5G/6G Private Networks for Vertical Markets: Just Add Some SDR and Spectrum

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Introduction

- StrathSDR team have deployed a number of demonstrator networks implementing a common SDR-based architecture.
  - Targeting Shared Spectrum and Pioneer Spectrum

- Common SDR infrastructure platform, but differing performance criteria for different verticals.
  - Security
  - Uplink speed optimisation
  - Device density

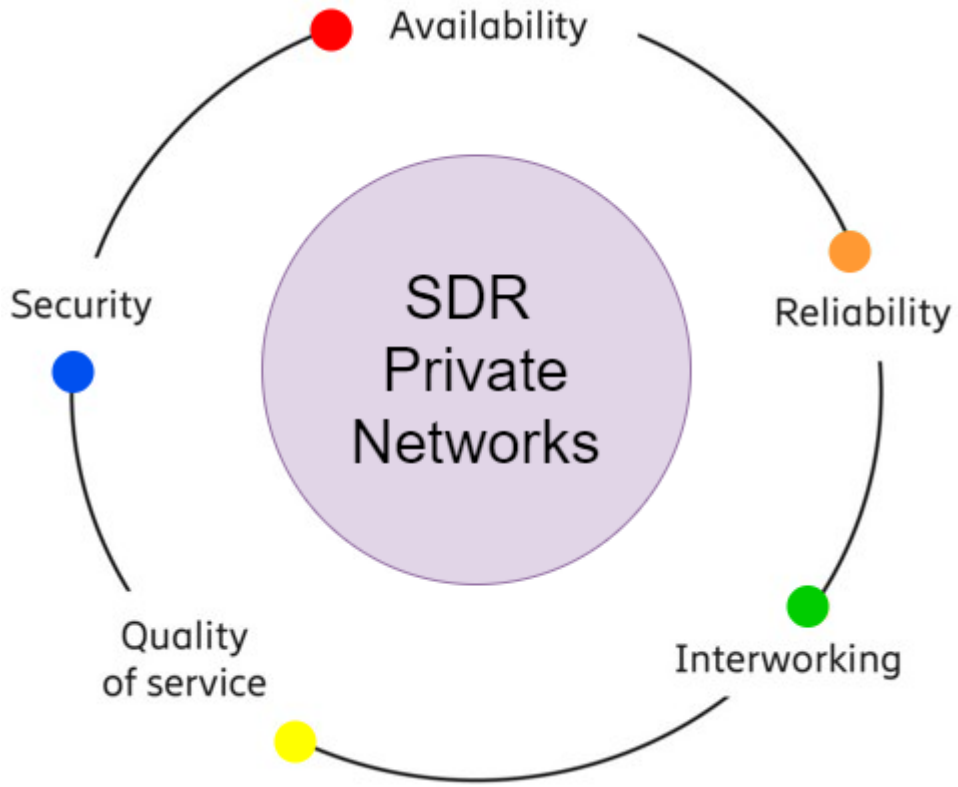
- We are SDR now at ‘Split-8’, but evolving (where appropriate) to O-RAN / other Lower Layer Splits (e.g., Split 7-2)

- 6G will require new spectrum access strategies to facilitate more economic deployments and more effective spectral usage.
  - Low/Mid band frequencies will be critical for both coverage and capacity.

