Engineering and Physical Sciences Research Council

Department for Science, Innovation & Technology

Federated Telecoms Hubs

JOINER National Spectrum Facility

Engineering and Physical Sciences Research Council

Department for Science, Innovation & Technology

IP Pool

Technical Standards

Thought Leadership

Academic Excellence

Skills & Training

Translation & Commercialisation

Federated Telecoms Hubs

CHEDDAR
Communications **H**ub for Empowering **D**istributed clou**D** computing **A**pplications and **R**esearch

TITAN
NETWORK OF NETWORKS HUB
PLATFORM DRIVING THE ULTIMATE CONNECTIVITY

HASC
HUB IN ALL-SPECTRUM CONNECTIVITY

JOINER
An experimentation platform for future connectivity.

One of Europe's Largest Research Consortia

- **27** leading UK universities
- **100+** researchers focused on advanced communications technologies
- **£12M+** awarded in 2025 for research in advanced communications technologies across the research hubs

UKRI Engineering and Physical Sciences Research Council

Federated Telecoms Hubs

The FTH Directors & Leadership Team

TITAN
NETWORK OF NETWORKS HUB
PLATFORM DRIVING THE ULTIMATE CONNECTIVITY

Led by
Prof Harald Haas,
University of Cambridge

Focusing on emerging seamless, intelligent and resilient Network of Networks (NoN) solutions and technologies

CHEDDAR
Communications **H**ub for Empowering **D**istributed clou**D** computing **A**pplications and **R**esearch

Led by
Prof Julie McCann,
Imperial College London

Researching 6G technologies that support edge-fog-cloud continuum of computation.

HASC
HUB IN ALL-SPECTRUM CONNECTIVITY

Led by
Professor Dominic O'Brien,
University of Oxford

Focusing on how to combine wired and wireless internet technologies to achieve end-to-end connectivity

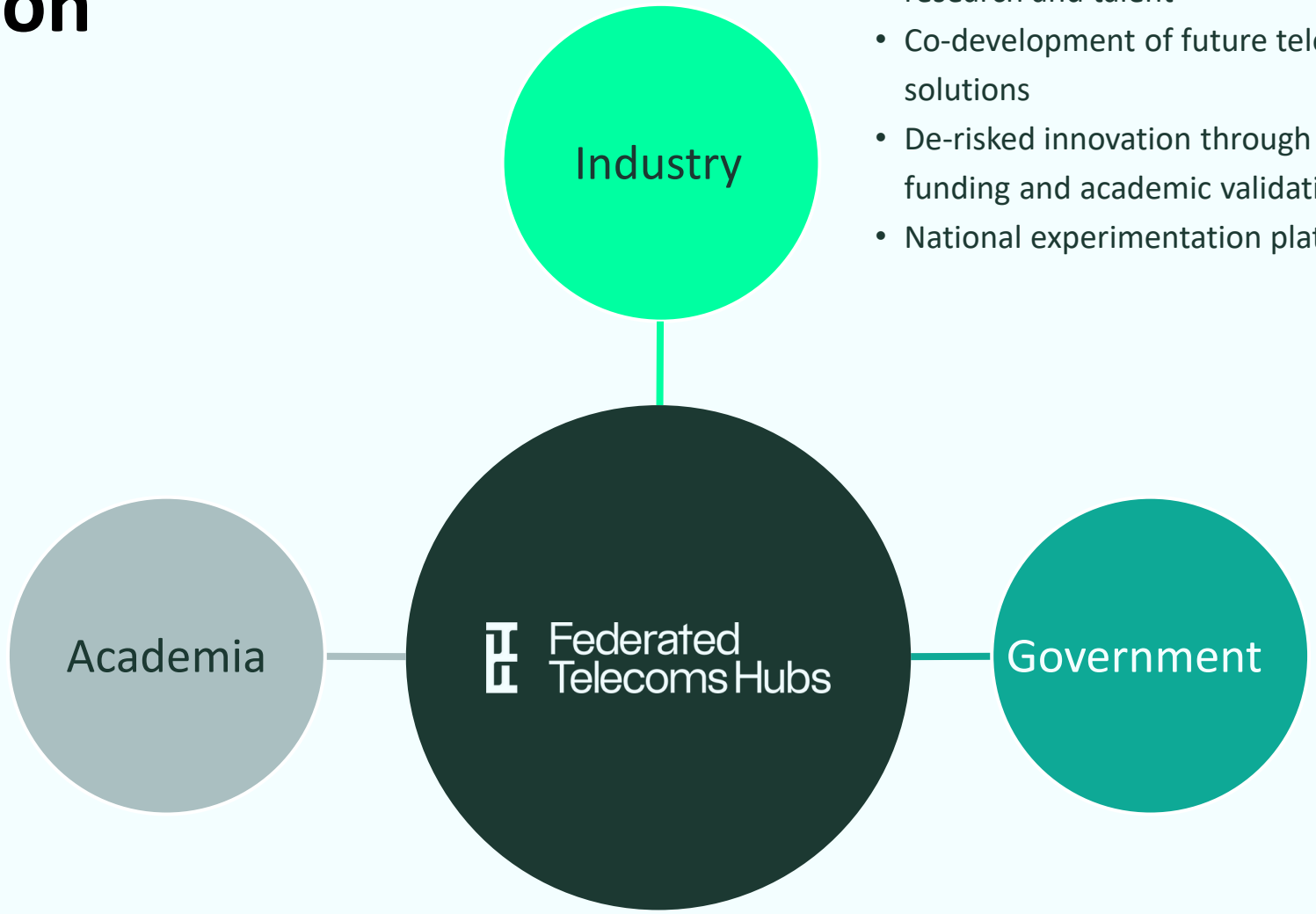
JOINER
An experimentation platform for future connectivity.

