6G Research Enabled by the National 6G Radio Systems Facility at Sheffield

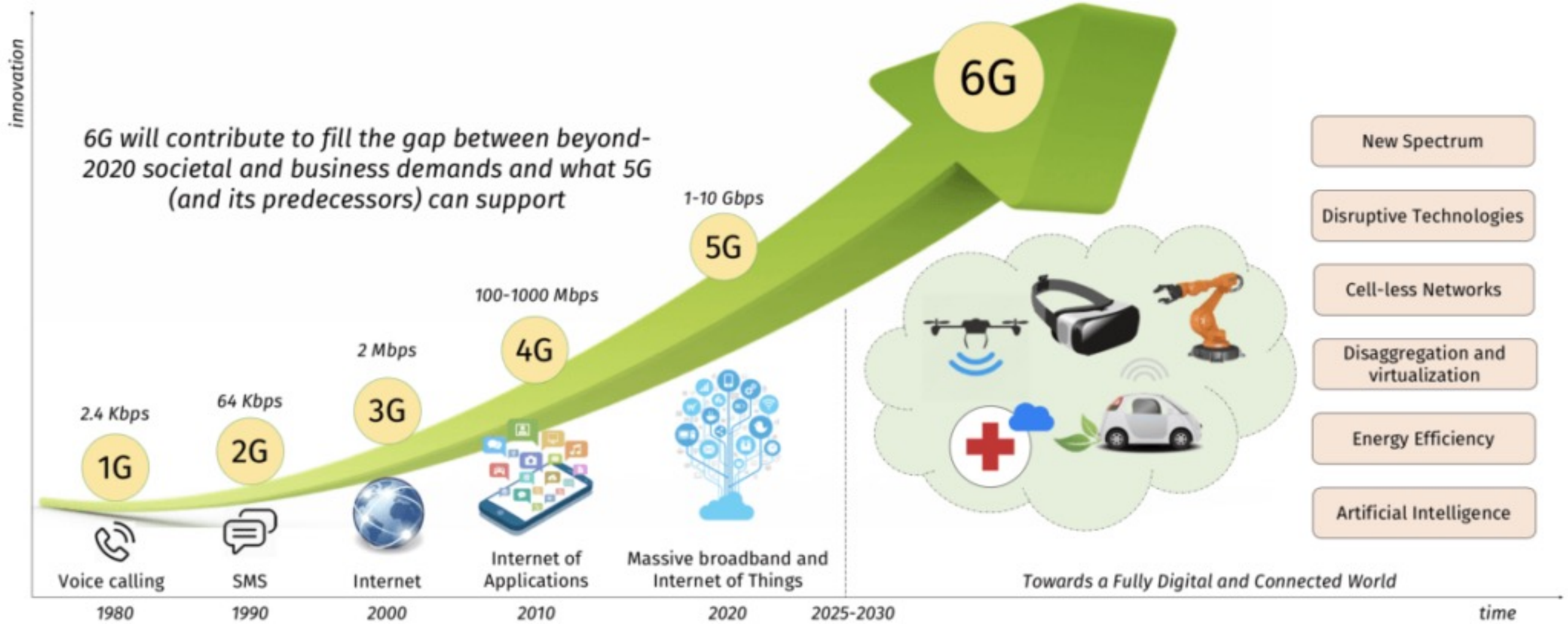
Professor Timothy O'Farrell CEng FREng
Chair Professor in Wireless Communication
Director National 6G Radio Systems Facility
Email: t.ofarrell@sheffield.ac.uk

School of Electrical & Electronic Engineering,
University of Sheffield,
UK

Presentation Outline

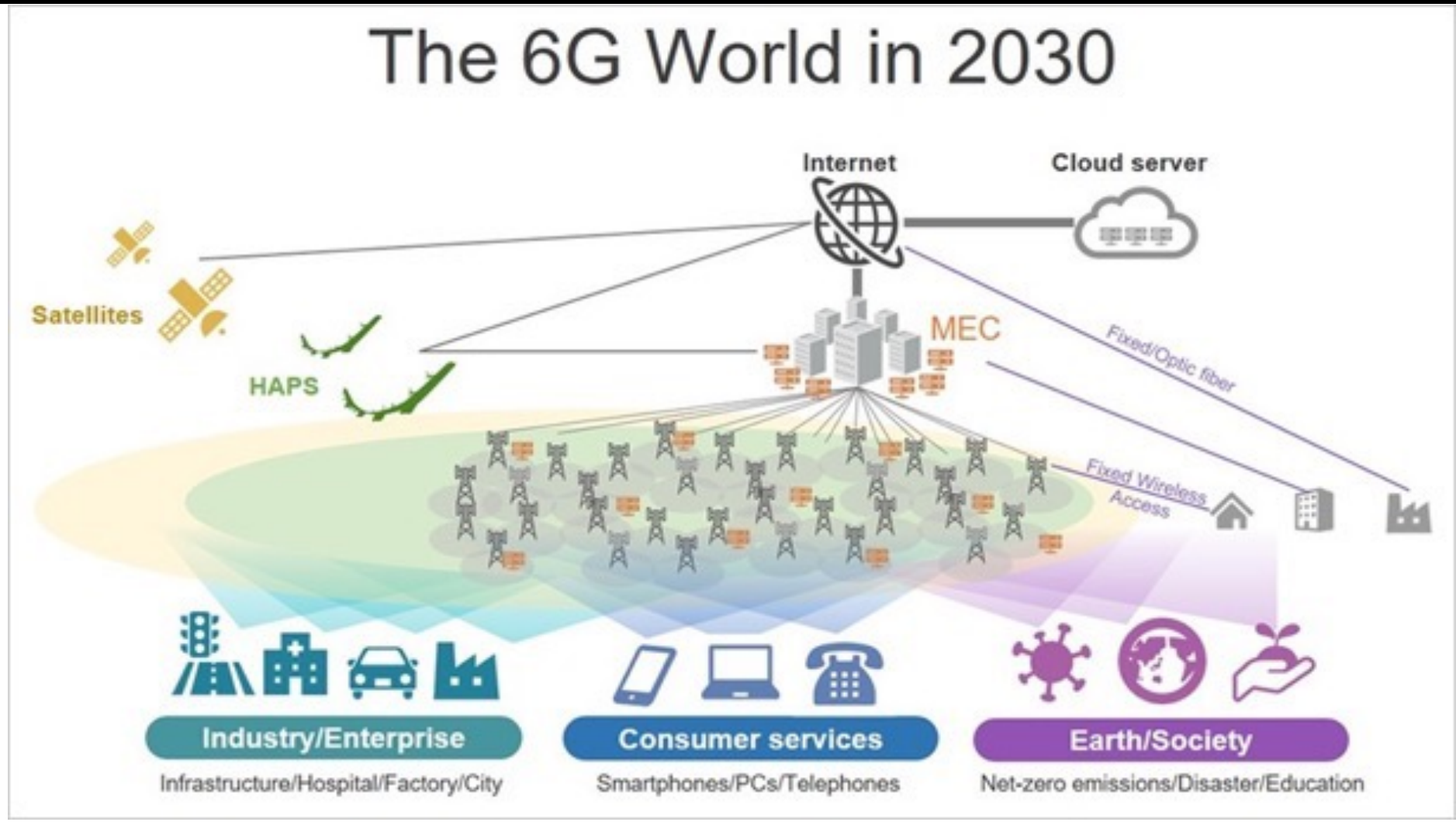
- What is 6G and Why it Matters?
- UKRI N6GRSF Award
- Description of the N6GRSF
- Facility Uniqueness and Capabilities
- Research Vision and Long-term Ambition
- Examples of 6G Research enabled by the facility
- 5G and 6G Research at Sheffield
- Engaging the UK 5G and 6G academic and industrial communities