Private Networks – Flexible and Scalable with SDR

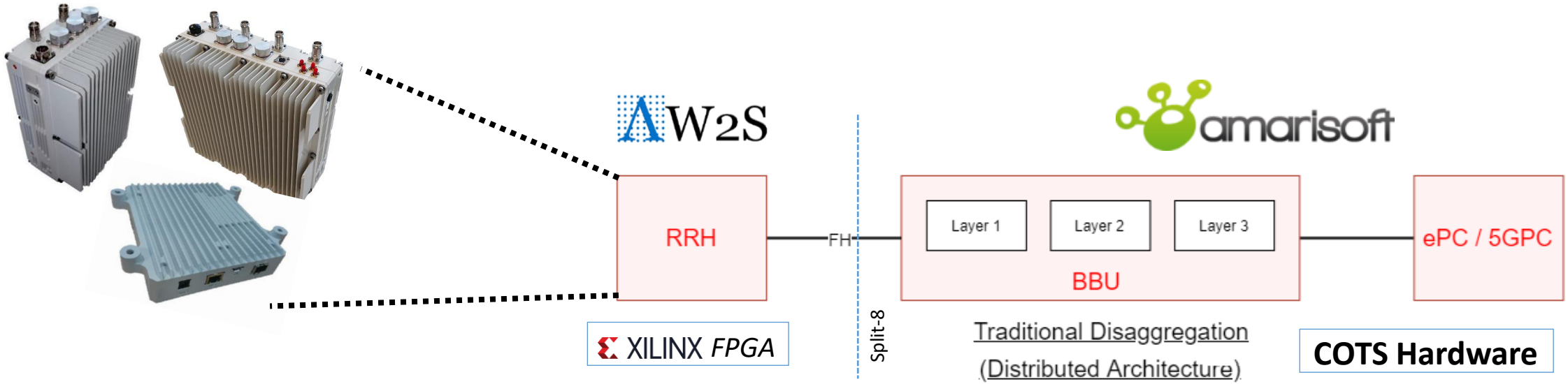
Motivation for Private Network Deployments

- Private networks - highly customable connectivity solutions, tailored to address the vertical market requirements.
- Particularly relevant for use cases and applications that require custom features.
- Software Defined Radio (SDR)
  - Cost effective platforms that enable reconfigurable, frequency agile deployments.
- An SDR-enabled RAN can support multiple technologies using the same network infrastructure.
  - 5G New Radio (NR), LTE, NB-IoT, and LTE-M



Private Networks – Flexible and Scalable with SDR

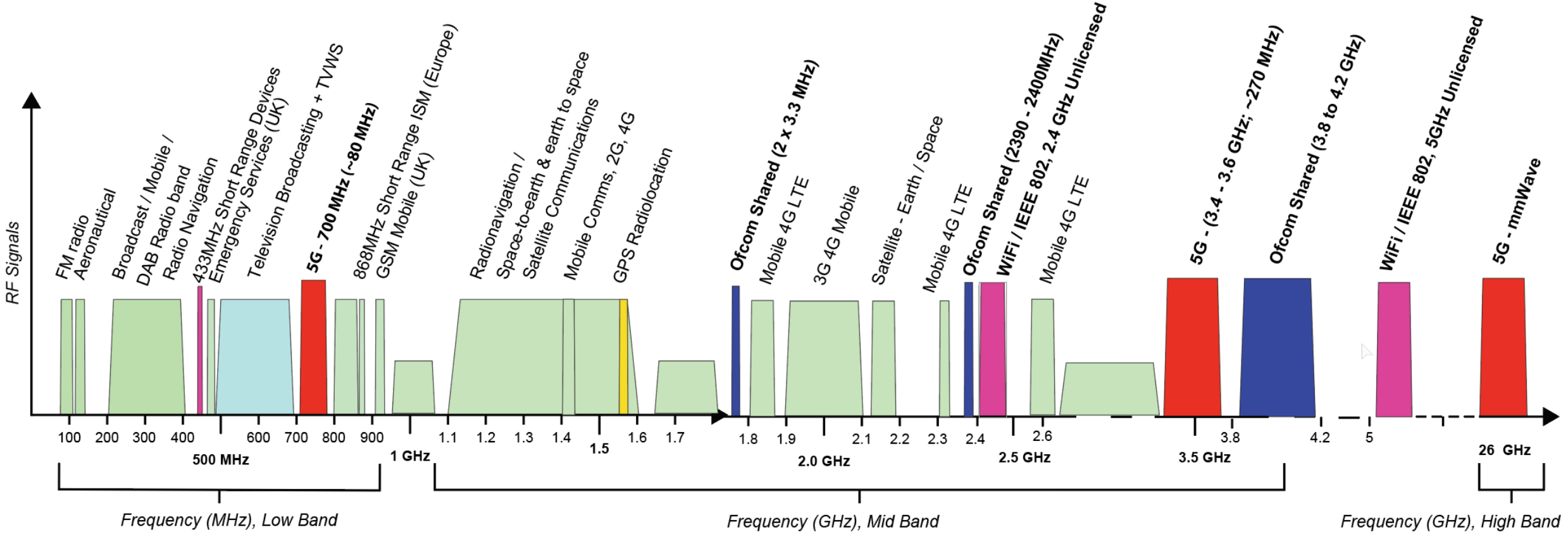
Current Architectures for 5G



- Distributed Architecture
  - Baseband Unit (BBU) + SDR Remote Radio Head (RRH)
- Multiple use cases and applications, covering multiple different industry verticals.
- A common base of:
  - Commercial-Off-The-Shelf (COTS) Compute Platform
  - SDR RRH powered by Xilinx FPGAs / SDR
  - Shared Spectrum