Led by
Prof Dimitra Simeonidou,
University of Bristol

A national experimentation platform to accelerate 6G and future network research

Collaboration

- Accelerated access to cutting-edge research and talent
- Co-development of future telecoms solutions
- De-risked innovation through public funding and academic validation
- National experimentation platform



- National platform to apply and test research at scale
- Industry and policy relevance for impact case studies
- Access to commercial and policy partners for knowledge exchange

- Evidence-based policy insights from technical experts
- Enablement of national R&D goals through public-private-academic collaboration

About
JOINER National Spectrum Facility

JOINER

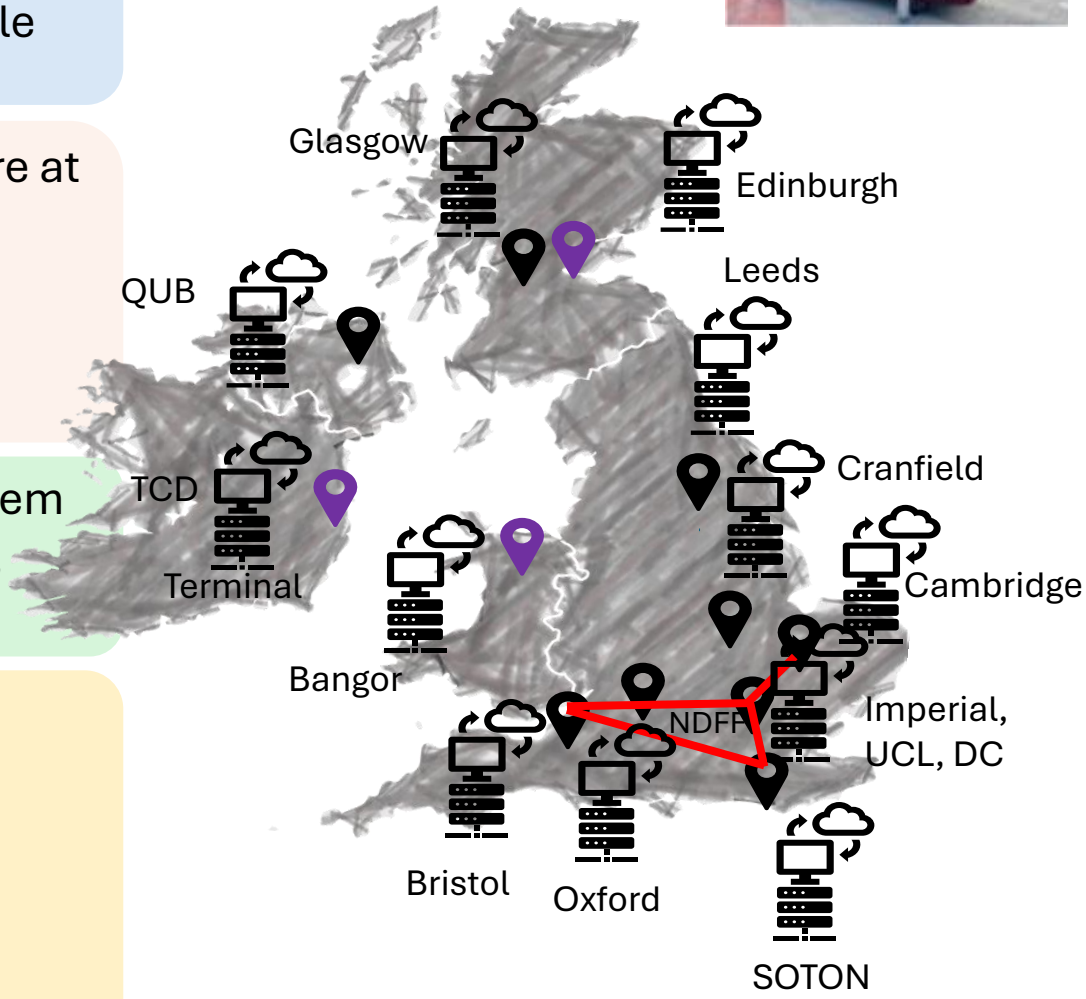
JOINER is a national-scale experimentation platform aiming to support future networks research, collaboration and experimentation at scale