What is 6G and Why it Matters? - 1



What is 6G and Why it Matters? - 2

- What should the 6G Air Interface be?
- Is a single waveform possible?
- Which frequency bands should be used?
- What radio technology will be deployed?
- How will AI/ML be deployed in the air-interface?
- The N6GRSF provides an empirical experimentation platform to answer these and other questions.

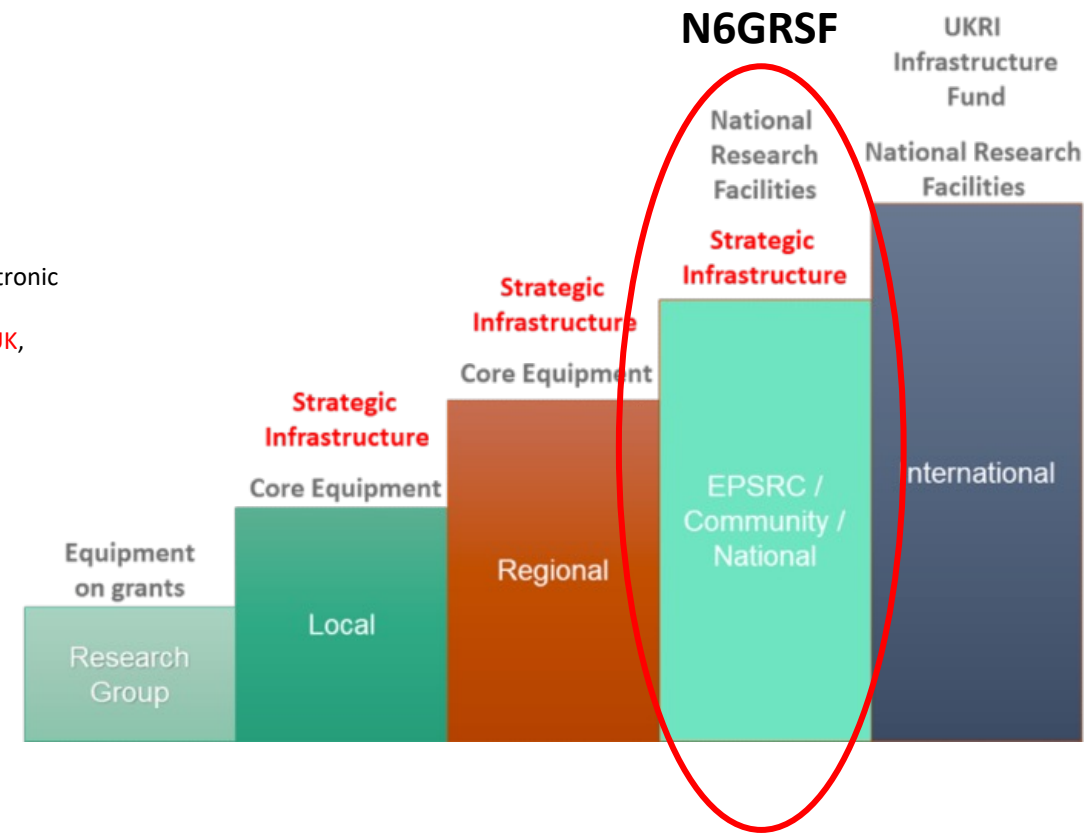


UKRI National 6G Radio Systems Facility Award

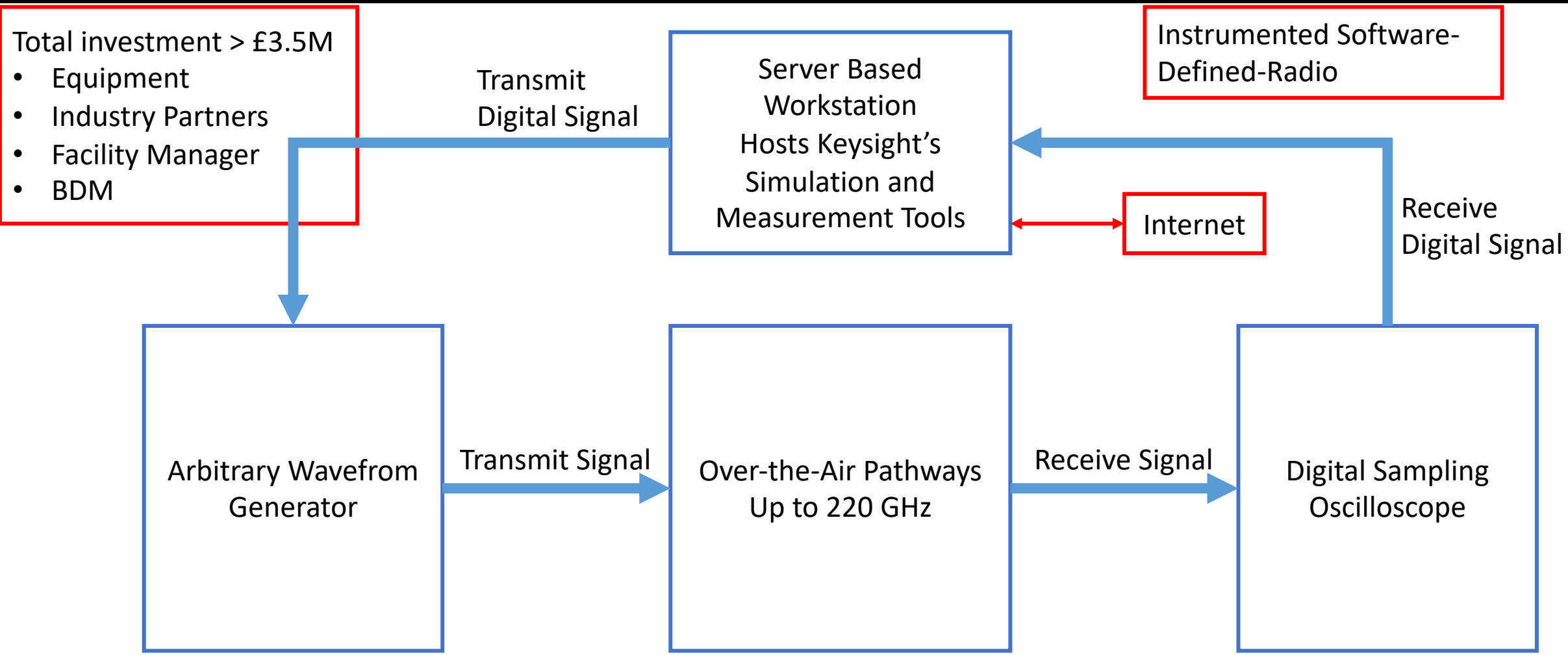
- EPSRC Strategic Equipment Grant for enabling world leading experimental research capabilities
- Award amount of £2.4M (largest capital equipment grant in FoE @ TUoS)
- Partners:
  - 19 Companies

    AccelerComm, BT, Cambridge Consultants, CellXica, Digital Catapult, Filtronic Broadband, Keysight Technologies, National Physical Laboratory, NEC, QinetiQ, Real Wireless, Roke Manor Research, Samsung R&D Institute UK, Slipstream Engineering Design, Telesoft Technologies, Toshiba Europe, Tyndall National Institute, UKTIN, VCE Mobile & Personal Comm
  - 21 Universities

    Birmingham, Bristol, Brunel, Edinburgh, Glasgow, Heriot-Watt, KCL, Lancaster, Leeds, Loughborough, Manchester, Newcastle, Oxford, QMUL, QUB, Southampton, Strathclyde, Surrey, UCL, Warrick, York.
- Start date: 1st February 2023 for 18 months to set up the facility
- A world leading facility

