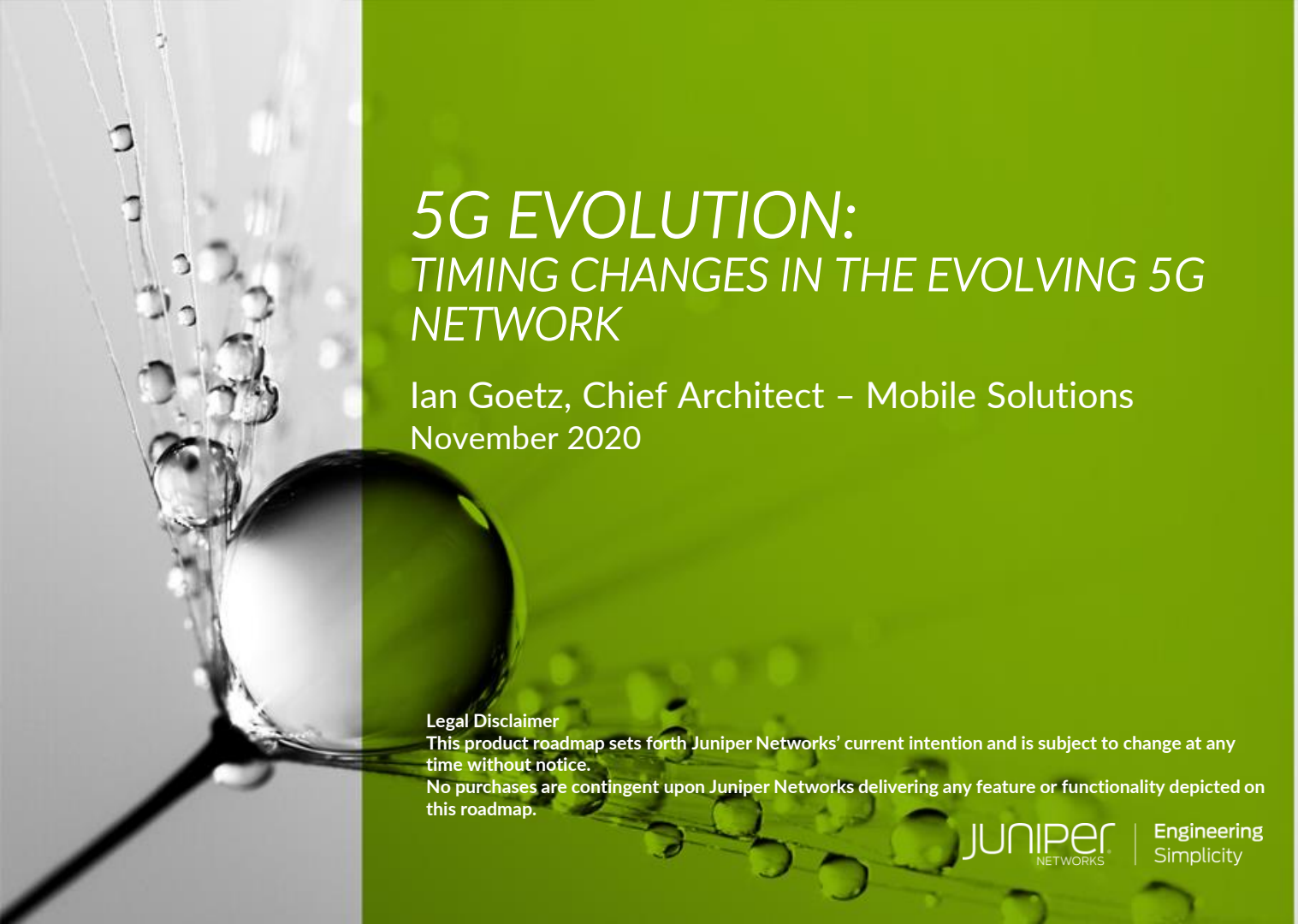

5G EVOLUTION:
TIMING CHANGES IN THE EVOLVING 5G NETWORK

Ian Goetz, Chief Architect – Mobile Solutions

November 2020

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No purchases are contingent upon Juniper Networks delivering any feature or functionality depicted on this roadmap.