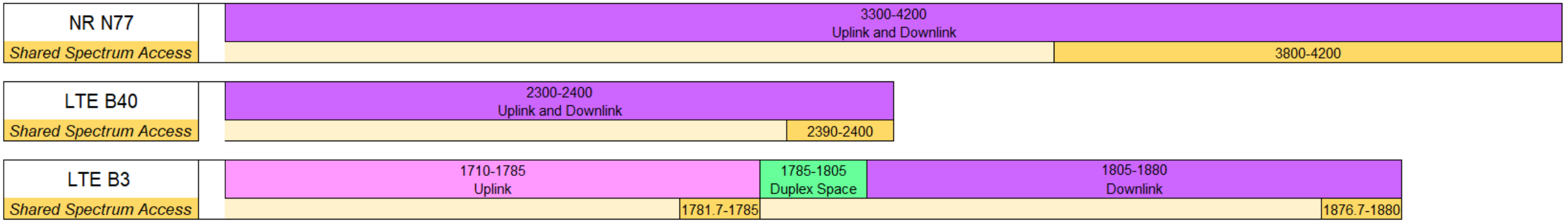
Licensed, Unlicensed & Shared – What's Available (now)?

- Licensed: Paid for or allocated by Ofcom for key service.
- Unlicensed: Open to all - use within the agreed rules (Wi-Fi).
- Shared Bands: Use within rules - Ofcom allocation, light licensing.



Shared Spectrum – Is there enough?

We need more for 6G!



"The traditional model of static frequency allocation is not sufficient, and a new model is needed to address the growing demand for access…"

US Department of Defense (DoD), Sept 2020

"Sharing is becoming a necessity"

Andrew Clegg,
Spectrum Engineering Lead at Google, Sept 2021

"Spectrum sharing must be the new normal"

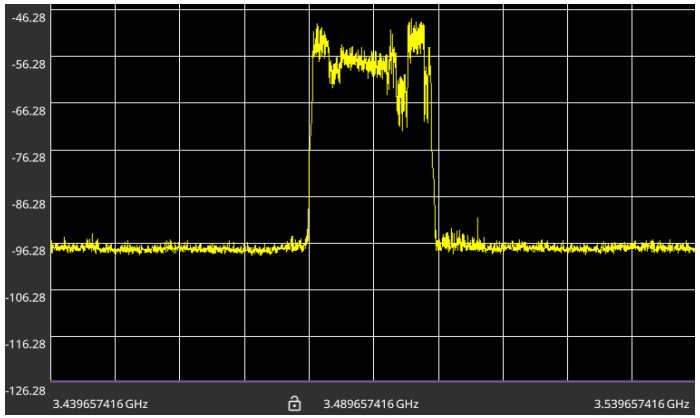
Vernita Harris,
Director of Spectrum Policy, US DoD, Sept 2021

https://tinyurl.com/SpecShare

https://tinyurl.com/SharedDoD

Private 5G Standalone Networks – Common Platforms

End-to-End Connectivity…with SDR driving RRH, BBU and UEs



User Equipment

Intel NUC

USB 3.0

SIMCOM

n77 (3500 MHz)

20 – 50 MHz Bandwidth

gNodeB (Basestation)

