StrathSDR
University of Strathclyde Software Defined Radio

Spectrum Sharing:

Database, Multiplexes & SDR for New 6G Opportunities

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https://sdr.eee.strath.ac.uk

Strathclyde Software Defined Radio Team

- **10+ Years of Spectrum Sharing –** *No show without Spectrum!*
  - Spectrum sharing and management strategies
  - International collaborations and projects
  - Software Defined Radio (SDR) agile RAN solutions
- **SDR RAN technology development and deployment**
  - Network design & deployment – 5G NSA, SA, OpenRAN
  - Spectrum sharing techniques (since TVWS) and management strategies
  - Private networks built on smart radios and SDR tech
- **Partnering with Industry, Govt, Academia, Communities**
  - Rural Connectivity – working with communities
  - Working to inform spectrum sharing policy
  - Like minded projects

Reminder – the ‘revolution’ is just starting!

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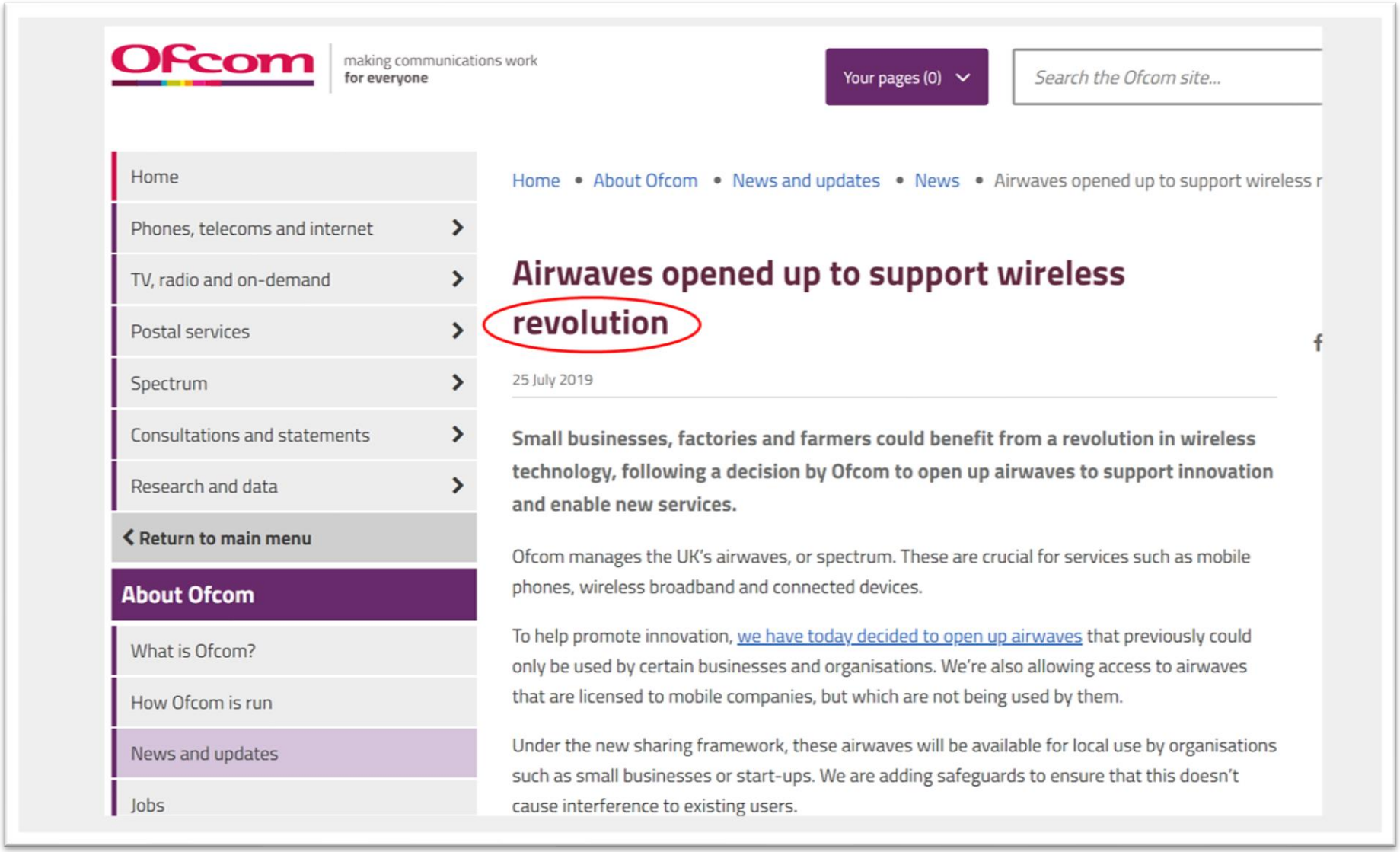
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Airwaves opened up to support wireless revolution

25 July 2019

Small businesses, factories and farmers could benefit from a revolution in wireless technology, following a decision by Ofcom to open up airwaves to support innovation and enable new services.

Ofcom manages the UK’s airwaves, or spectrum. These are crucial for services such as mobile phones, wireless broadband and connected devices.

To help promote innovation, we have today decided to open up airwaves that previously could only be used by certain businesses and organisations. We’re also allowing access to airwaves that are licensed to mobile companies, but which are not being used by them.