Juniper Networks | Engineering Simplicity

WHERE'S THE MONEY COMING FROM? - Revenue Growth in 5G Mobile

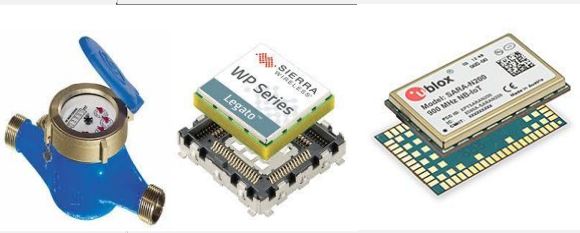
CONSUMER — Google, amazon.com, NETFLIX

ENTERPRISE — SAP, salesforce

IoT — Microsoft Azure, amazon web services, AWS Greengrass

AUTOMOTIVE — 5GAA Automotive Association




Trusted Reliability | Pervasive Coverage | Seamlessly Converged | Ubiquitous-Coverage | Low-Latency | Security

- **CONSUMER**:
  - Value Added Services are now OTT…… **BUT AR Gaming** on Edge Cloud could add new revenue
  - Content is key for consumer segment, but is mainly OTT… unless operator owns content
- **CURRENT ENTERPRISE**:
  - SIM & Roaming Packages for Mobile, VPN/SD_WAN connectivity.
  - OTT MVNO – under threat from Cloud Providers

eMBB

REDUCE COST

(Open RAN but needs Edge Cloud)

- **FUTURE ENTERPRISE**:
  - **Private Network Coverage**: Industry 4.0, IIoT, Healthcare etc
  - **Ubiquitous Coverage**: *IoT, Augmented/Fully Autonomous Vehicles & Smart Cities*
  - **Low Latency Services:** *Across 4G & 5G, <25ms*
  - **Battery Efficiency**: *key to IoT business case, Often need >10 years*
  - **Security**: *Already seeing attacks from compromised devices – currently no defence from such attacks*
  - **Drives Edge Cloud: Mobile needs the edge cloud to deliver new services and grow revenue**

Low Latency & Massive IoT

EDGE CLOUD INVESTMENT

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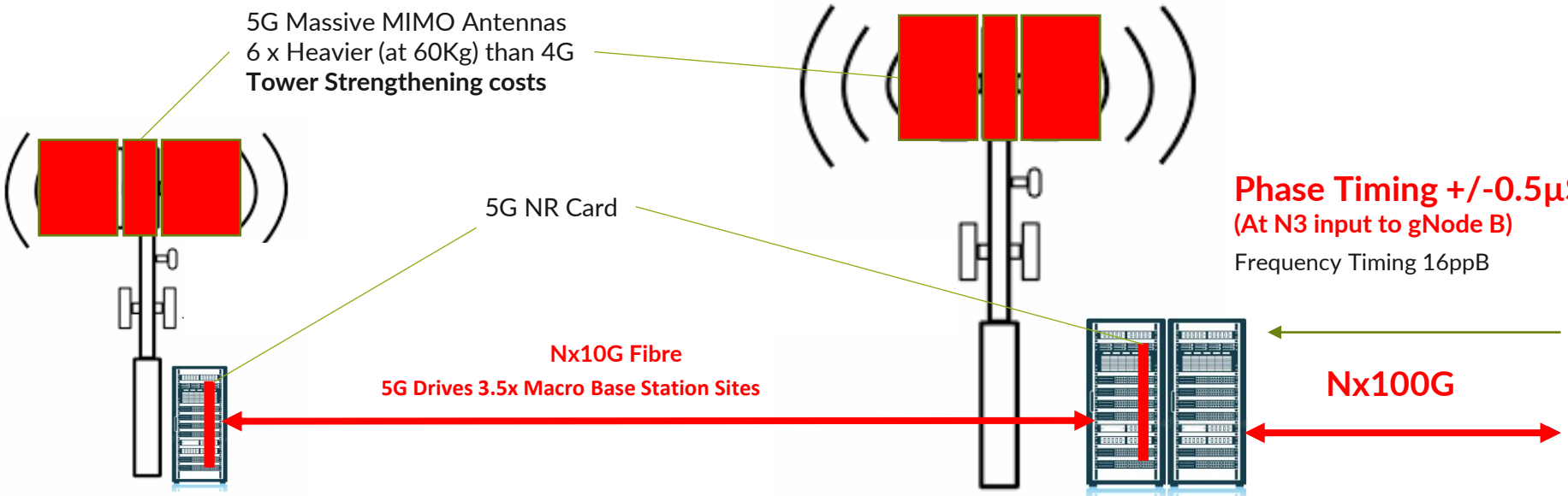
NETWORK CHANGES FROM 4G TO 5G: FIBRE TRANSPORT & PHASE TIMING