SDR RRH

CPRI

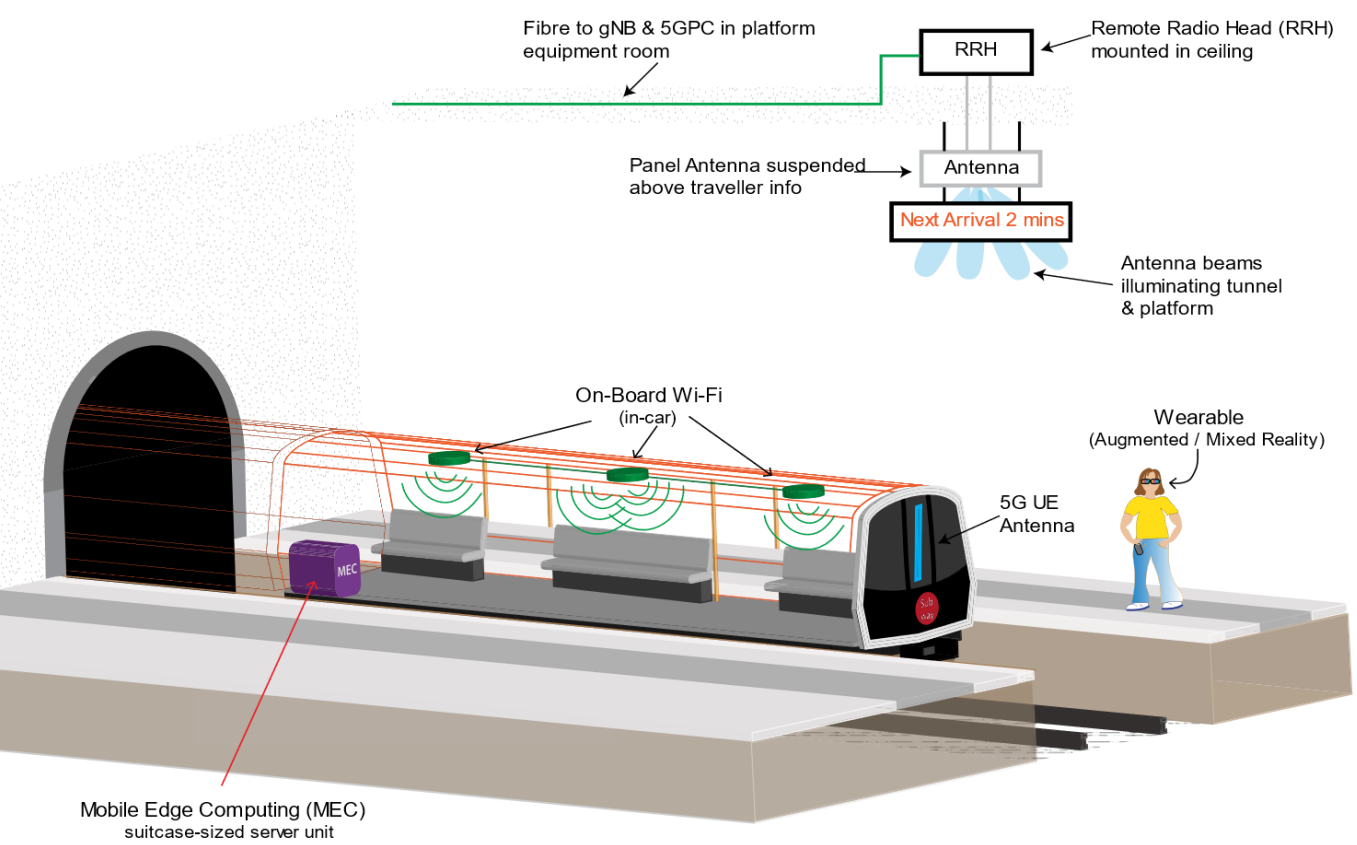
BBU

ng signal

5G Packet Core

5G RailNext

In Tunnel, On-Train, Private Spectrum 5G SA Network



- UK and South Korea collaboration
- Immersive infotainment services.
  - Augmented Reality / Mixed Reality AR/VR and Wearable technology.
- 5G SA track-to-train connectivity demonstrated in the Glasgow Subway using mid-band pioneer spectrum.

- **Critical Performance Criteria:**
  High Throughput and Resilience

5G for Remote Broadcast and Production

World's First 5G SA Network for Sports Broadcasting

https://tinyurl.com/Silverstone5G

- Early stage PoC for 5G Remote Production capabilities, with mid-band shared spectrum & SDR solutions
- Live to air demonstration at Silverstone – Aug 2021

- **Critical Performance Criteria:**
  High **Uplink** Throughput / Low Latency

Private 5G Demonstrator Network for Industry 4.0

- Demonstration of key 5G features in a manufacture-focused environment to provide a quantitative performance evaluation.
- Supporting a number of vertical use cases:
  - Factory Ecosystem Monitoring, Decentralised Expertise, Automated Production Assets
- Using a combination of low-band pioneer and shared spectrum.