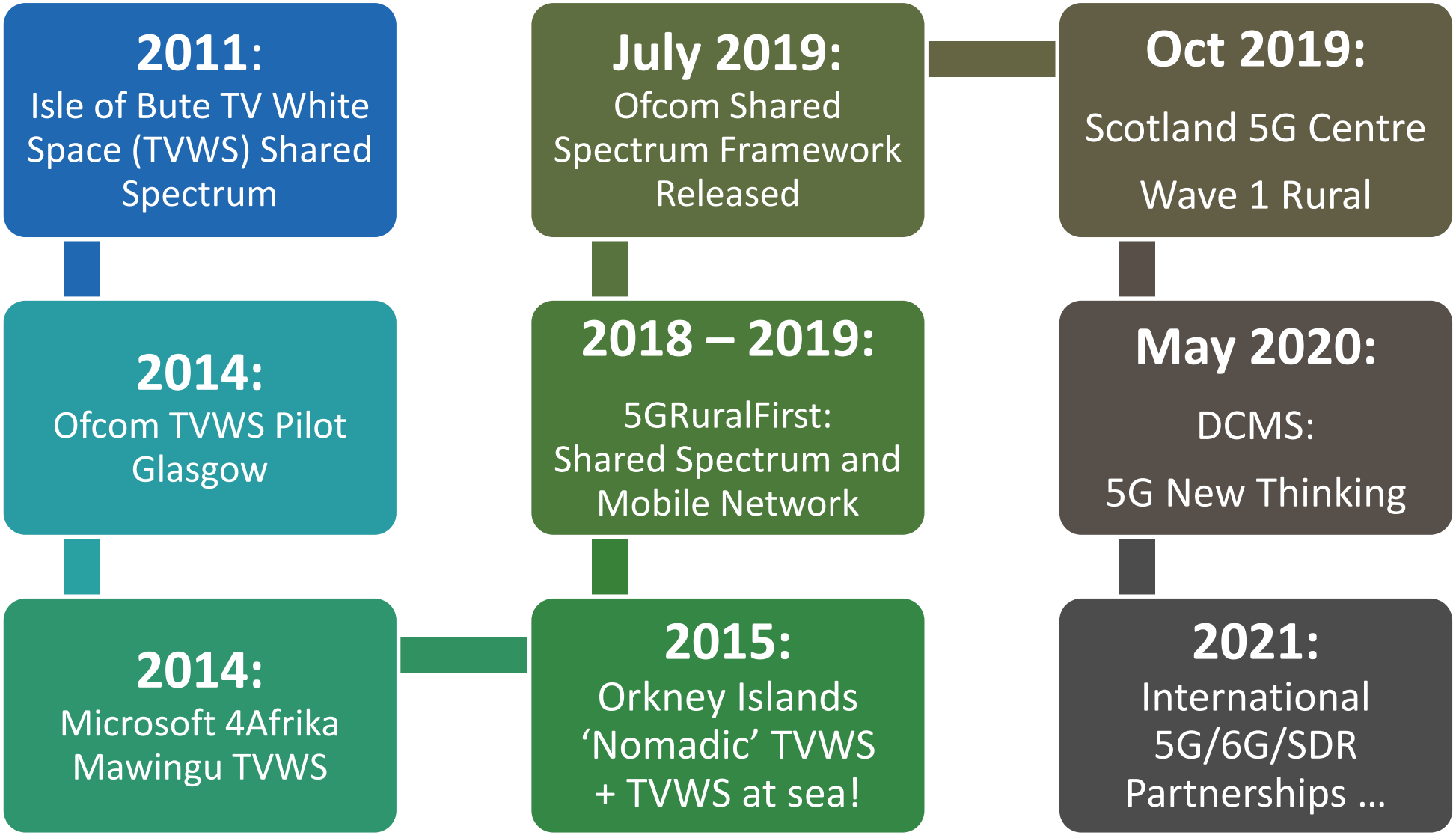
Under the new sharing framework, these airwaves will be available for local use by organisations such as small businesses or start-ups. We are adding safeguards to ensure that this doesn’t cause interference to existing users.

Shared Spectrum Revolution!

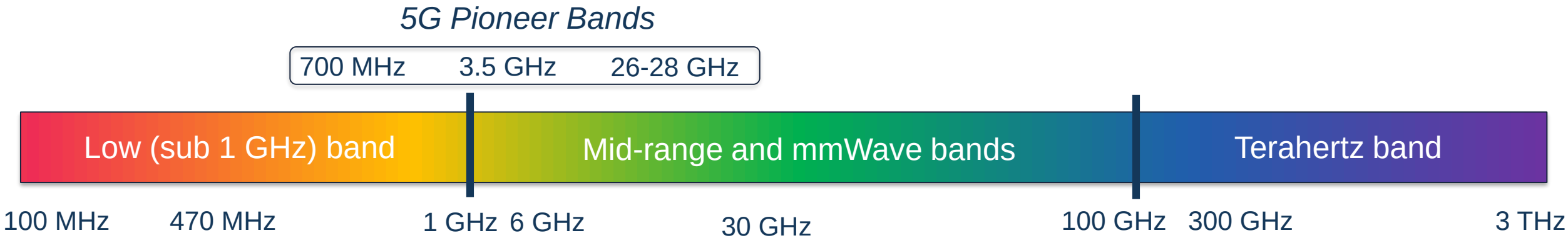
25th July 2019

Use it or ~~lose it~~ share it…

Key Steps in 10 year Shared Spectrum Journey



‘6G’ Radio Spectrum – Look Ahead



- Wide area propagation properties
- Tranditional BTS deployments
- 10s to 100s MHz Bandwidths
- Data rates 100s Mbits/s ++

- Poor propagation, often requiring LoS
- Requiring small cell deployments
- 1GHz+ Bandwidths
- Data rates 1Gbit/s ++

- Small area propagation
- Wireless everything local
- Multi- GHz Bandwidth potential
- Data rates 10Gbits/s

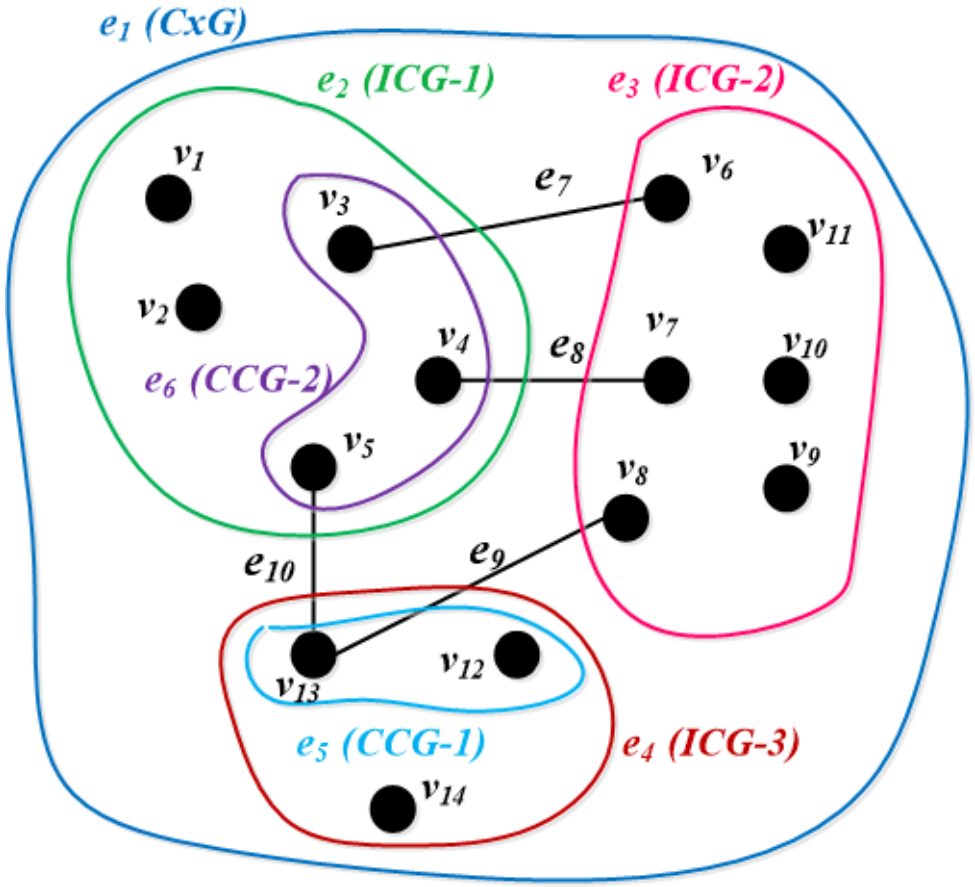
- Many 6G applications and use cases require near-ubiquitous coverage, which requires use and access to lower-band spectrum.
- High data rates via wide bandwidths in mmWave / THz will drive new opportunities and applications … ***but sub 6GHz remains critically important***

