Card

Link Delay Accuracy <= 8.138 ns

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REMOTE RADIO HEAD

REMOTE RADIO HEAD

REMOTE RADIO HEAD

Fiber Link (10-20 km)

BTS Channel Card Chassis

Daisy Chained Remote Radio Heads

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Transmit Diversity/ MIMO Timing Requirements

ANTENNA

Control Card (Clock)

MODEM Or Channel Card

BTS Channel Card Chassis

Fiber Link (10-20 km)

REMOTE RADIO HEAD

Phase Difference <= 65 ns

Sources: 3GPP – 25.104/ 36.104

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CPRI Protocol Terminology

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RADIO EQUIPMENT CONTROLLER (REC)
BASEBAND CHASSIS

OPTICAL OR ELECTRICAL LINK

RADIO EQUIPMENT (RE A)

OPTICAL OR ELECTRICAL LINK

RADIO EQUIPMENT (RE B)

CPRI (MASTER)

D0 D1 D2

D0 D1 D2

CPRI (Slave)

CPRI (Master)

D0 D1 D2

CPRI (Slave)

Packets flow between REC and RE A

Packets flow between REC and RE B

Link Speeds = 0.6; 1.2; 2.4; 4.9; 6.144G
+ 9.8G (spec expected to be released soon)

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CPRI Protocol Frame Synchronization

CONTROL   DATA

| 0 | 1 – 15 WORDS |

BASIC FRAME NUMBER (260.42 ns)

| BFN 0 | • • • | BFN 255 |

HYPER-FRAME (66.67 µs)

| HF 0 | • • • | HF 149 |

SYSTEM FRAME (10 ms)

FRAME DELIMITER SYMBOL

NODE B FRAME NUMBER

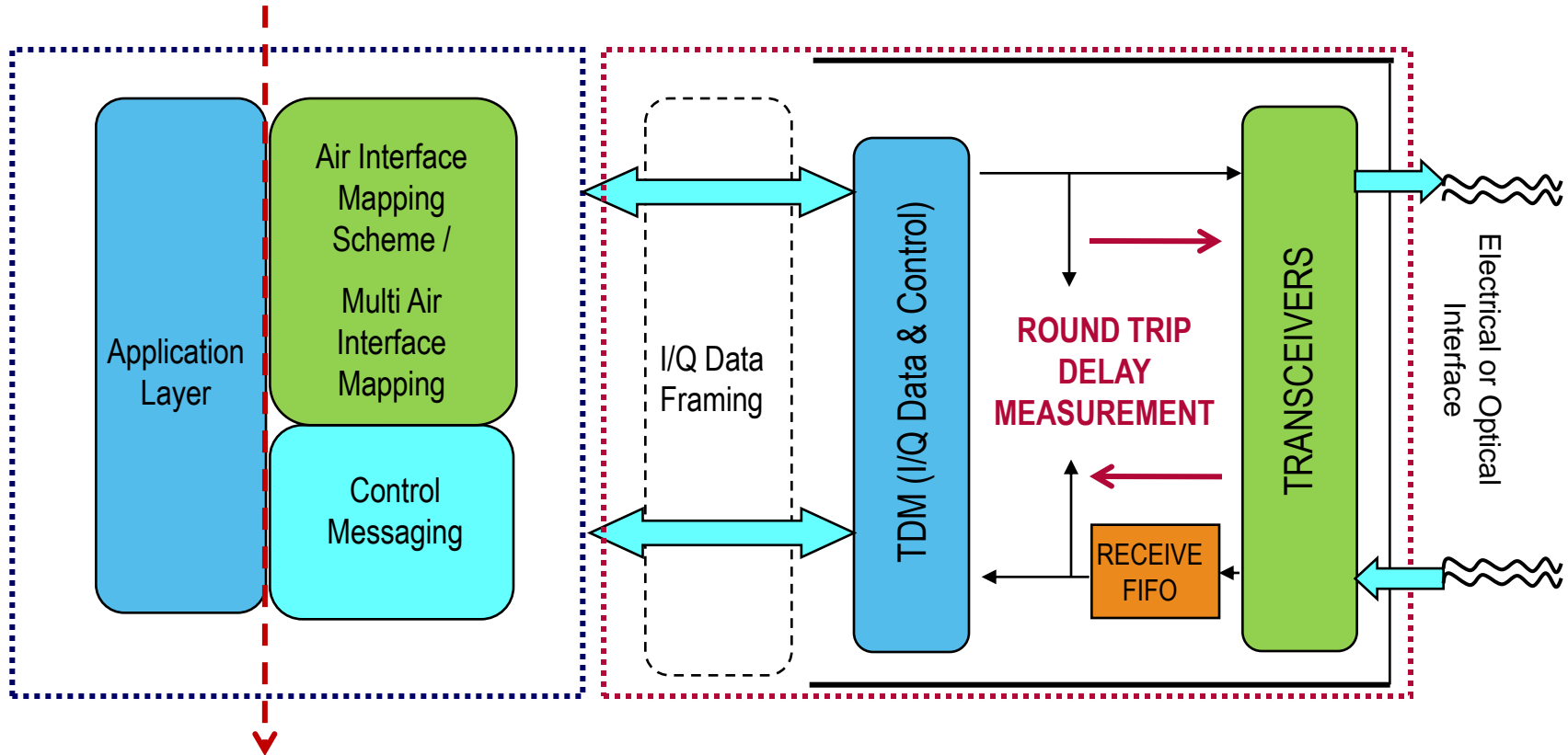|	0	1	2	3
0				
1		HFN	SFN	SFN
2				
3				
5				
6				