- **Critical Performance Criteria:**
  High Throughput, Low Latency,
  High Device Density, High Security

The Green-Economy Driven by NB-IoT

- Connect environmental systems to private network NB-IoT technology for sensing/actuation.
- Using a combination of low-band pioneer and shared spectrum.

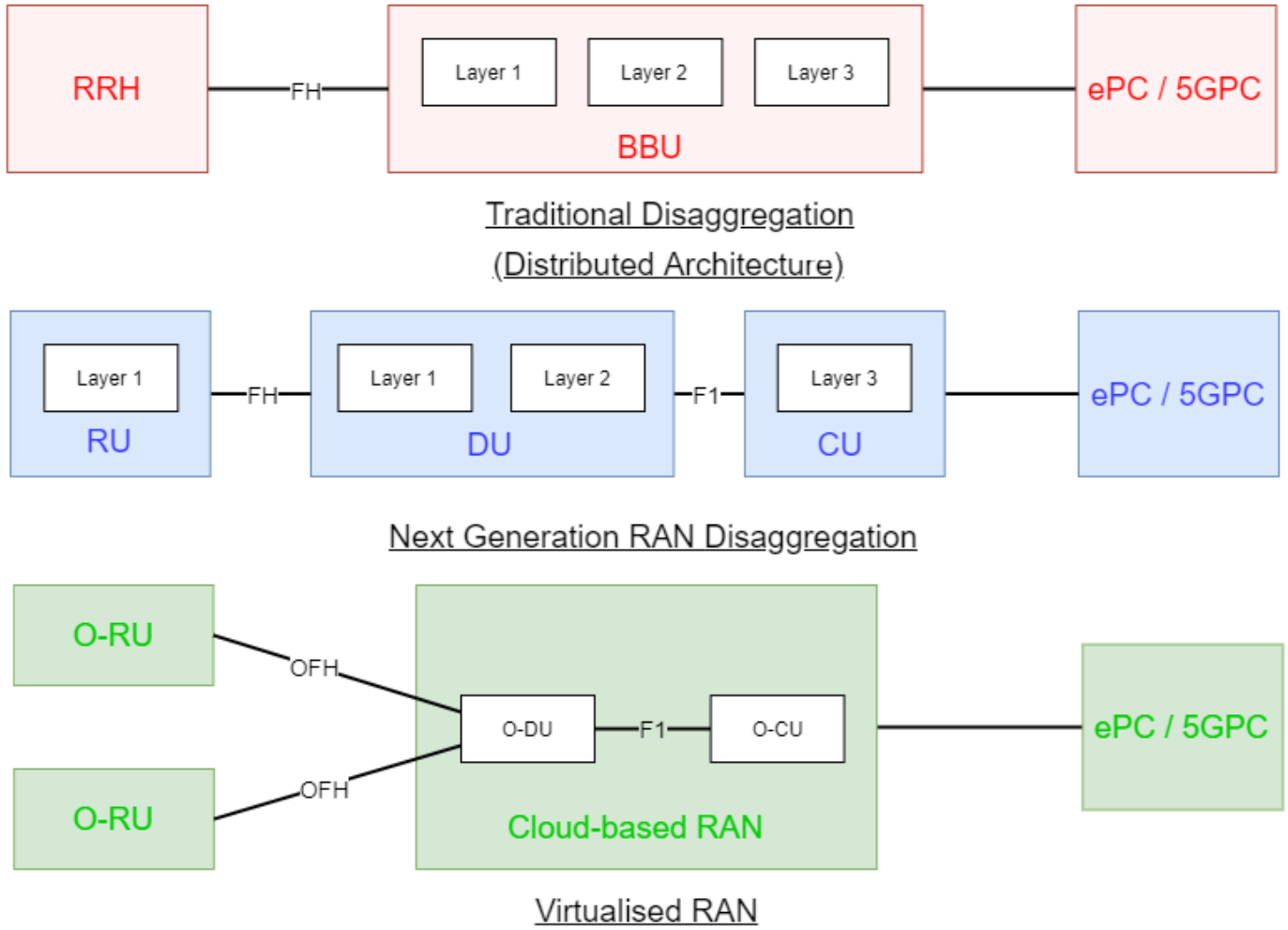
- Demonstration and Phase 1 Installation Sites:
  - Mount Stuart, Isle of Bute
  - Broomhead Drive, Dunfermline, Fife