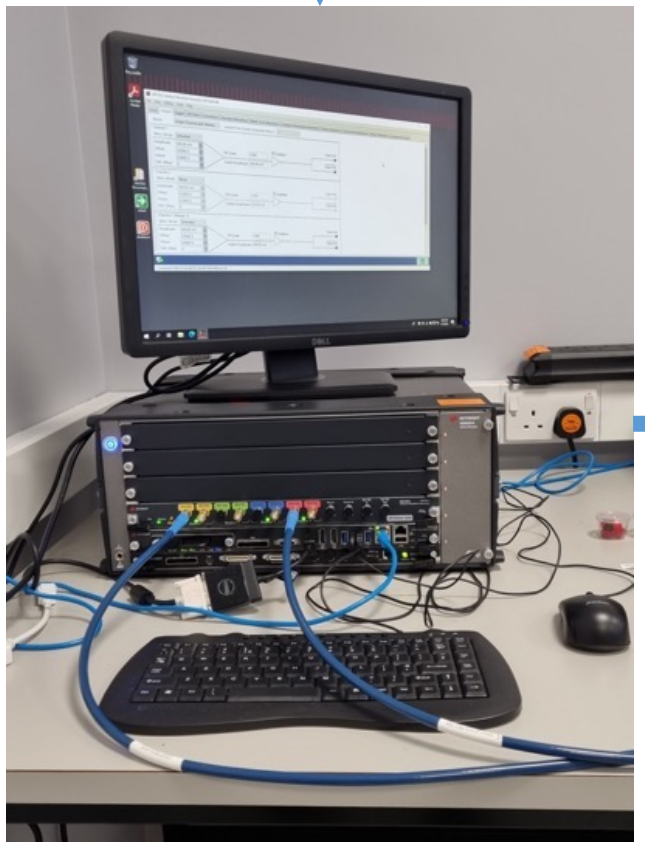


N6GRSF: Uniqueness and Capabilities - 1



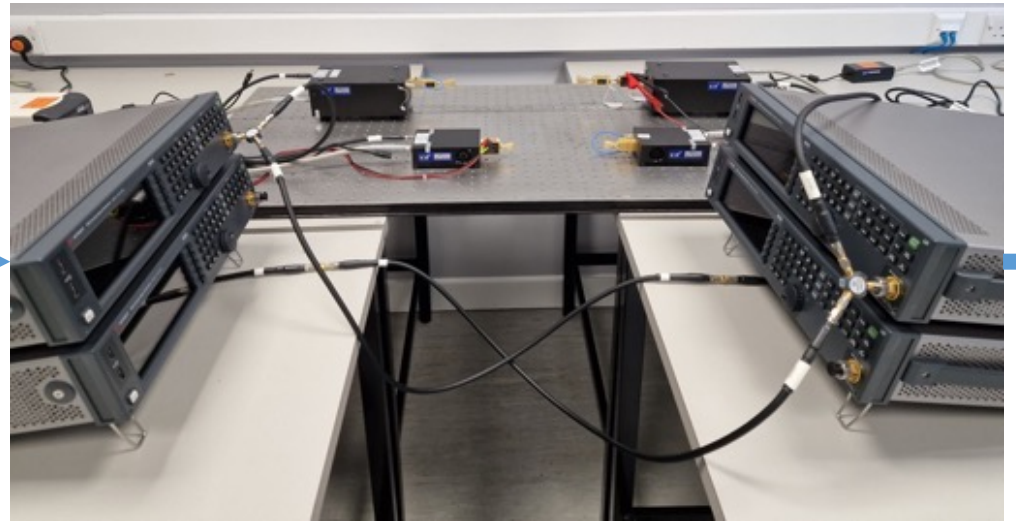
N6GRSF: Uniqueness and Capabilities - 2

Arbitrary Waveform Generator



Work-Station

Digital Oscilloscope



Over-the-Air Pathways

N6GRSF: Uniqueness and Capabilities - 3

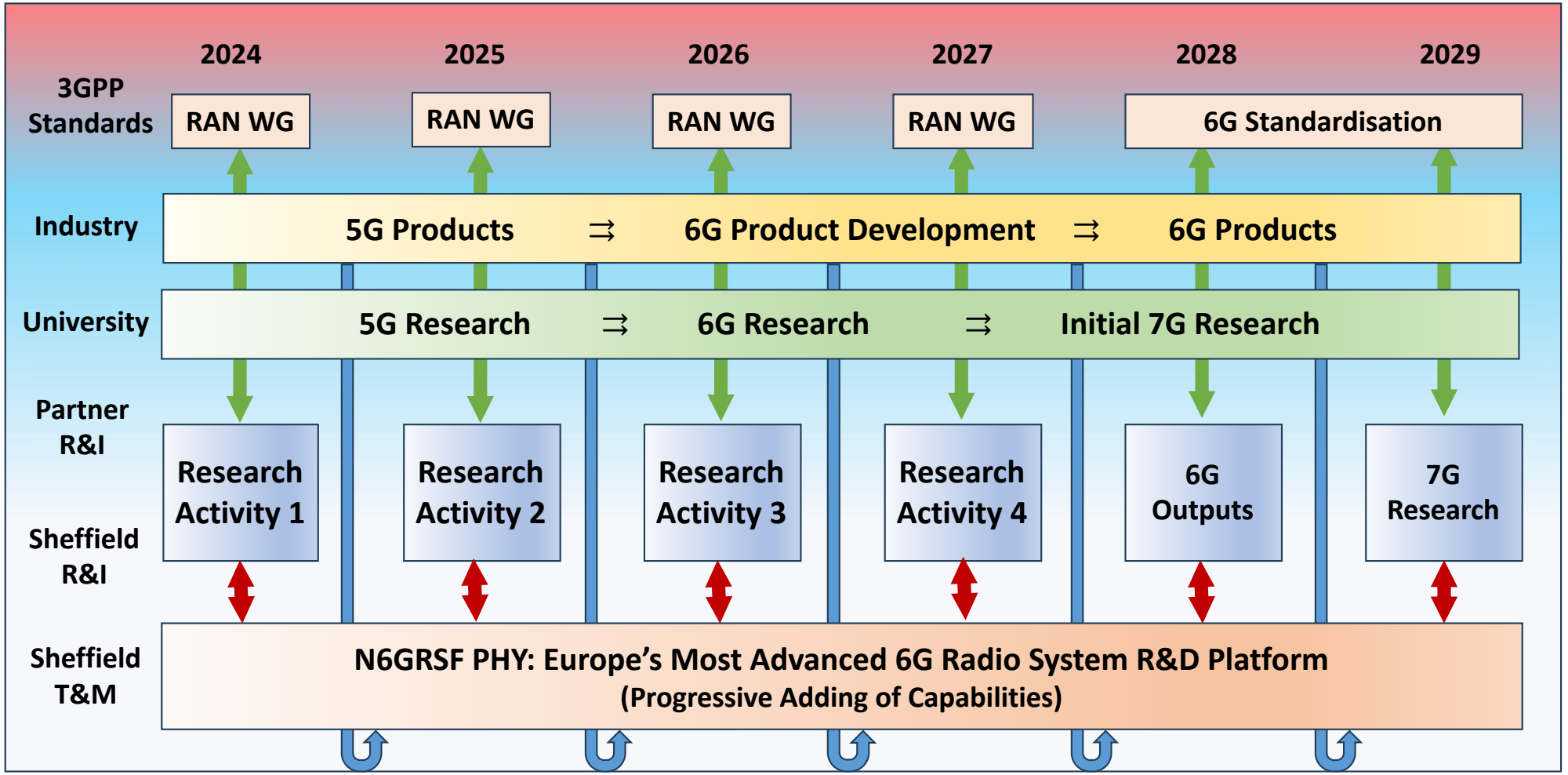
- Frequency range spans from DC to 220 GHz
- Instrumented software-defined-radio (SDR) architecture with modular hardware and software components
- Digital oscilloscope with 110 GHz bandwidth, 256 GSa/s sample rate per channel
- Multiple over-the-air radio pathways
- Wideband signal generation up to 25 GHz
- Signal analysis software for 4G, 5G and candidate 6G waveforms
- Extensions for propagation measurements, device characterisation, photonics research

Research Vision - 1

Vision

- To create a flexible instrumented SDR platform for the research and development of radio systems up to sub-THz frequencies in a 6G AI/ML era.
- To enable empirical experimentation on waveforms, baseband signal processing, RF signal processing, RF sub-systems and RF circuits.
- To deploy the facility for use by the UK and internation academic and industrial communities.