| 62 | | | | |
| 63 | | | | |

Control Sub Channels in a Hyper-frame
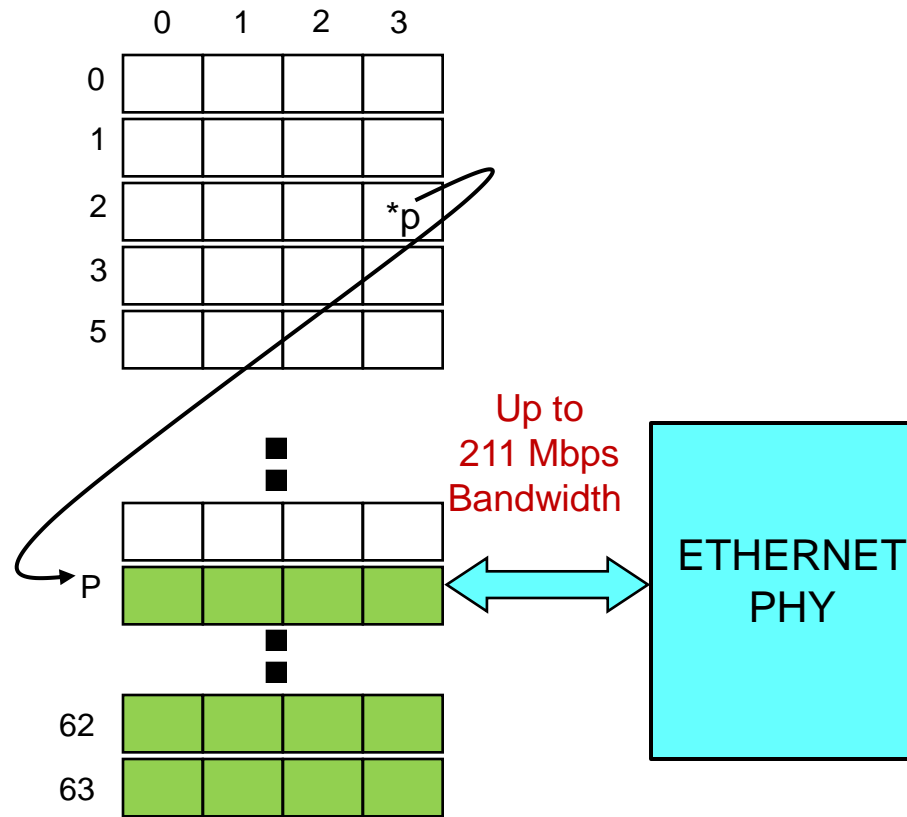