More Effective Use of Low/Mid-Band Spectrum

Need to maximise spectrum utilisation:

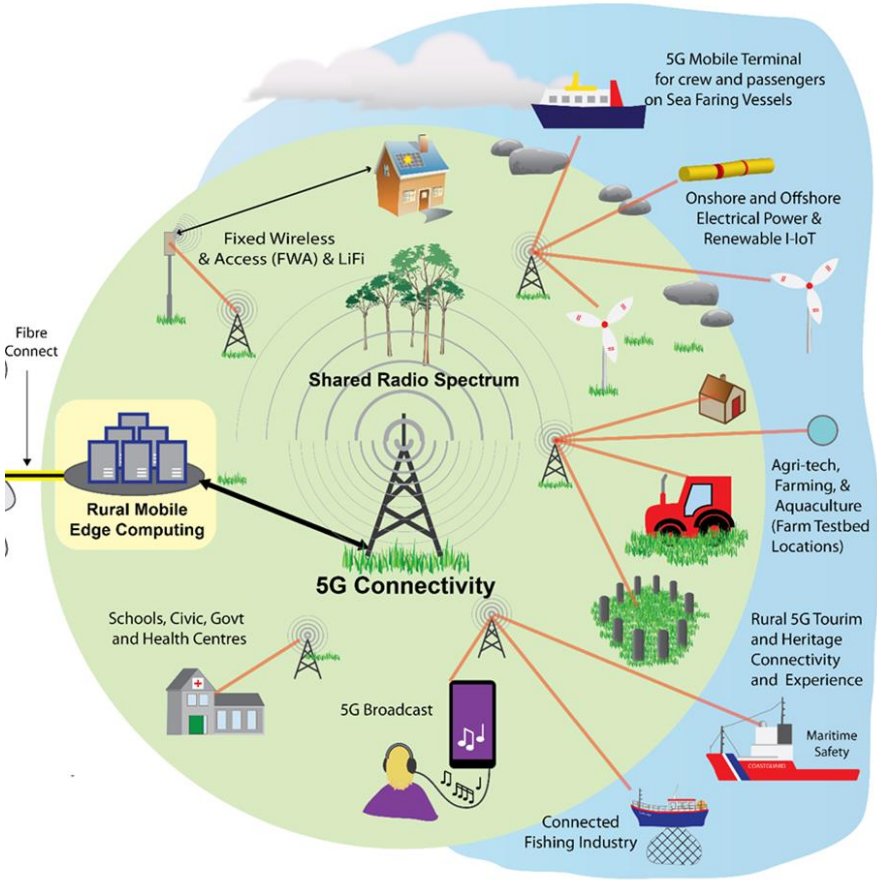
- Flexible and ***dynamic access*** to spectrum
- Smart spectrum ***management***
  - Centralised control (databases) with smart (AI-based?) spectrum management algorithms making effective use of information obtained via distributed sensing.
- Spectrum ***sharing*** regulations
- Tech such as carrier ***aggregation***
  - Inter band/intra band - highly dynamic

All highly challenging –
However, the basic building blocks are already here



The 6G Sharing Technology Building Blocks

- Software Defined Radio (SDR)
- Cognitive Radio / Spectrum Sensing
- Database technology
- Geolocation
- Cloud / Core and remote compute/edge
- AI and optimisation algorithms
- *And working/new business models!*



There is a momentum of Use Case and Market Drivers
Driven by cooperation, technology and business models

Spectrum Sharing – 5G to 6G Evolution

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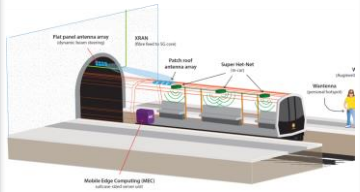
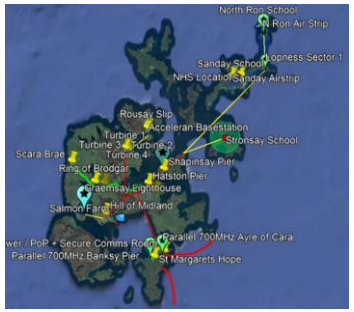
Collaboration: Government(s), Industry, Academia, Community