Significant Cost for MNO – Spectrum, 5G NR Cards, Fibre, **Phase Timing** & Nx10G/100G Routing
Moving from 1G to 10G and 2x10G and also Open RAN means Microwave has to be replaced by Fribre



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5G RAN COSTS & GEO-POLITICS DRIVING NEW OPEN APPROACH

Major Announcements in Open RAN driven by 3x requirements for 5G Cell Sites, Geopolitics and the need to cut RAN Cost

Operators see no revenue from eMBB but need to drive 3x Cell Sites for 5G in an era where "High Risk Vendors" may no longer dominate – the answer is seen as Open RAN… growing number of trials, RFPs and deployments happening globally

FierceWireless

WIRELESS TECH 5G IOT

Wireless

Vodafone just gave open RAN vendors a huge opportunity

by Linda Hardesty | Nov 13, 2019 4:22pm

In other big news from Vodafone, the company also issued a request for information for 5G new radio. (Screenshot of TIP Summit slide)

Vodafone's head of network strategy and architecture Santiago Tenorio announced today at the Telecom Infra Project (TIP) Summit in Amsterdam that Vodafone will issue a request for quotes (RFQ) for open RAN technology for its entire European footprint.

"That's significantly more than 100,000 sites, and all the technologies are to tender — 2G, 3G, 4G, and 5G."

TIP Members Vodafone, Telefónica to Issue OpenRAN RFIs

Sue Marek
June 26, 2018 6:43 PM

Vodafone and Telefónica, which are both members of the Telecom Infra Project (TIP), are issuing a request for information (RFI) to vendors for products that use OpenRAN principles. The two operators plan to make the specifications for the RFI available to the OpenRAN project group in the coming days, and they will announce the results of the RFI along with a shortlist of potential vendors at the TIP Summit Oct. 16-17 in London.

The RFIs are focused on 4G LTE RAN solutions, although Vodafone and Telefónica said they would also consider 2G and 3G platforms.

The RFIs are intended to help OpenRAN technologies gain traction in the market and determine which vendors are innovating in this area. The submissions will be evaluated using certain benchmarks. Those vendors that want to submit to the RFI process are encouraged to provide detailed information on their products as well as their development plans for the next year. Only RAN nodes that demonstrate open interoperability of the baseband processing platform, radio hardware, software, and business model will be evaluated.

JUNE 5, 2019

RAKUTEN MOBILE, INC.
NEC CORPORATION

Rakuten Mobile and NEC to Build Open vRAN Architectu

Rakuten Mobile and NEC to col
equipment for world's first hig

Tokyo, June 5, 2019 – Rakuten
Group, and NEC Corporation, a
today announced that the two
first 5G open vRAN architectur
equipment for Rakute

Through the partnership, Raku
5G antenna radio unit (RU), wh
NEC's RU are ideal for 5G cond
level of power, which reduces i

Rakuten Mobile is currently bu
native mobile network. This in
network to core and adopts 5G
Mobile received approval from
Communications for its 5G spe
services in June 2020.

telecoms.com

news

Dish adds more credibility to OpenRAN with Mavenir selection

Mavenir has boasted of signing new US entrant Dish as its latest customer, as the emerging telco sets its sights on the most enviable of tasks; a greenfield network deployment.