XILINX
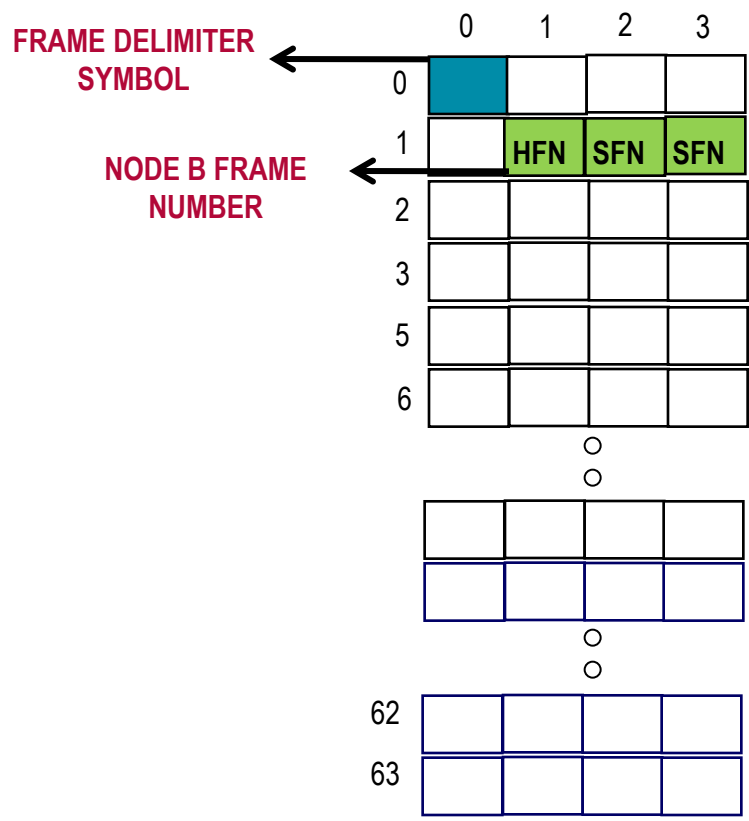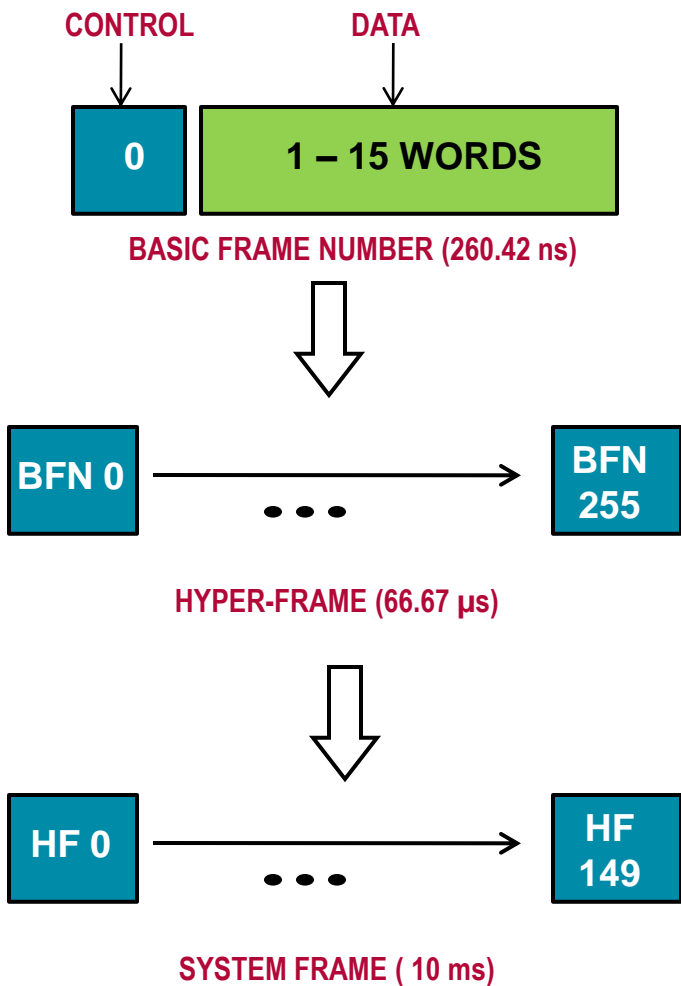
CPRI Protocol – Clock Synchronization