5G New Thinking
www.5Gnewthinking.co.uk

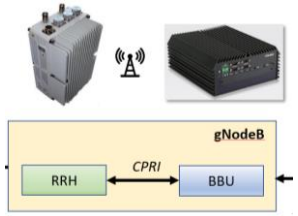
5GRailNext
www.5GRailNext.uk



Wave 1 Rural 5G Testbed
www.Scotland5GCentre

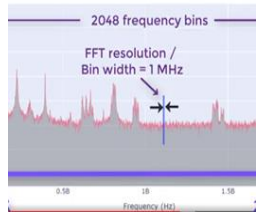


5G Remote Production



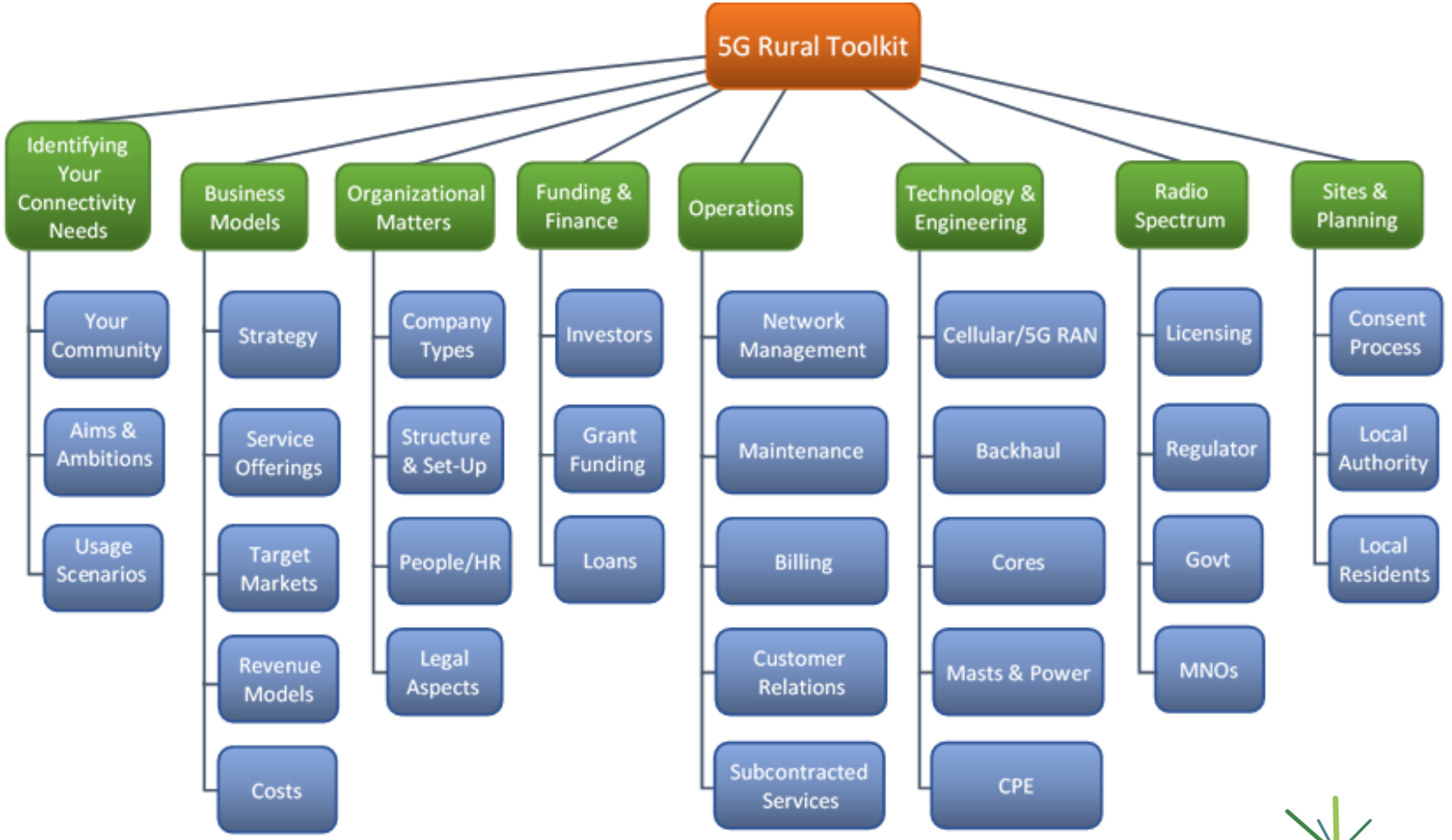
EPSRC DSP/SDR ARIA
www.wirelesswhitespace.org

RFSoC SDR
http://rfsoc-pynq.io



5G New Thinking: Private Community Networks

- Developing a **5G community network & deployment 5G toolkit** for private networks
- **Design, build, and operate commercially viable and sustainable mobile/wireless networks**
- **Community supported, or MNO Partnership, SLA based, Neutral Host** – the tenets of sharing again.



5G New Thinking: The Consortium

StrathSDR

www.5GNewThinking.co.uk

- Shared Spectrum;
- Neutral Host;
- 5G Core features

5G new thinking

Department for Digital, Culture, Media & Sport

Lead Partner	Principal: R&D / Engineering	Spectrum Sharing	Scotland Integration	Mobile Network Operator	Broadcast & On-line safety	Rural Deployment	Private Finance	5G NR Technologies	BenCom / Cooperative

Engineering and Network Deployment and Business Modelling Partners

Scottish Islands	Central & North	Scottish/English Border	N. Ireland

Location and Council Partners

Emergency Network & MNOs	Health & Welfare Tech Lead	Private Fibre Networks	Animal Management	Agri-Technology Lead

Use Case & Technology Partners

5G RailNext

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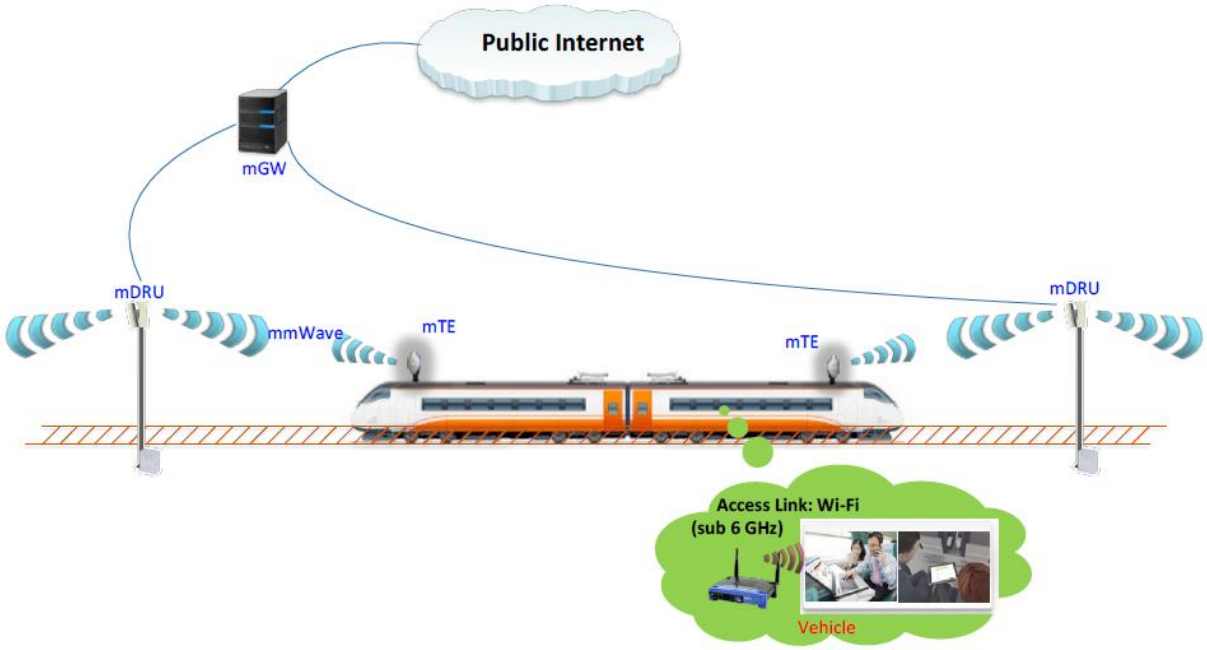
- UK and South Korea collaboration demonstrating immersive infotainment services and experiences in Metro Rail environments.
- 5G train connectivity demonstrated in the Glasgow Subway and in the Seoul Metro using Shared Spectrum.



