CPRI “FrontHaul” requirements discussion with TSN

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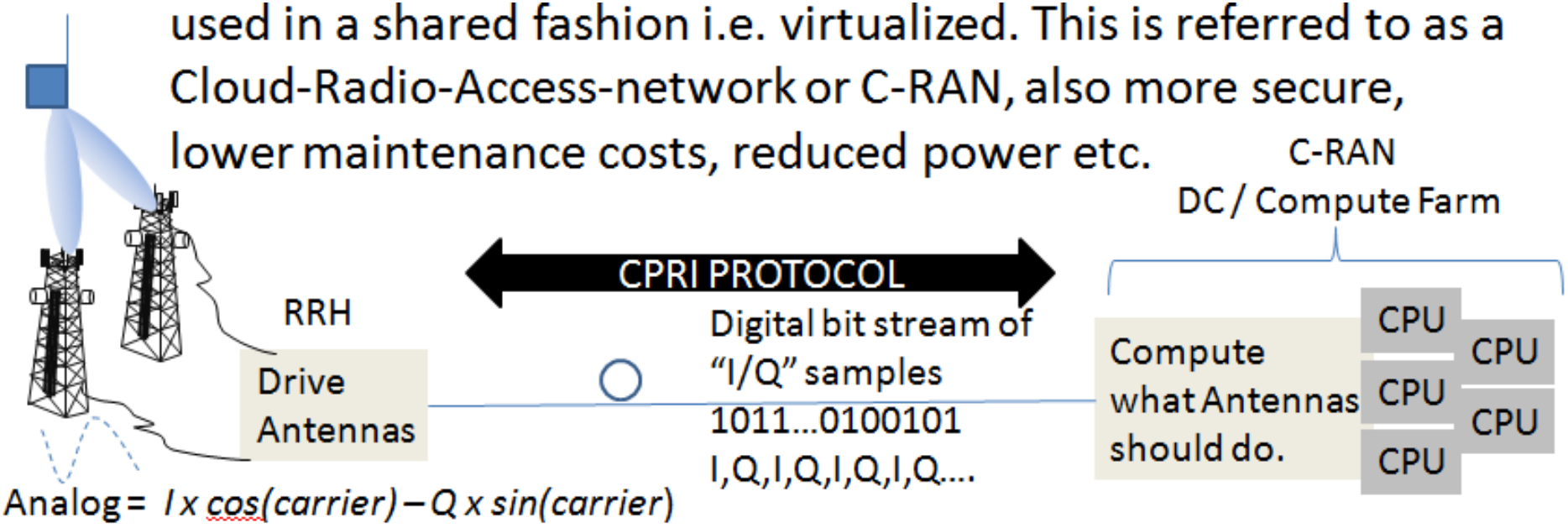
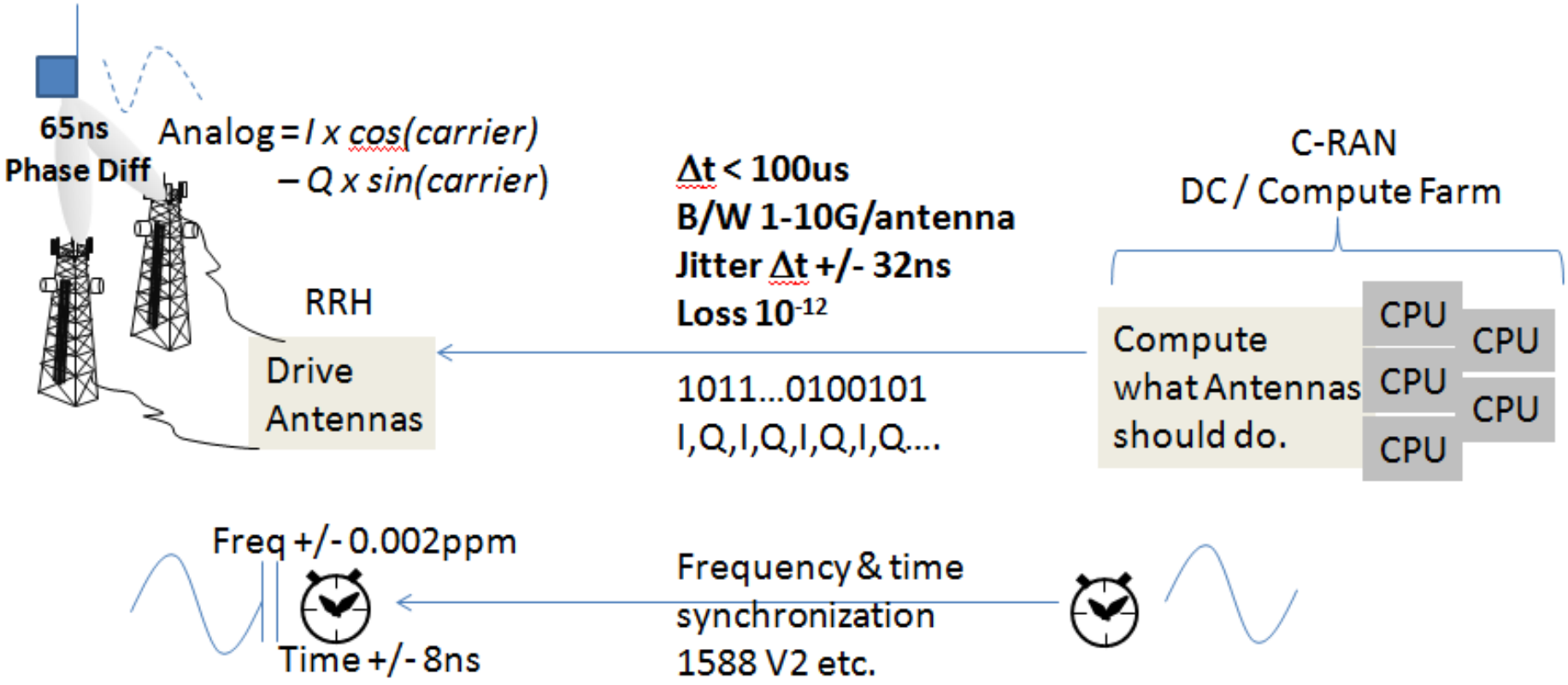
What is Common Public Radio Interface (CPRI)?