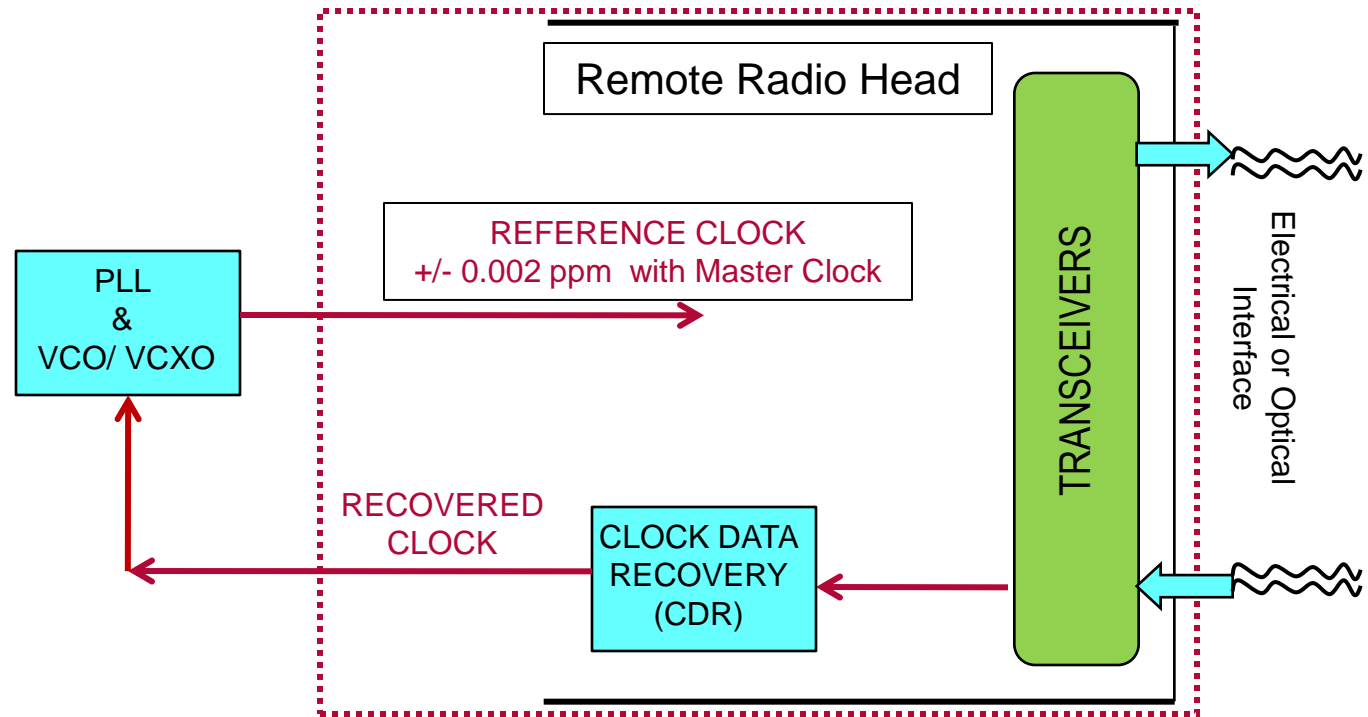
CPRI link similar to synchronous Ethernet in Clock Recovery