Research Vision - 2



N6GRSF: Waveform 6G Use Case

E.G. Waveform Development

1

Research Challenge

Modelling and Validating 6G waveforms for high mobility channels

2

SystemVue Modelling

Waveforms in 6G radio systems with large Doppler spreads

3

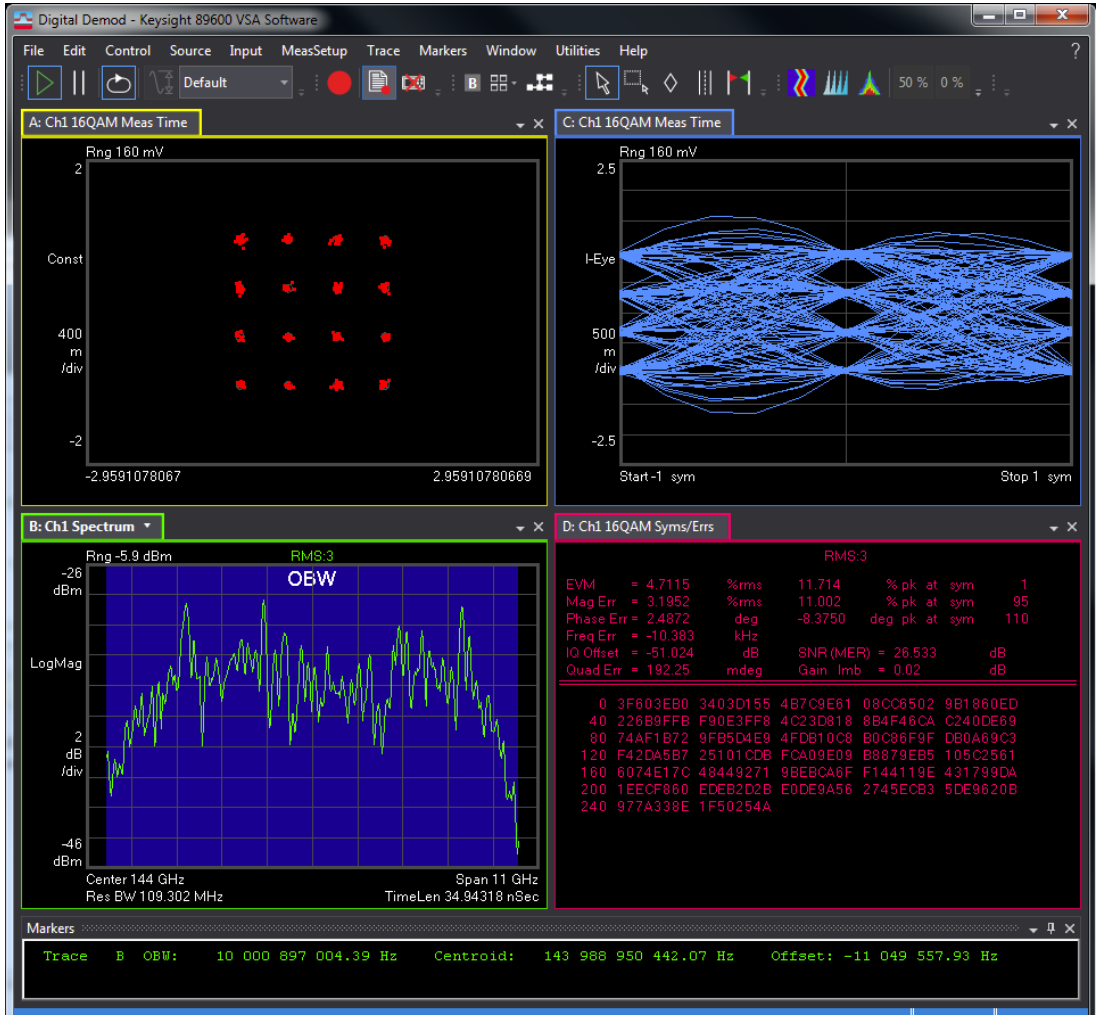
SystemVue Validation

Empirical Measurements of waveforms on N6GRSF

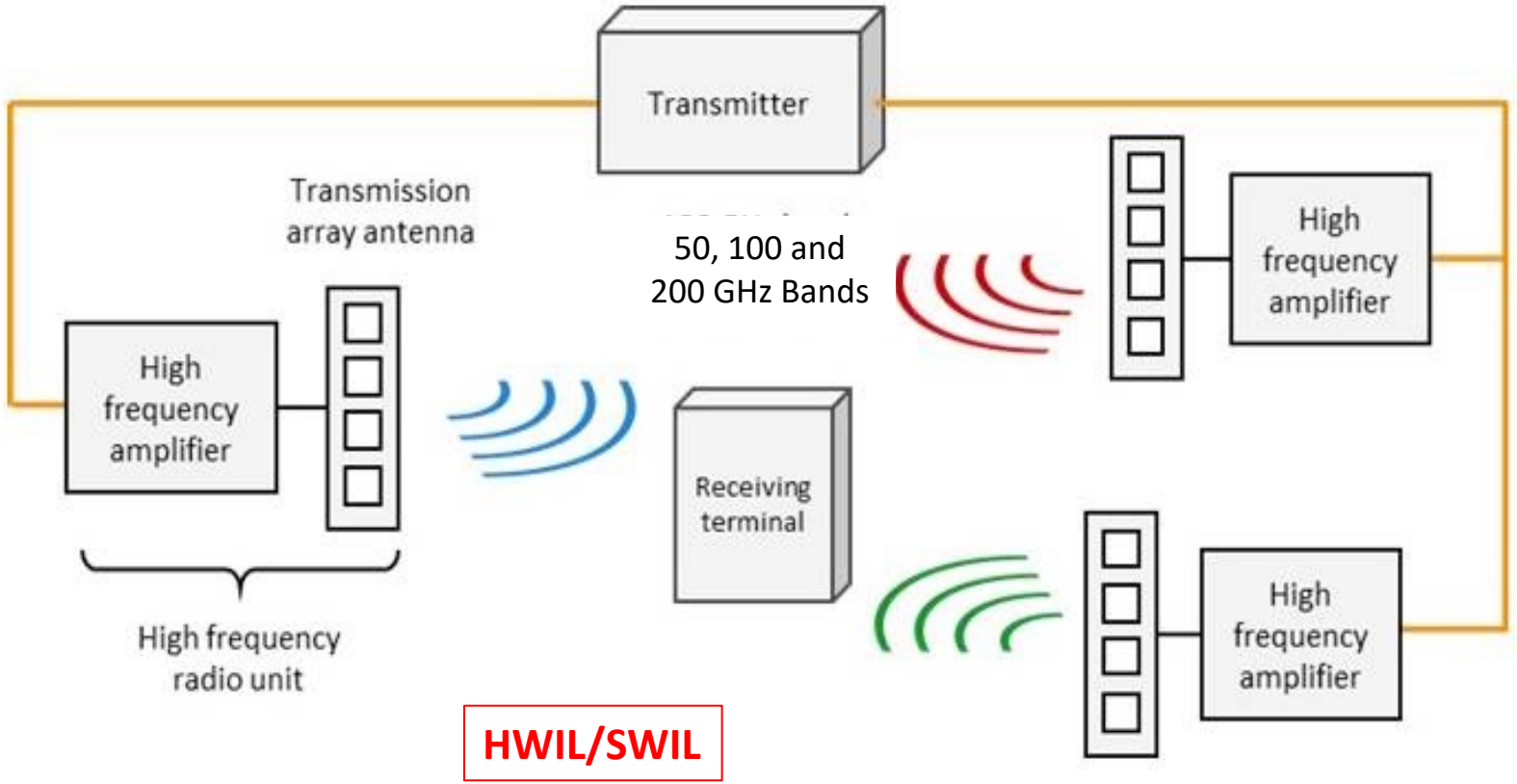
4

SystemVue Use Cases

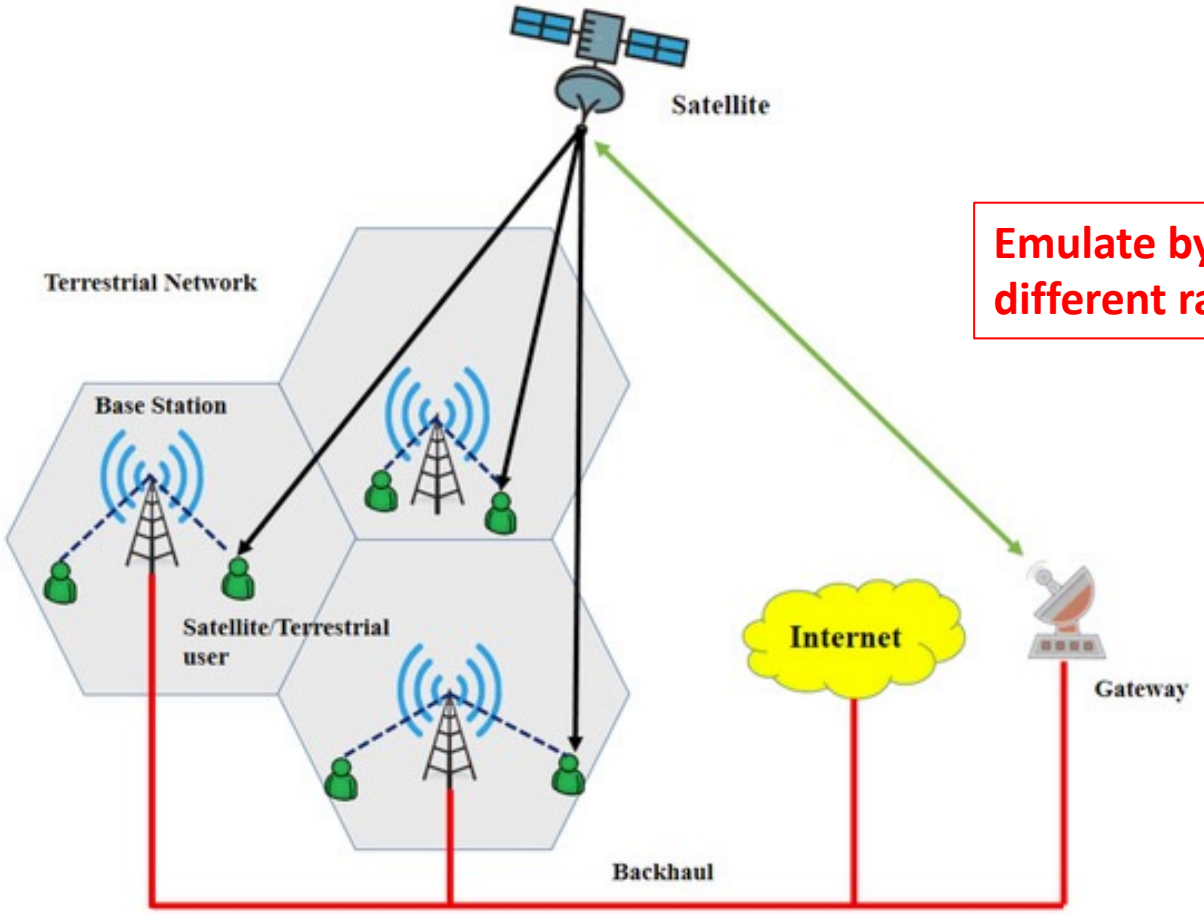
TM Evaluation of waveform in SystemVue for 6G use cases