Like Rakuten in Japan, Dish is able to embrace the OpenRAN movement like few others can around the world. Without being inhibited by legacy technologies or traditional operational models, the Dish team can build a network from scratch, without making compromises or concessions. It is a dream-come-true for any network engineer; the opportunity to deploy a network exactly as you would want to.

"The open and intelligent architecture of our greenfield network will give us the ability to source a diverse technology ecosystem, including US-based solution providers," said Marc Rouanne, Chief Network Officer at Dish, and former Nokia executive.

"Mavenir will help us lay the foundation for an innovative software-defined network with the flexibility, intelligence and scalability to deliver applications that will redefine the US wireless industry."

As part of the agreement, Mavenir will provide Dish with a cloud-native OpenRAN software, which the new telco hopes will underpin the US' first software-defined 5G wireless broadband network.

While the obvious and most proclaimed benefit of the OpenRAN ecosystem is a wider array of suppliers, all promising there is no such thing as vendor lock-in, another significant upside to the OpenRAN movement is on the operational side of the business.

According to Tareq Amin, Chief Technology Officer at Rakuten, commoditised hardware and open software can lead to a 40% [illegible] in CAPEX costs for network deployment; but it is in the operations team that the real benefits can be seen. Amin has [illegible] team should not exceed 350 employees when the entire network has been deployed, compared to thousands who [illegible]

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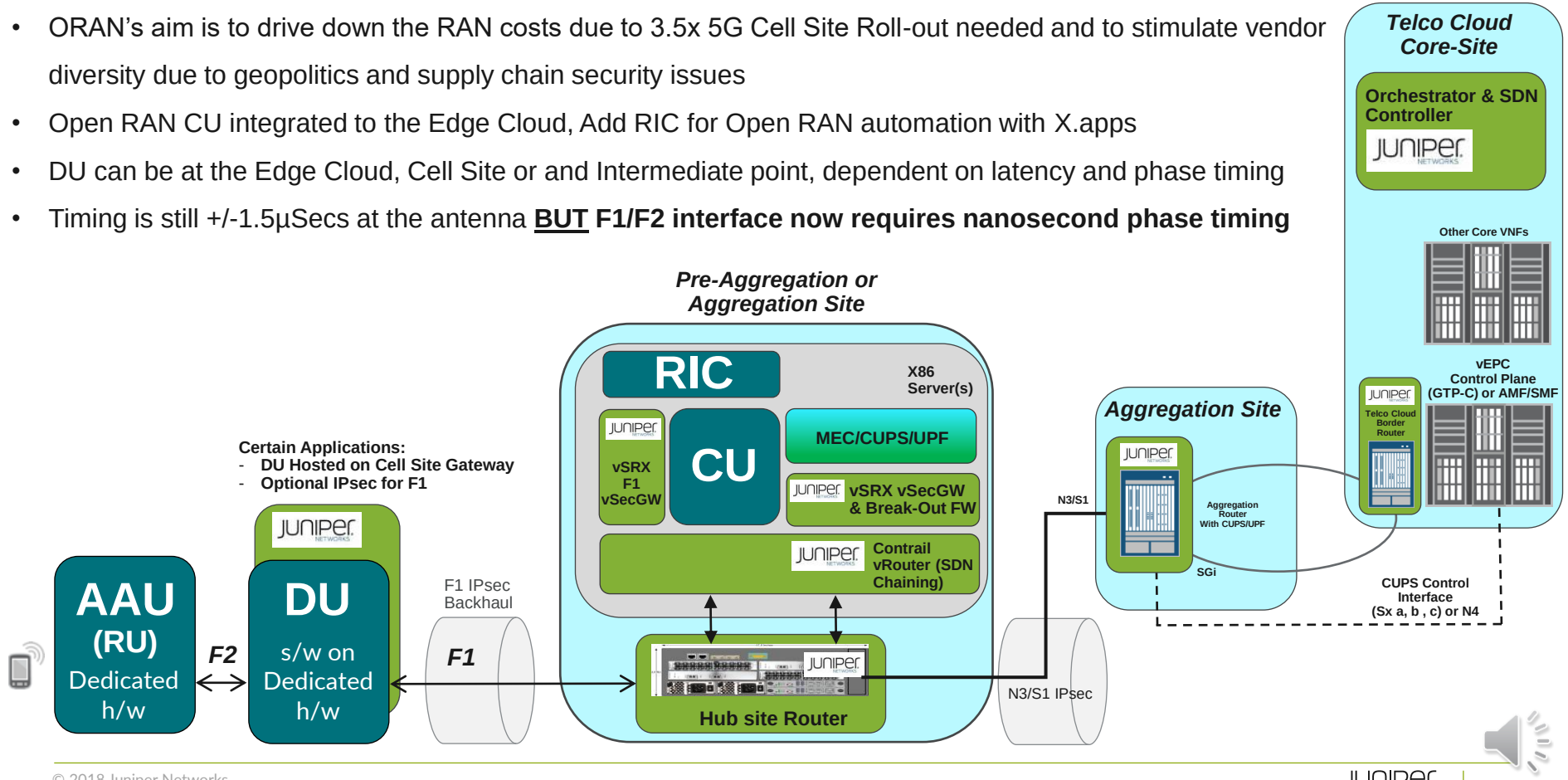
OPEN RAN: EDGE CLOUD – TIMING & LATENCY