cisco SPT Seoul Metro WILUS SUBLIME DKU DANKOOK UNIVERSITY

ETRI Electronics and Telecommunications Research Institute University of Strathclyde AMPLESPOT Glasgow CITY COUNCIL CLEVERLOGIC

Co-funded by: Department for Digital, Culture, Media & Sport

5G NR Testbed Facilities: Rural and Urban

StrathSDR

- Private Shared Spectrum Testbed Facilities as part of the the Scotland 5G Centre Wave 1 testbed platforms for Urban & Rural:

Wave 1 Rural Loch Lomond Testbed
Director: *Prof Bob Stewart*

Wave 1 Urban UoG Campus City Testbed
Director: *Prof Muhammed Imran*

The Scotland 5G Centre

IBC Accelerator: 5G Remote Production

- *To design and evaluate an early stage PoC for **5G Remote Production** capabilities, with shared spectrum and SDR solutions*
- *The key challenge here is the uplink (need 'upside down network')*
  https://www.ibc.org/ibc-showcase/ibc-accelerators-5g-remote-production/6126.article

BBC *Project Lead*

BBC, AJ Jazeera, BT Sport, ITV, TV2, SVT, Yle, ViacomCBS, Olympic Broadcast Services

Enabling Affordable Internet Access: DSA & SDR

StrathSDR

- Investigate **dynamic spectrum management** with geo-location database technology, combined with **software defined radio (SDR)** implementations, may be used to enable **effective and efficient wireless** networks to be built at scale to support **affordable Internet access**
- Supported by UK Government's Grand Challenges Research Fund (GCRF)
- Participating Countries: **UK, Ghana, Kenya, Malawi, Zambia**
- Academia, Industry & Participating Regulators

EPSRC
Engineering and Physical Sciences Research Council

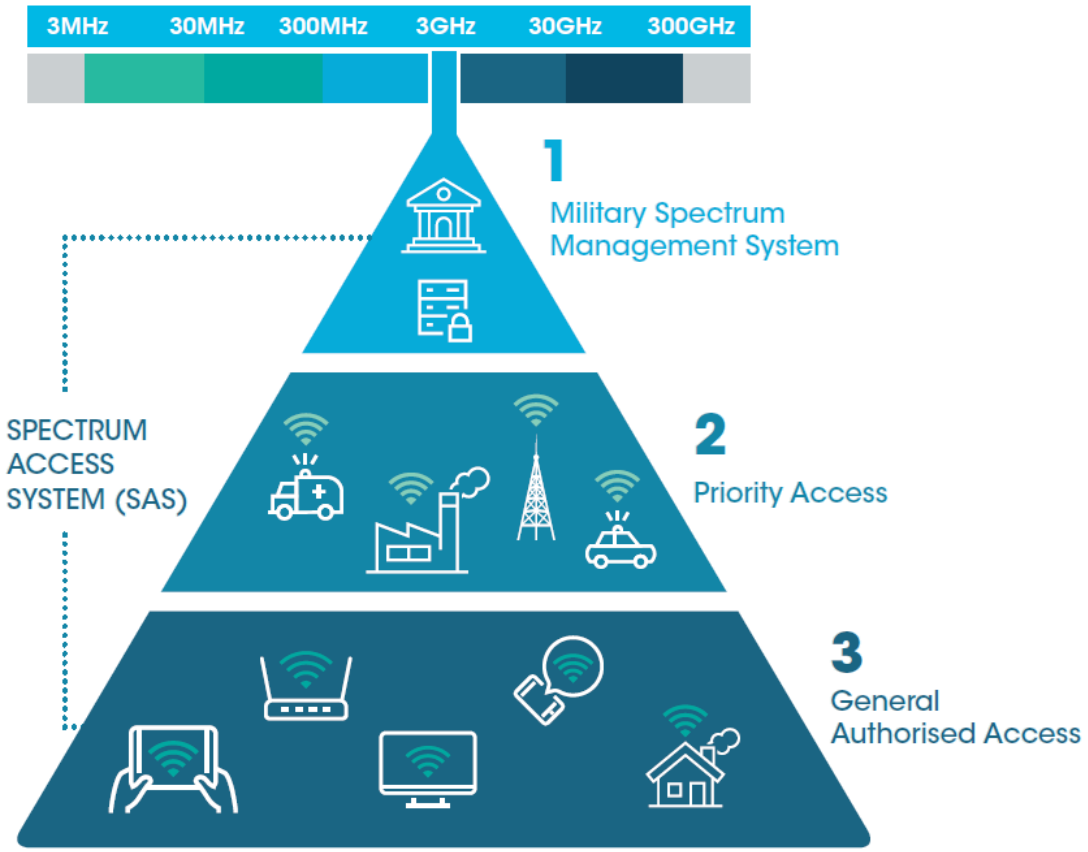




Dynamic Spectrum Alliance*

DSA
DYNAMIC • SPECTRUM • ALLIANCE

- StrathSDR a member of DSA since 2013, supporting its efforts to create *more efficient utilization of spectrum and foster innovation and affordable connectivity for all.*



Source: http://federatedwireless.com/wp-content/uploads/2017/02/CBRS-Spectrum-Sharing-Overview.pdf

* http://dynamicspectrumalliance.org/

UK Spectrum Sharing R&D: Impact !