N6GRSF: Multiband Cell Free MIMO 6G Use Case



N6GRSF: Terrestrial/Satellite 6G Use Case



Emulate by serially concatenating different radio links

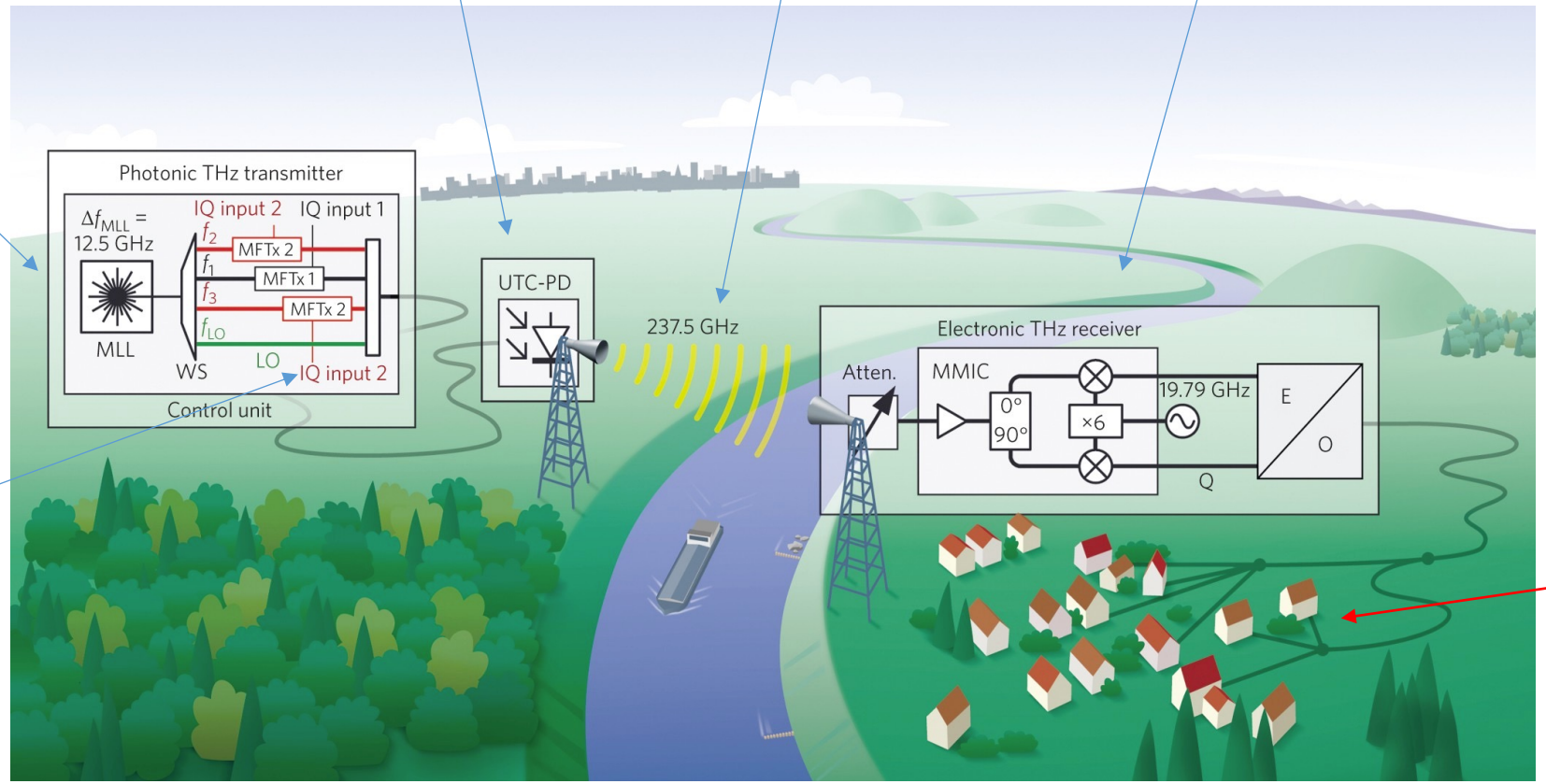
N6GRSF: Sub-THz Fixed Access 6G Use Case