- ORAN's aim is to drive down the RAN costs due to 3.5x 5G Cell Site Roll-out needed and to stimulate vendor diversity due to geopolitics and supply chain security issues
- Open RAN CU integrated to the Edge Cloud, Add RIC for Open RAN automation with X.apps
- DU can be at the Edge Cloud, Cell Site or and Intermediate point, dependent on latency and phase timing
- Timing is still +/-1.5µSecs at the antenna **<u>BUT</u> F1/F2 interface now requires nanosecond phase timing**



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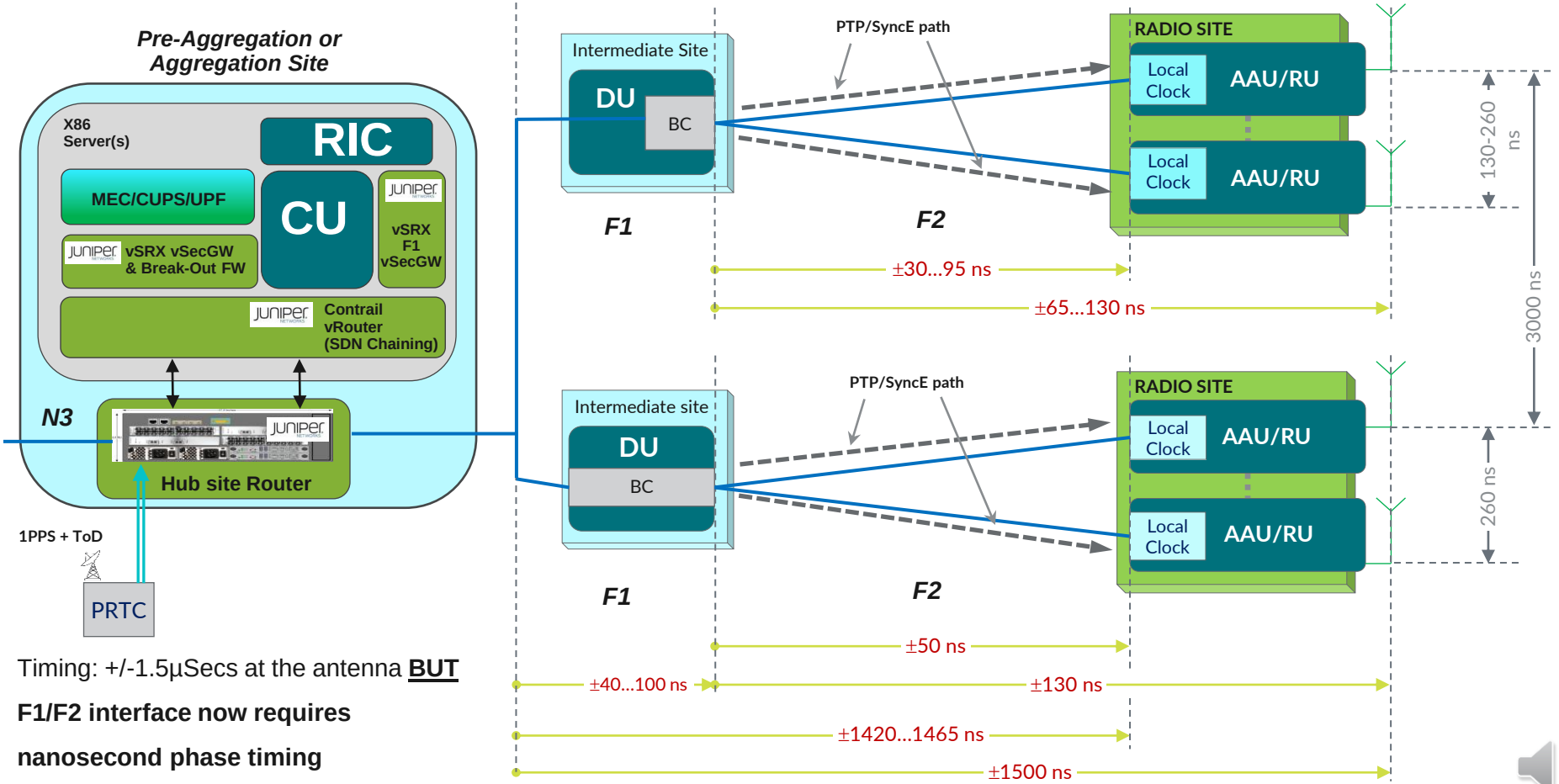
OPEN RAN: EDGE CLOUD – TIMING & LATENCY