- **Critical Performance Criteria:**
  High Device Density, High Security, NBIoT

Next Generation Radio Access Networks

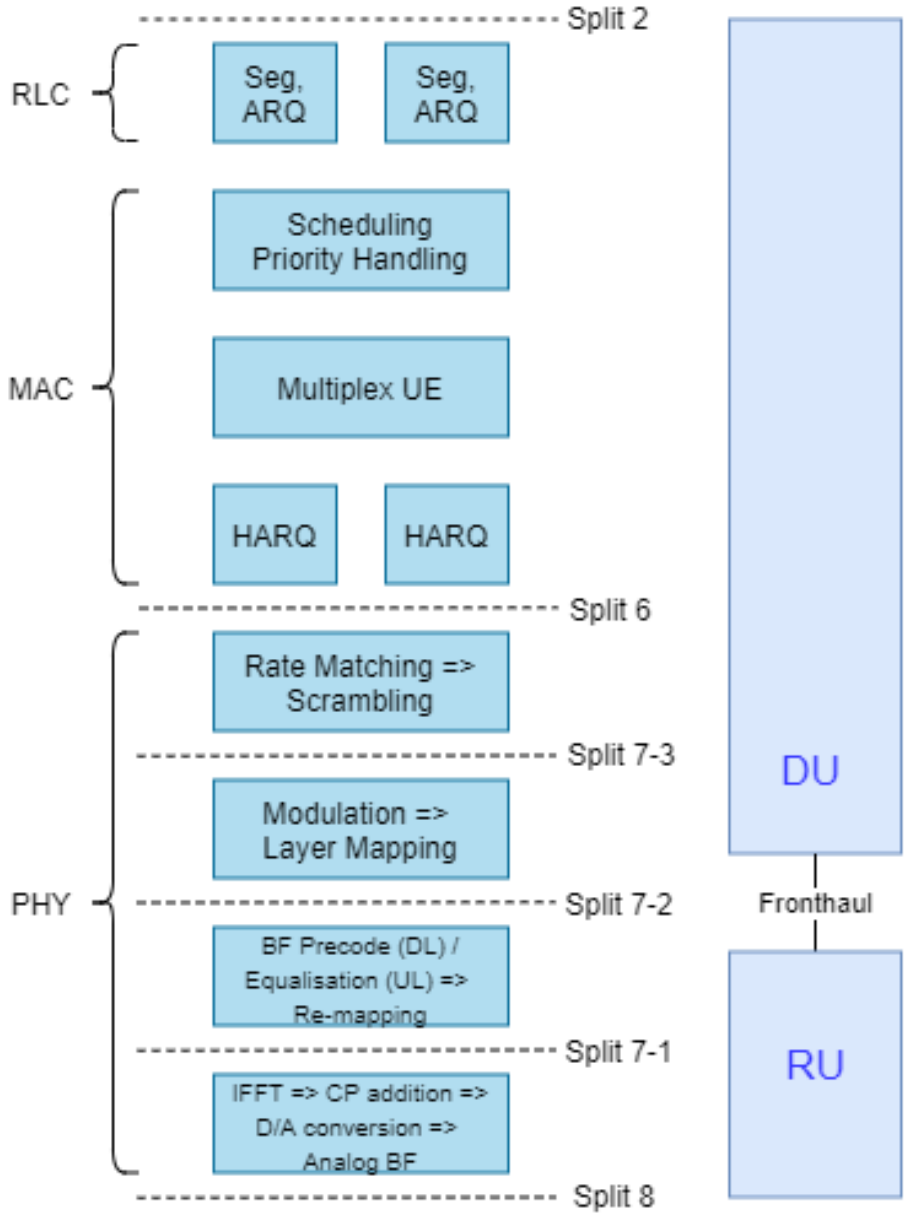
Future Architectures for 5G and beyond

- Distributed Architecture
  - Two-unit system with a Baseband Unit (BBU) and Remote Radio Head (RRH)
- Next Generation Disaggregation
  - Multi-part system with a Centralised Unit (CU), Distributed Unit (DU), and Radio Unit (RU).
- Virtualised RAN (vRAN)
  - CU and DU functionality has been virtualised and moved to a Cloud environment.
  - OpenRAN / O-RAN industry initiatives.