Sub-THz Multiband Signal Generation

Sub-THz RFE Tx

Channel

Sub-THz RFE Rx



Waveform Generation

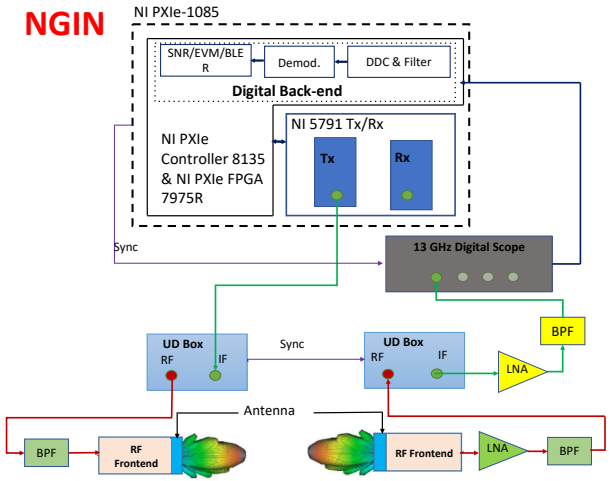
Information Reception

5G and 6G Research at Sheffield - 1

- YO-RAN (£7.8M, Research)
  - DSIT funded
  - To develop Open-RAN technology for neutral host providers
  - York, Sheffield, ADTRAN, Radio Design, Slipstream Engineering, BT, CellNex, AQL, Safenetics and Jet Engineering
- NGIN (£6M, Research)
  - Gov funded
  - To develop millimetre-wave technologies for Next Generation Information Networks operating in Disaster Scenarios
  - Edinburgh, Bristol, Heriot-Watt, Leeds, Sheffield, QUB, UCL
- 5G Factory of the Future (£10M, Infrastructure)
  - DCMS funded
  - To develop a private 5G network for an advanced manufacturing site
  - AMRC-NW, BAE Systems, IBM, Digital Catapult, AQL, Fuuse, MTT
- FoFoRAN (£2.7M, Infrastructure)
  - DSIT Funded
  - To develop, test, and showcase flexible Open RAN deployment approaches for the manufacturing sector
  - AMRC-NW, Dassault Systèmes, AQL, Productive Machines, Safenetics

YO-RAN
Yorkshire Open Radio Access Networks

NGIN



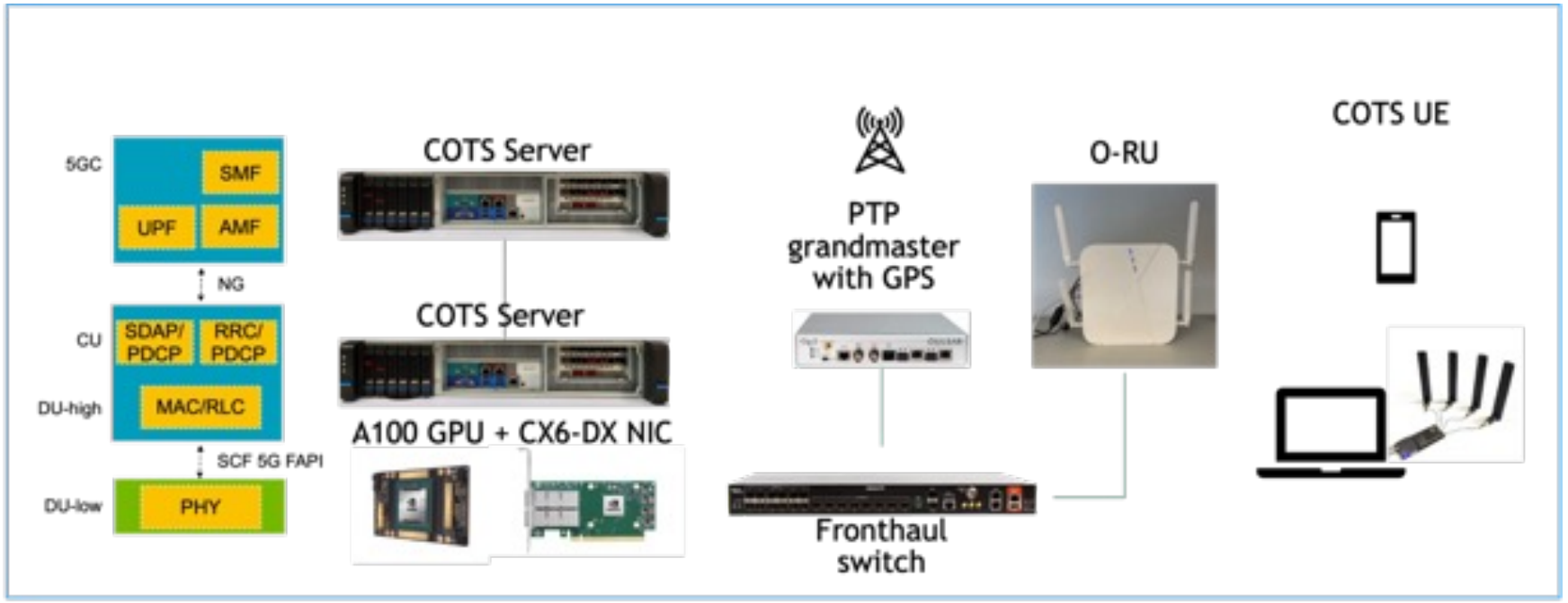
Schematic for the SISO direct IF sampling transceiver

5G and 6G Research at Sheffield - 2

THzAIr

- Funder: Federated Telecom Hubs (EPSRC/DSIT)
- Topic: To introduce an AI/ML capability into the N6GRSF
- Partners: Keysight, NVIDIA, KCL, Oxford, Sheffield

NVIDIA's AERIAL Research Cloud



N6GRSF: Engaging the Community, Growing the Facility

- Simulation, measurement, emulation, digital twins, HWIL and SWIL
- Industry Users (hardware/software testing above TRL3, 3GPP aligned…)
- Academic Users (hardware/software research up to TRL3…)
- Horizon Europe (network of testbeds for 6G evaluation)
- EPSRC Small Research Facility (JeS chargeable resource)
- Website and Booking Portal (revenue stream)
- N6GRSF Network (CommNet-6G, UKTIN, FTH, mVCE)
- National Training
  - Industry short courses (Keysight, Samsung, InnovateUK, UKTIN, DSIT)
  - ECR workshops (EPSRC Communications Hubs)

N6GRSF: Open All Hours!

We look forward to working with you in the near future to help with your R&D journey

University of Sheffield

6G NATIONAL RADIO SYSTEMS FACILITY

KEYSIGHT

Questions

Management Team

Chair: Prof Timothy O'Farrell FREng

(t.ofarrell@sheffield.ac.uk)

Advisory Board

Simon Fletcher, Realwireless

Prof Edward Wasige, University of Glasgow

Prof Kirill Horoshenkov, Sheffield

Prof Mohammed Benaissa, Sheffield

Prof Merlyne de Souza, Sheffield

Dr Aparajithan Sivanathan, Sheffield

Mr Eddie Ball, Sheffield

To Discover And Understand