- Standard interface between the compute, intelligent, expensive part of a wireless base station and the dumb cheaper antenna driving part (RRH – Remote Radio Head)
- Separating them allows the intelligent bits to be more centrally located in a compute farm. Kind of DC.
- Central location allows the expensive intelligent bits to be used in a shared fashion i.e. virtualized. This is referred to as a Cloud-Radio-Access-network or C-RAN, also more secure, lower maintenance costs, reduced power etc.

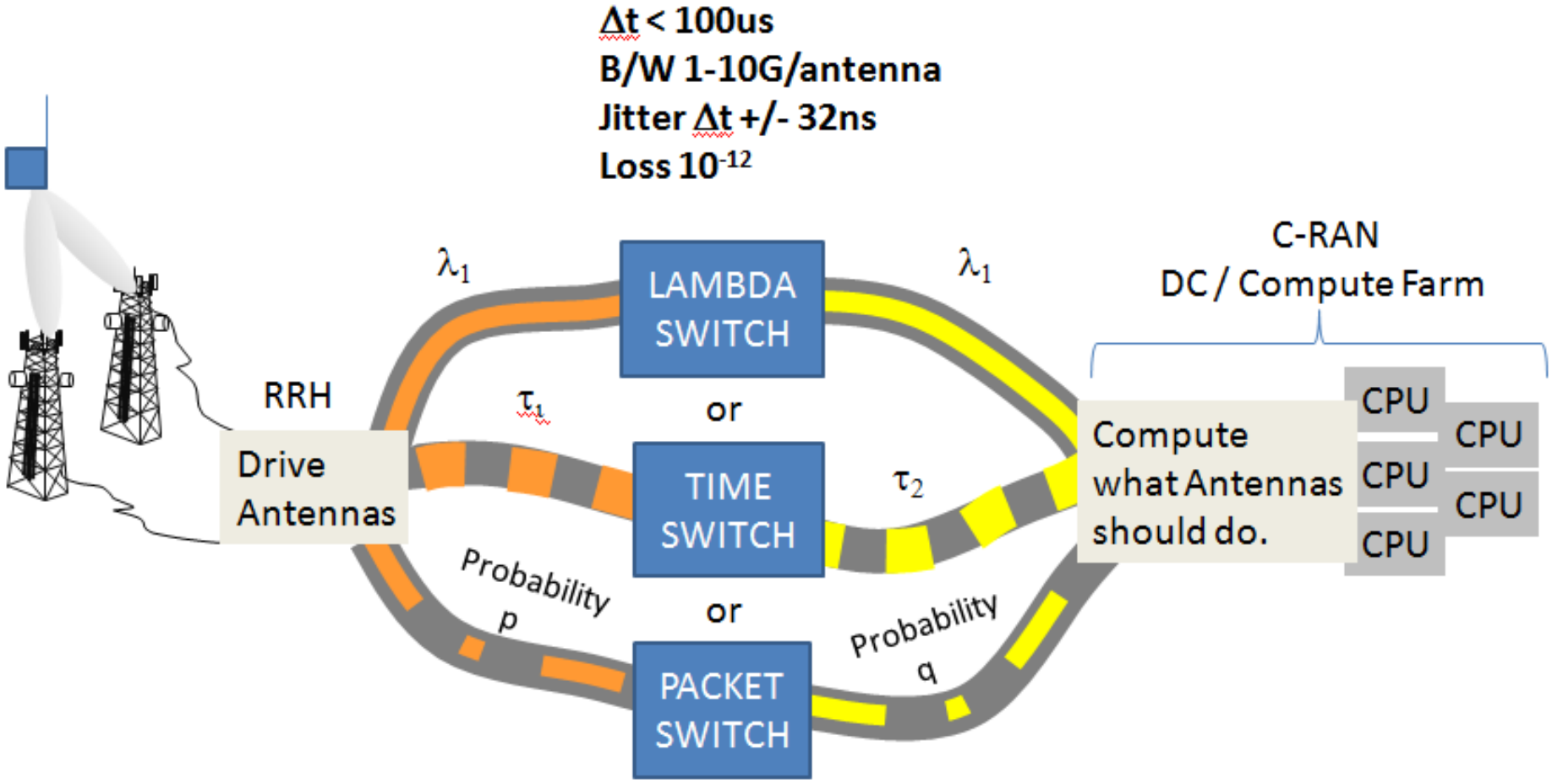


Functional Requirements

- **100us** – Maximum one way Delay between Antenna and Compute
- **65ns** – Maximum variation in Delay (Jitter).
- **1-10G** – Throughput per antenna (compression possible).
- **10^{-12}** – Maximum Bit Error Rate



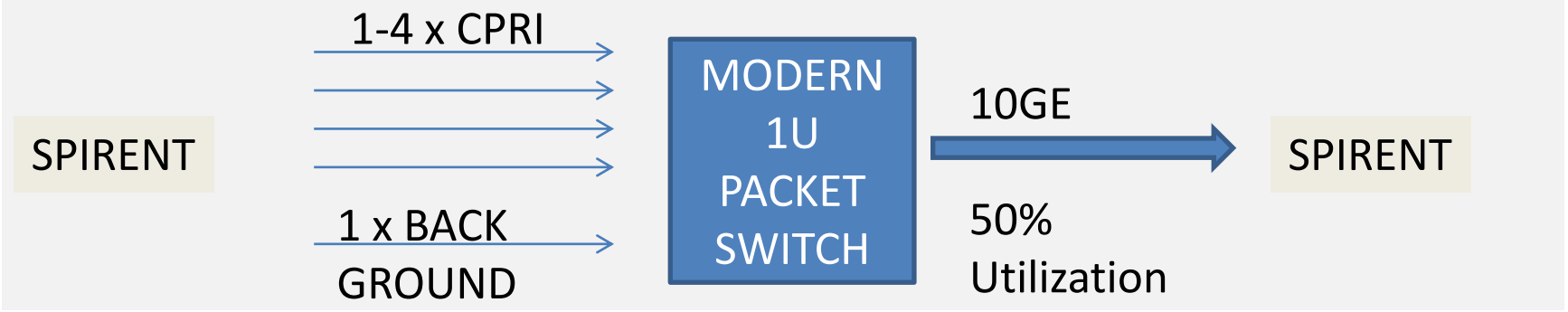
Carrying CPRI – DWDM & TDM works. Can we replace with Ethernet?