Timing: +/-1.5µSecs at the antenna **BUT**

F1/F2 interface now requires nanosecond phase timing

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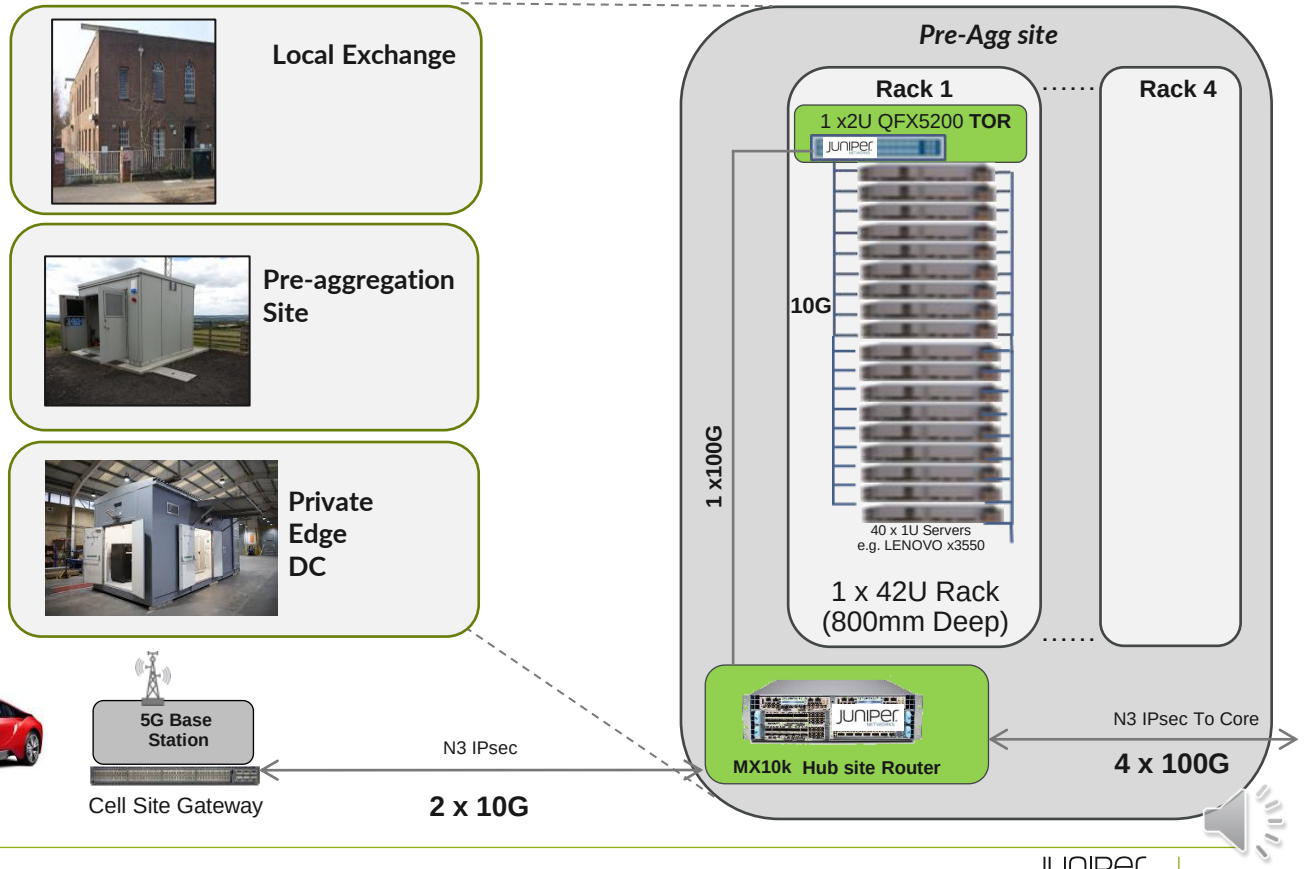
MOBILE EDGE CLOUD: – Micro Edge Data Centre