COMMUNICATIONS AUTHORITY OF KENYA

DSA DYNAMIC • SPECTRUM • ALLIANCE

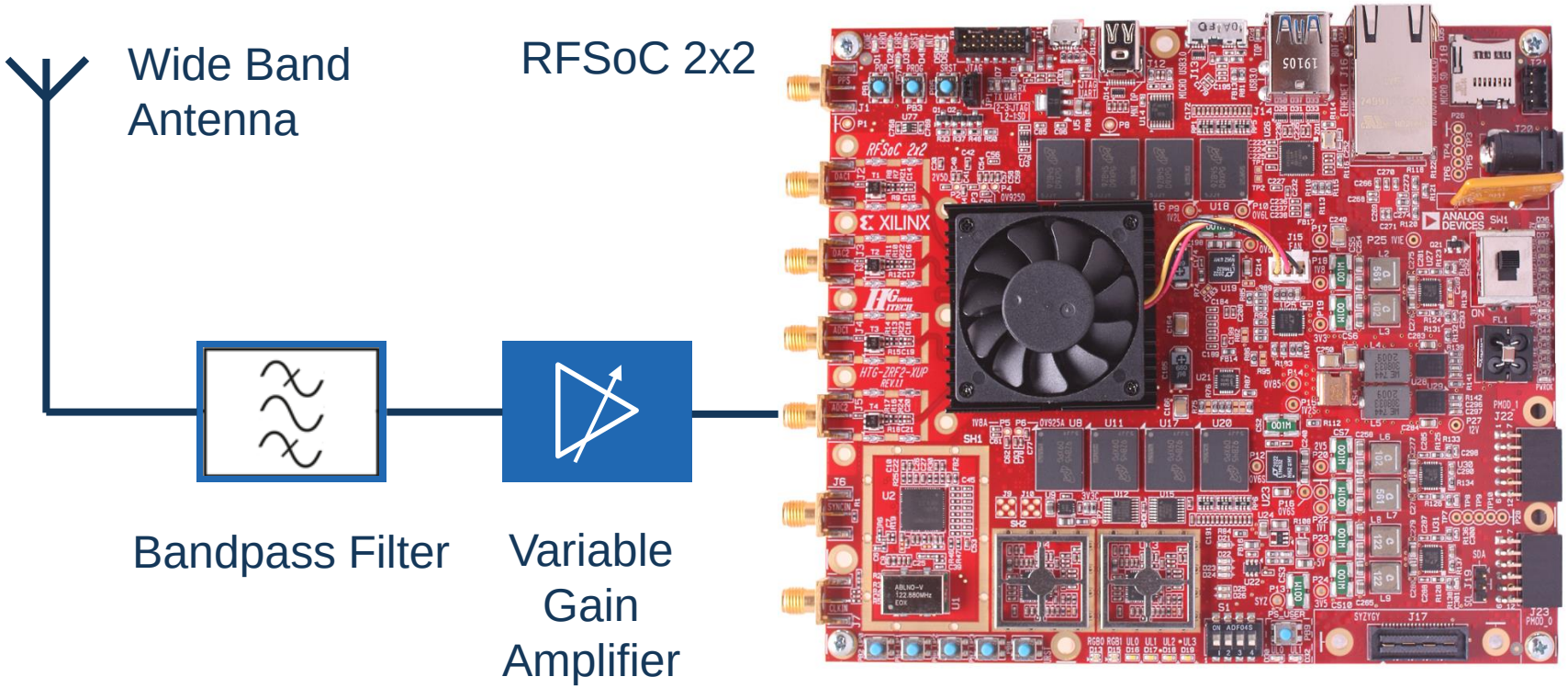
https://ca.go.ke/authority-wins-global-award-for-innovative-spectrum-policies/

*"The first framework covers the use of **TV White Spaces** while the second framework will cover spectrum use by **Community Networks**. A third framework is planned to cover a **neutral host** approach for mobile networks and **dynamic spectrum access** to improve mobile broadband Internet access in Kenya … The Authority has partnered with Strathmore University of Kenya and **Strathclyde University of the UK** to investigate opportunities for various spectrum models in Kenya … supported by the UK's Department for International Development (DFID) and the UK Engineering and Physical Sciences Research Council."*

Mr. Tom Olwero, Director Frequency Spectrum Management, Nov 2020

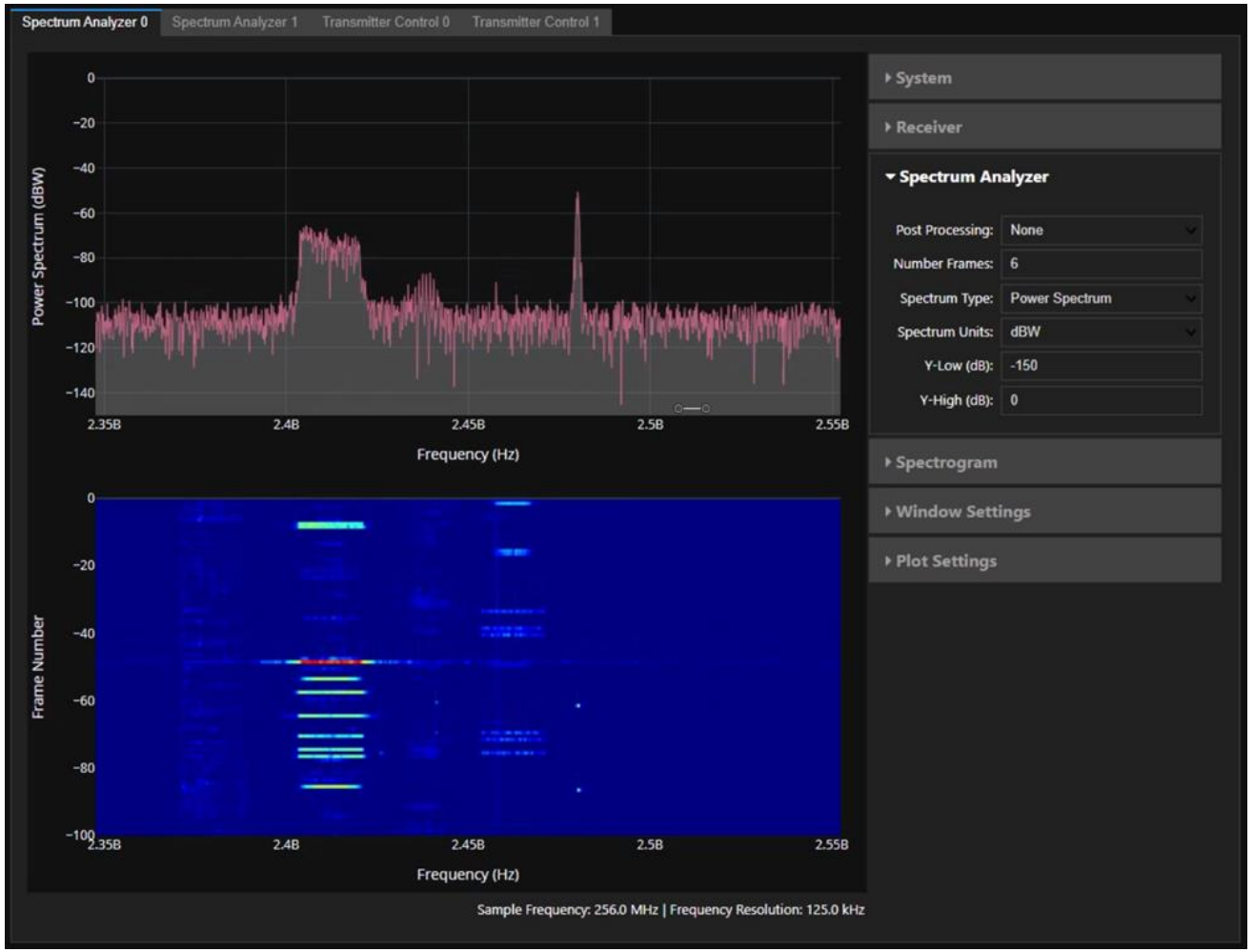
Partnership with Xilinx on the RFSoC 2x2

- ***Desktop*SDR** design flows using the RFSoC 2x2 : http://rfsoc-pynq.io
- 4GHz direct RF sampling for RF DACs and ADCs, 16 channels!