If we can meet the requirements with Packet (Ethernet) network then we can eliminate DWDM/TDM network => Big costs savings in operations and parts costs.

Current state of affairs

SIMPLE TEST

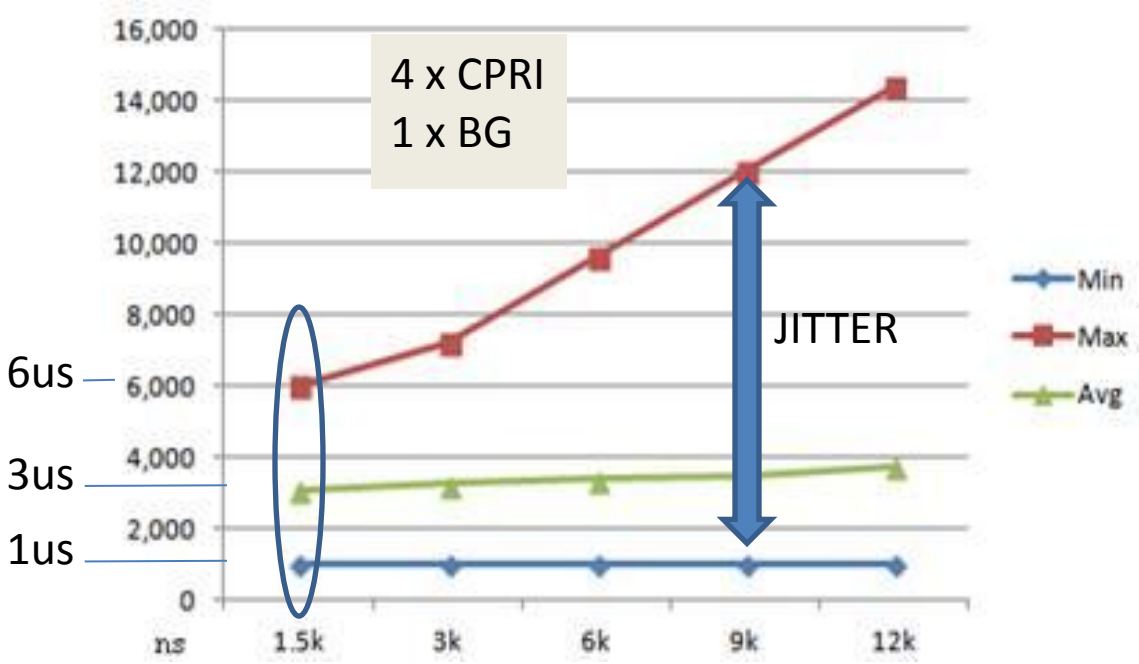


REQUIRED

Δt < 100us
B/W 1-10G/antenna
Jitter Δt +/- 32ns
Loss 10^{-12}

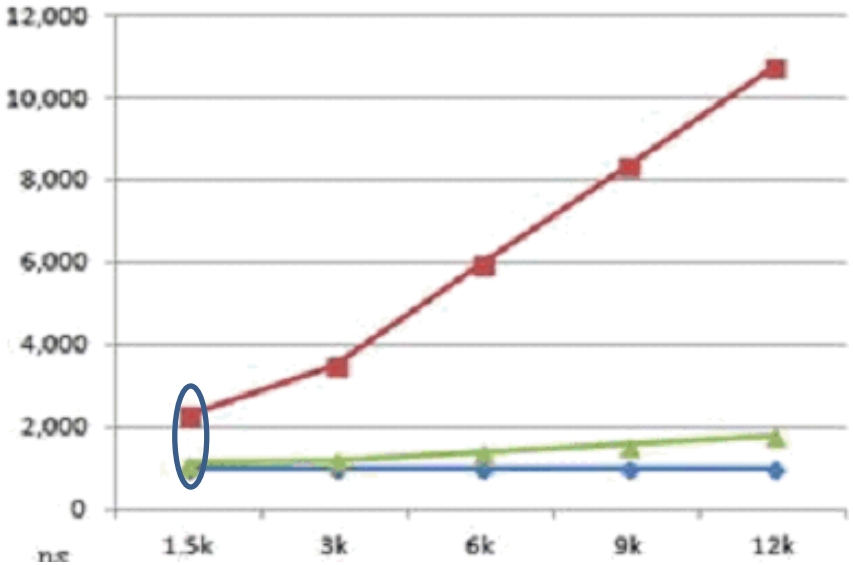