- To Deliver Low Latency Services & ORAN capability an Edge Micro DC is needed
- Classic DC architecture … but smaller:
  - N x 2U 24 Core servers/rack, 2U TOR
  - Pre-agg Router “DC Gateway” (timing etc)
  - SDN Service Chaining, Supporting MEC/CUPS/UPF, CU etc



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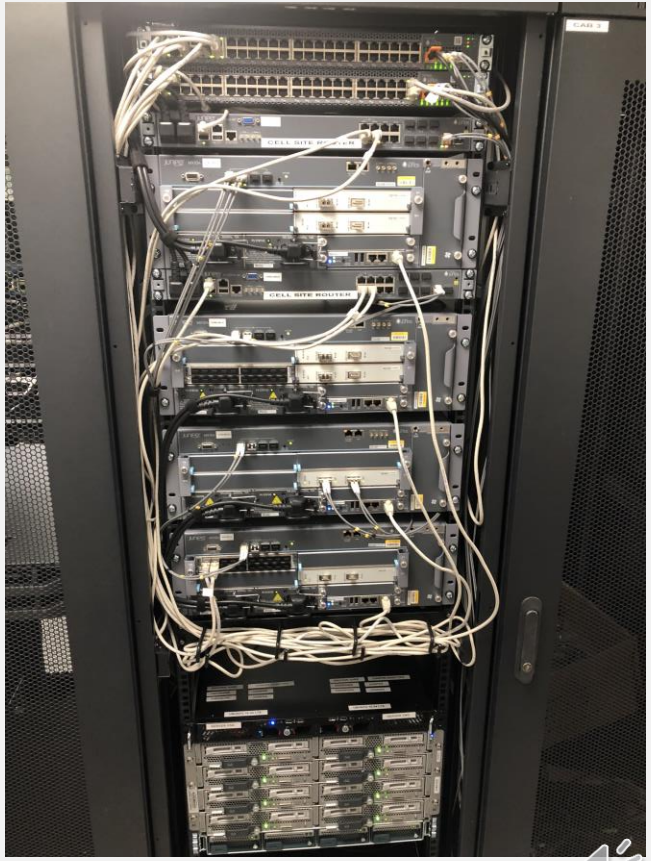
United Kingdom 5G TEST BED: JUNIPER UNDERPINS UK 5G Test Bed



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THANK YOU!

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