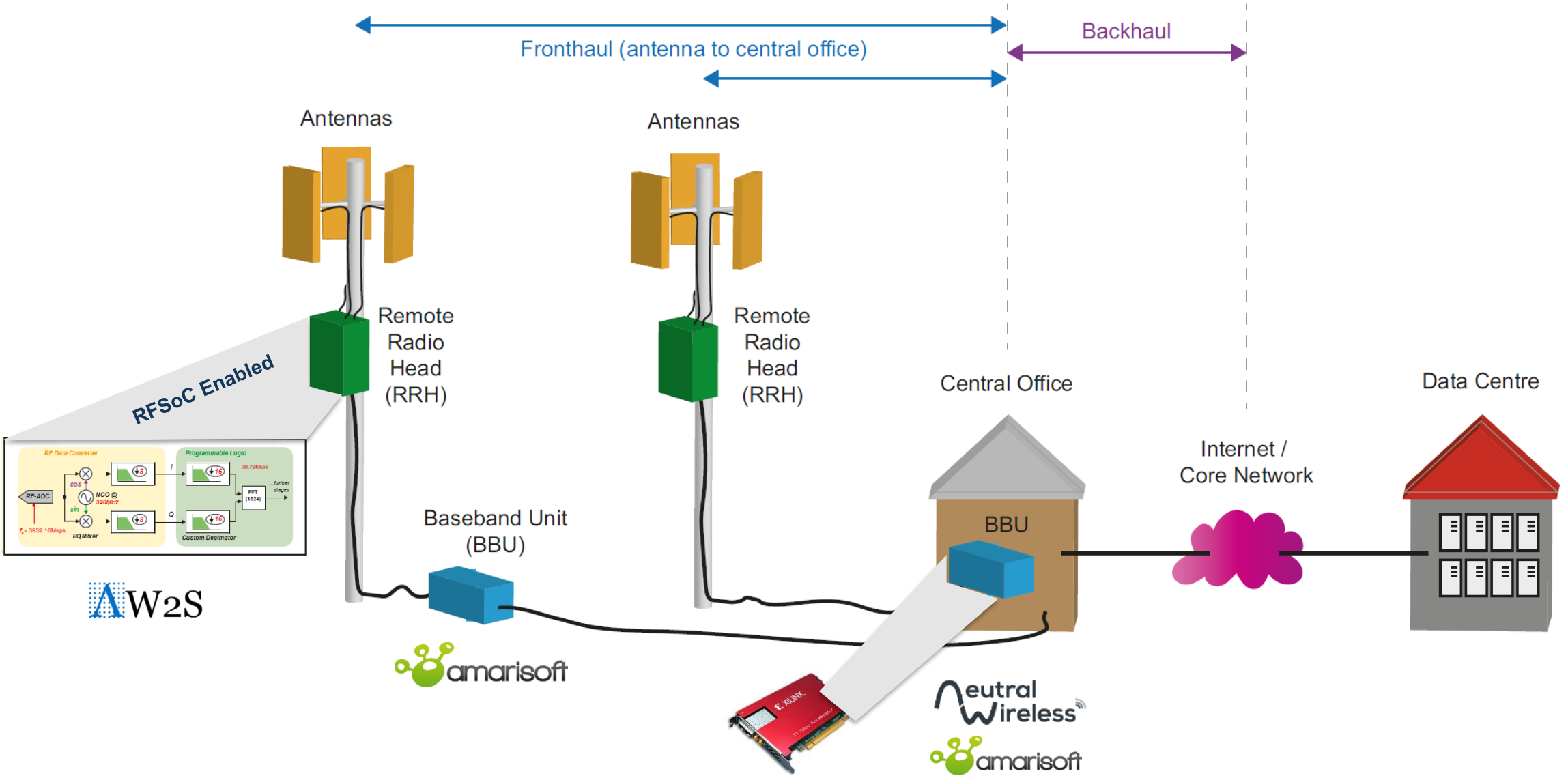


SDR Desktop Design Environment

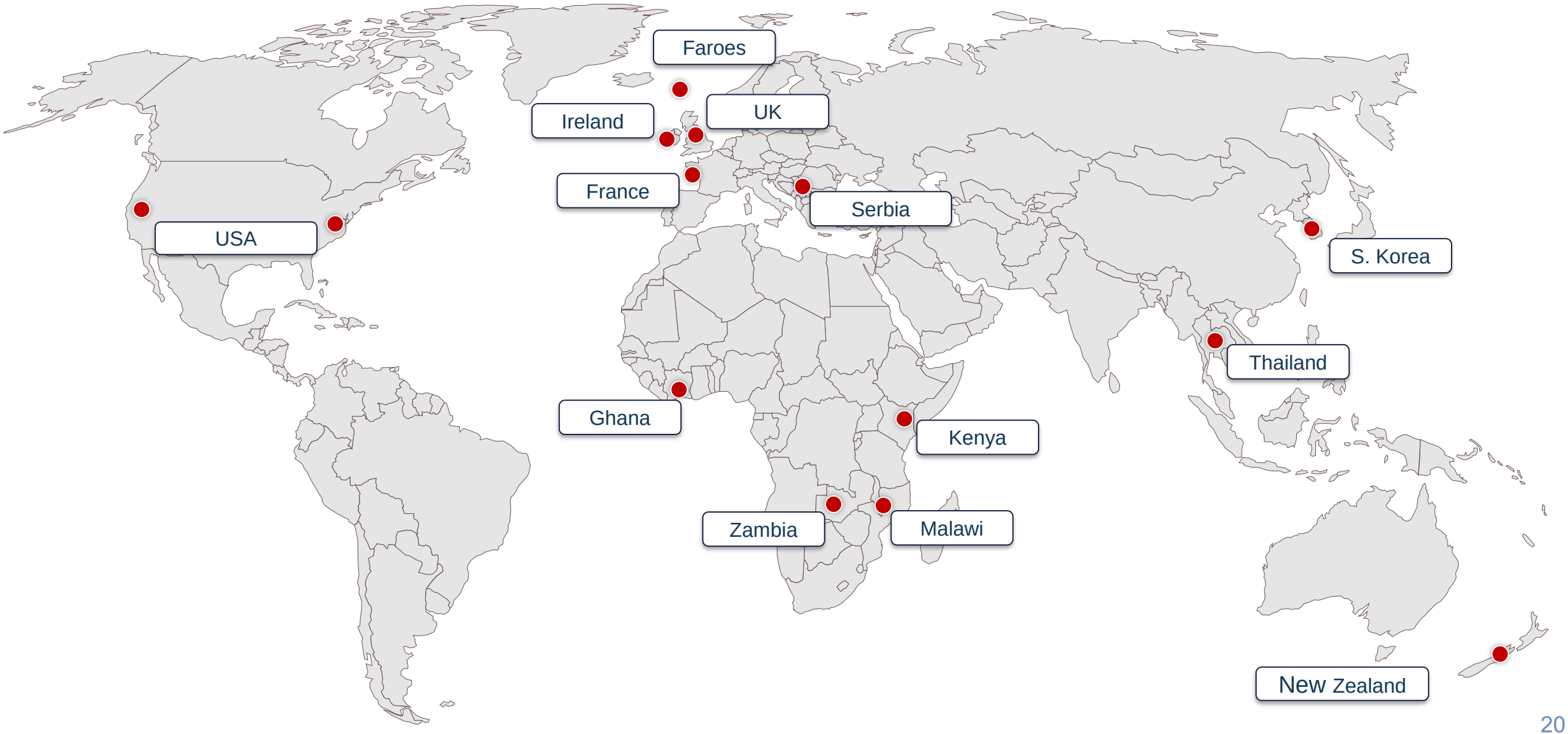
- Plugin and get started…
  - https://youtu.be/wfdvBpoA2f4
- Spectrum Analyser 0 to 4GHz
  - https://youtu.be/rxSnSdtuCCo
- Scanning the spectrum
  - https://youtu.be/AF1_H2elzyc
- Github Support/Solutions
  - https://github.com/strath-sdr
- Want to get one?
  - https://www.xilinx.com/support/university/boards-portfolio/xup-boards/RFSoC2x2.html