OBSERVED

Average Δt = 3us per hop ☺
Jitter = Δt +/- 2500ns per hop ☹



Back ground packet size in K

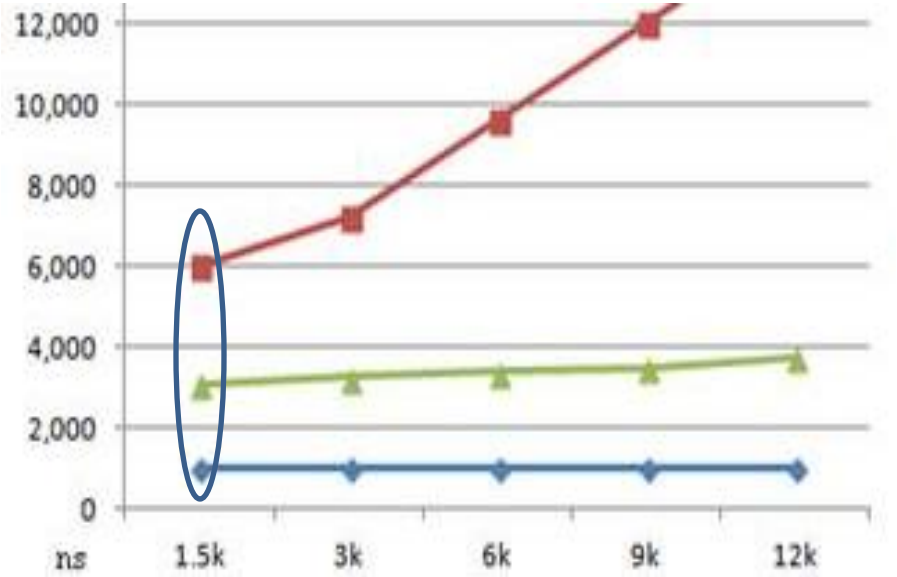
Current state of affairs (cont'd)



1 x CPRI
1 x BACKGROUND

Jitter is nearly **<u>1000ns</u>**

This would be equivalent of two CPRI streams with 1.5k packets even with Interrupting queue.