CPRI Protocol – Link Delay Accuracy Challenge

Round Trip Delay Accuracy of < = 16.276 ns fairly challenging

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Ethernet over CPRI
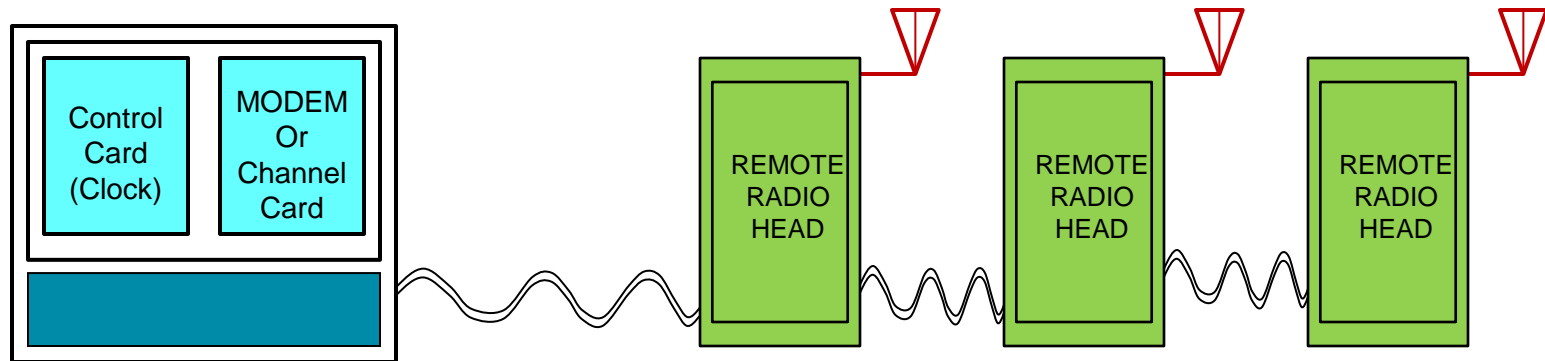

Control Sub Channels in a Hyperframe

Could spare Ethernet bandwidth be used for PTP to reduce timing cost?

Topics

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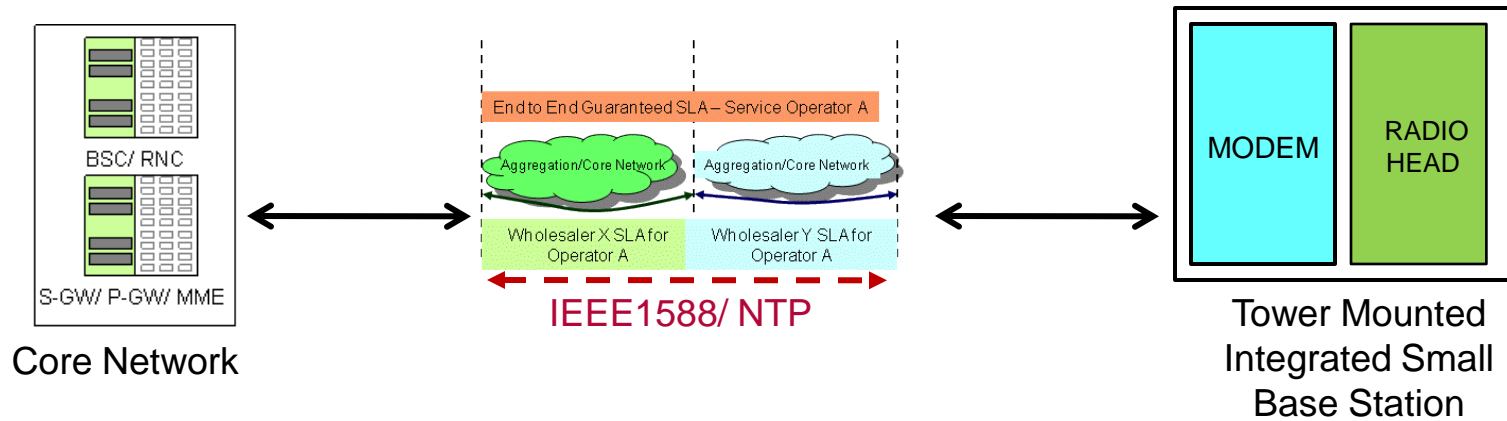# Fiber Sharing – CPRI over Carrier Ethernet?

Network Convergence

FIBER SHARING – Currently dedicated fiber link being laid out for Radio Interface

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Small Cell Connectivity

PTP plus Ethernet over Power?

Core Network

IEEE1588/ NTP

Tower Mounted Integrated Small Base Station

IEEE 1588 – Could PTP + Power over Ethernet be used in the last segment?

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Summary

- **Mobile Network witnessing exponential growth**

- **Architectural innovations to keep CAPEX /OPEX in bounds**

- **Standardization important for healthy ecosystem**

- **Challenges & Opportunities abound**

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