StrathSDR 5G O-RAN Split 7.2 Project *(soon…!)*



International Partnerships (Shared Spectrum!)



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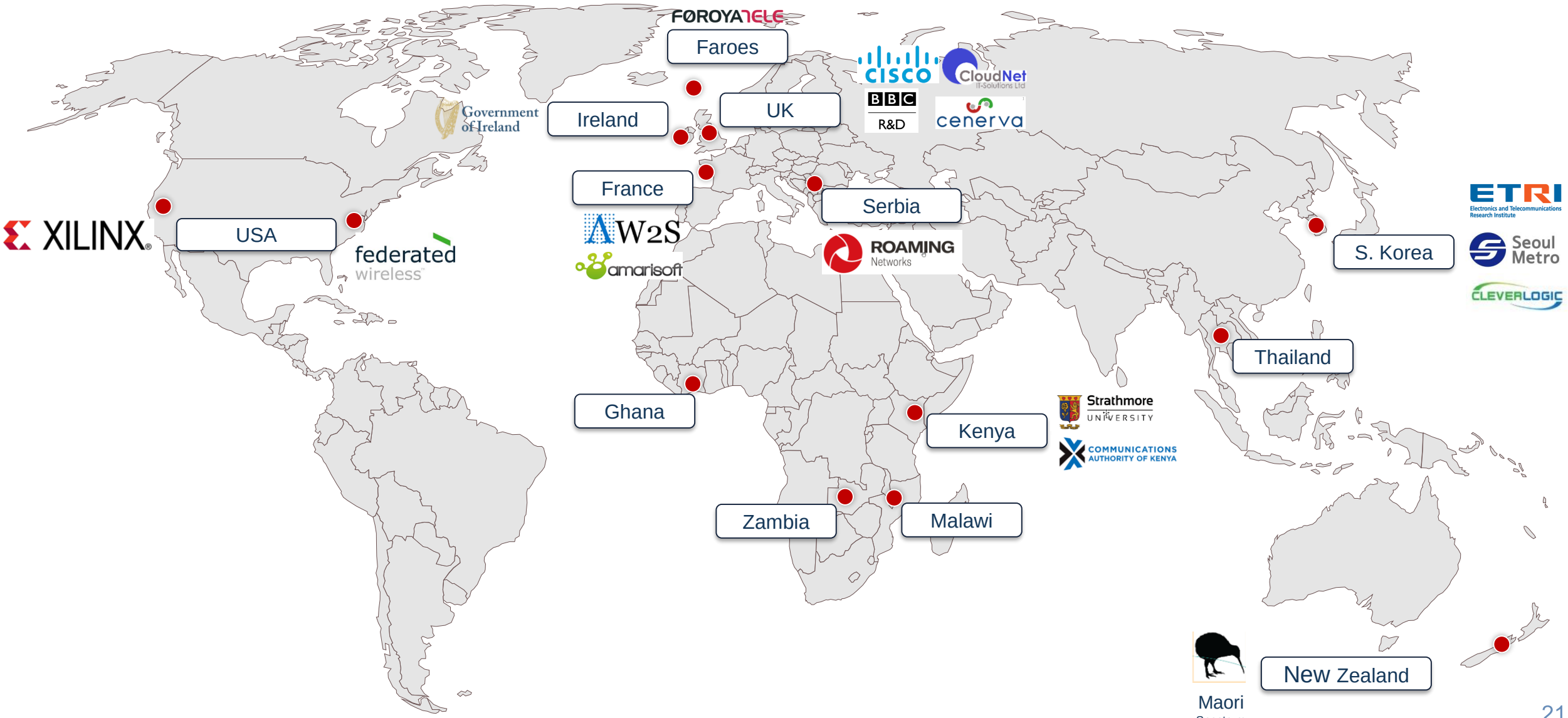

Conclusions and Acknowledgements

- 6G Spectrum usage and efficiency will feature low and mid bands
- Spectrum sharing and new management efficiency opportunities are a key part of 6G opportunities
- SDR and RF sampling technologies bring a new agility for design of customisable radios - desktop low cost multichannel SDR is here
- International collaboration and common purpose to adopt shared spectrum brings new business model opportunities
- Excellent opportunity for UK to collaborate and build leadership
- Connecting people.

Thank You (for sharing!)

https://sdr.eee.strath.ac.uk/

@StrathSDR

https://github.com/strath-sdr

Acknowledgements :

StrathSDR Team: Bob Stewart, Douglas Allan, Malcolm Brew, Louise Crockett, Kenny Barlee, David Northcote, Dani, Anderson, Josh Goldsmith, Craig Ramsay, Ivan Marjanovic, Tawachi Nyasulu, Lewis McLaughlin, Shawn Kalade, Dennis Sonoiya, Shruthi Kumar, Lewis Brown, Marius Siauciulis, Ehinomen Atimati, David Crawford.