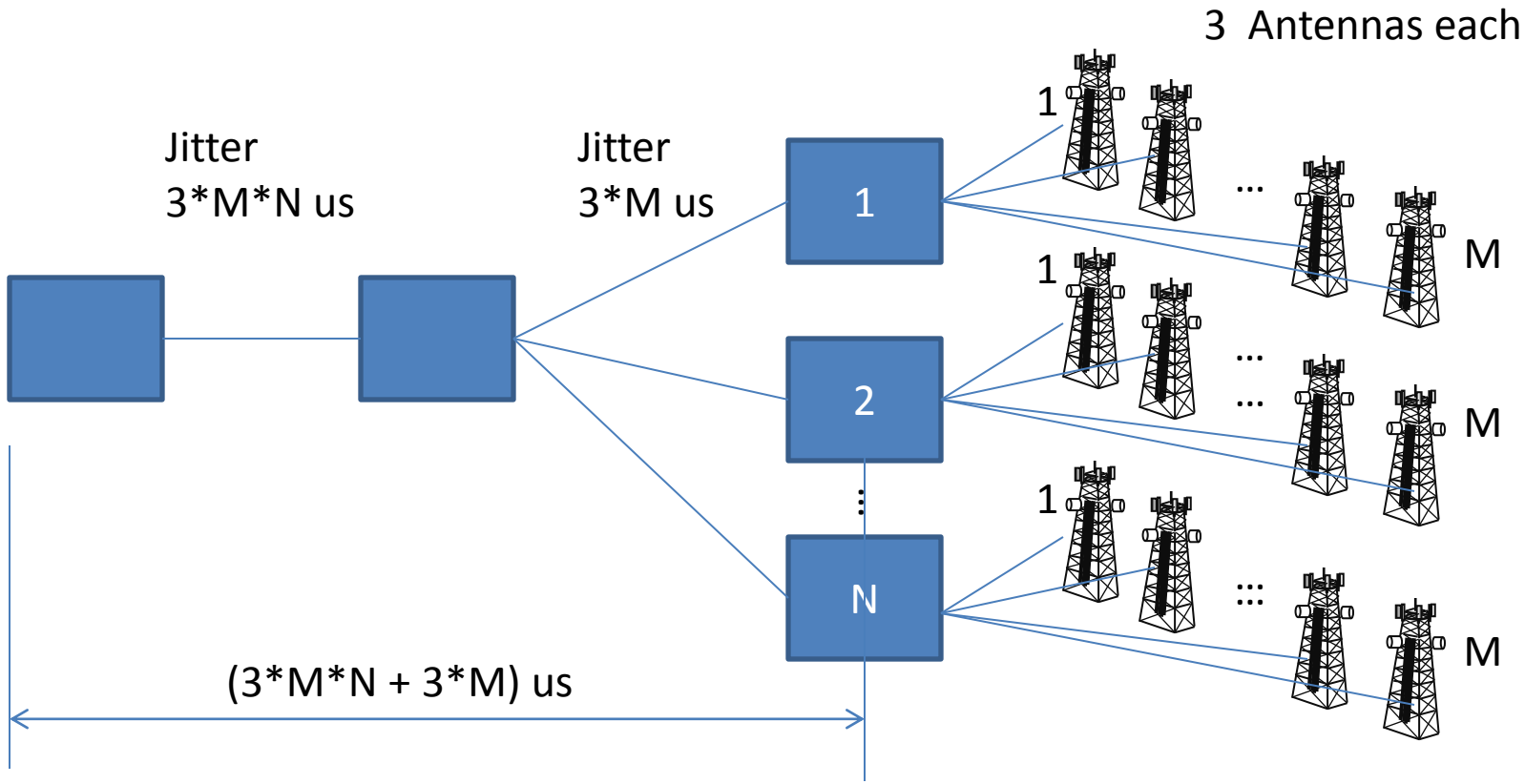
4 x CPRI
1 x BACKGROUND

Jitter is nearly **<u>5000ns</u>**

This would be equivalent of 5 CPRI streams with 1.5k packets even with Interrupting queue.

CPRI packets can cause self Jitter

Removing Jitter egress reduces diameter



1. Speed of light in glass approx: 200,000 km/sec, so 5us means about 1km distance.

2. So for every 5us of jitter to remove we must reduce diameter by about 1km **and <u>add 5us</u>** of egress buffering.

3. Based on this trivial example where every 5 additional antennas (~two towers) create 5us of added jitter and with a budget of 100us/20km to work with we can see cost of jitter adds up quickly.

Observations

- **Interrupting will definitely help but CPRI packets will also cause *self inflicted jitter*.**
- **Possible to time-stamp packets, buffer egress and play them out at proper time, but this adds delay.**
- **Pretty big market to consolidate the FrontHaul & Backhaul for 5G over Ethernet.**

Questions

- **Could modified TSN protocols address jitter/delay requirements of CPRI? Reduction translates to $$**
- **Does IEEE/TSN want to address these issues for CPRI?**

References

http://www.cpri.info

http://www.cpri.info/downloads/CPRI_v_6_0_2013-08-30.pdf