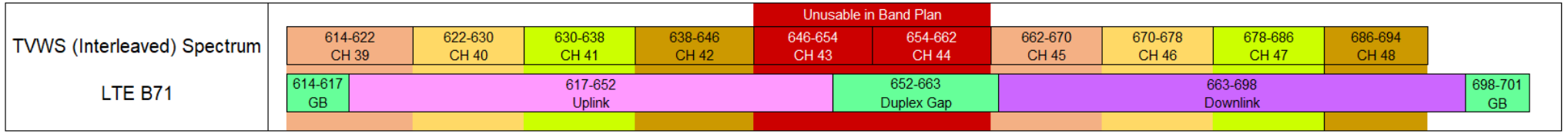
Next Generation SDR RU (fka RRH)

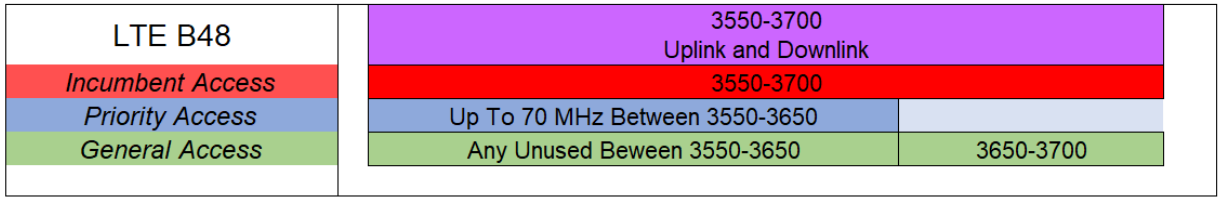
- vRAN could enable better **system harmonization.**
  - A uniform platform enabling both core and RAN functions.
  - Simplifies management and reduces OPEX.
- It would also be possible to **co-locate multi-vendor solutions**
  - Further increasing flexibility for a service provider.
- **Standardised interfaces** enables an open and inter-operable ecosystem.
  - In support of, and complementary to, standards promoted by 3GPP and other industry organisations.

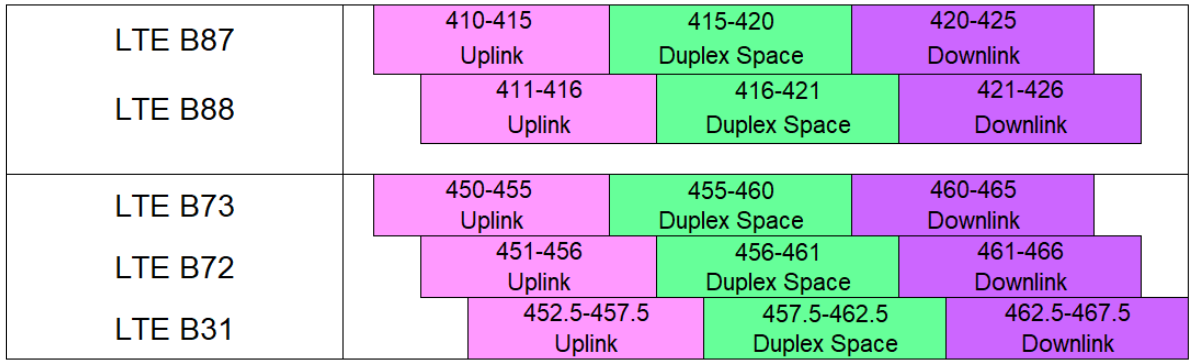


Next Generation Spectrum

Opportunities to Share and Improved Low/Mid-Band Usage and Efficiencies







- Evolving spectrum access strategies, operating DSA, and new regulatory models will enable new deployment opportunities in many vertical markets and improved spectrum efficiency.

- As the hardware ecosystem grows and develops, new frequency bands become practically available to use.

Conclusion – The Ingredients …

- Private networks can be tailored to suit the needs and requirements of the vertical markets.

- **Dynamic Spectrum Access (DSA) …** *across many bands*
  - New access spectrum mechanisms enable new network deployment opportunities.
  - Improved utilisation of low/mid band spectrum for coverage and capacity.

- **Software Defined Radio (SDR) …** *for the RU (RRH) and the UE*
  - Even though RAN architecture is evolving, an SDR-based RU will bring increased deployment flexibility and application scope.

- Improved economic viability of networks across multiple deployment verticals

StrathSDR

Thanks for listening!
Engage with us:

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