It is delivering an open, programmable and feature rich infrastructure at scale interconnecting 14 labs (including SONIC Labs) + a nomadic terminal, offering connectivity, cloud, RIC & mobile packet cores, monitoring, management, orchestration, spectrum measurement, ORAN, NTN emulation platforms

It is already developing capability to support the wider telco ecosystem including international (US/FABRIC, EU/SNS, Ireland, etc.), industry, SMEs and regions.

Key attributes include:
Large scale host for Future Network Experimentation:

- Collaborative by design
- Heterogeneous platform
- Led by world-class research labs
- Enabler of system-level research addressing end-to-end challenges



Key Areas of Technical Development

Onboarding New Hardware
Radio, OWC,
HW programmable platforms,
ultrafast switches, new
fibres, etc.

Infrastructure Evolution
Convergence (wireless,
optical, satellite,
computing, sensing),
Distributed &
disaggregated

Native Security
Cyber
Physical layer & Quantum
QKD security as a service for
6G, integration of QKD and
post-quantum cryptography

AIaaS
For network and
AI applications

Open software/platforms/interfaces
Higher reliance on open
infrastructure, platforms and
interfaces

Cloud & Edgification
Continued cloudification
Federated and Split Edge computing

Spectrum
RF, THz and optical (infrared
and visible light)

JOINER Brain: Measurement & Analytics, Orchestration & Management, User Management, Policies

User Equipment

Access Network

mmWave /THz

WIFI

B5G/6G

LiFi

Fibre Broadband

Sensing

Spectrum

JOINER Terminal

Local Experimenters

- User Portal
- mATRIC (multi-access control)
- On-Premisses Hybrid Cloud
- Private Cloud
- SDN Control
- Storage and Computational Resources — CPU/GPU/RAM AI Nvidia Platform
- Hosting for equipment, platforms and users-terminals
- ASIC/FPGA — Programmable ICs
- L3 Routing — Service Router, SD-WAN
- L2 Switching — Programmable Packet Switches
- L1 Switching — Optical Switches

JOINER Fabric

Hybrid Cloud

- VI Monitoring and Data Collection Platform
- Virtual Infrastructure Management Platform
- Virtual Infrastructure
  - AI models
  - Open-Source Platforms
  - RICs
  - Monitoring Data
  - Storage
  - Spectrum Data
  - Serverless Compute
  - Mobile Packet Core

Physical Infrastructure

- Infra Monitoring and Data Collection Platform
- Infrastructure Management Platform
- L 2/3 Hybrid Cloud Connectivity [e.g., AWS VPN/Private Link]
- Satellite links (GEO, LEO) at specific locations, e.g., Cranfield
- 10-40Gbps Layer2 Transport Network Connectivity at all 14 locations [JISC, Heanet for Ireland]
- Layer 1 Optical Connectivity [existing NDFF infrastructure across Bristol, Cambridge, Southampton, UCL]

The big picture – future spectrum management needs research and innovation

DSIT's Spectrum Statement 2023 calls for:

"A renewed focus on innovation in wireless technology, enhanced sharing of spectrum bands, continuing to expand the frontiers of usable spectrum, advanced spectrum management techniques, improved interference management, monitoring and resilience will enable us to significantly improve spectrum availability, ensuring that spectrum access is not a limiting factor on the UK's economic and societal potential.

Ofcom's Spectrum Management Strategy 2014 identifies areas which need research:

Table 1 - Ofcom's Spectrum Management Strategy illustrated on a page

Key spectrum duty	To secure optimal use of spectrum in the UK i.e. the use that delivers the greatest value to UK citizens and consumers		
The context for future spectrum management	Requirements for wireless service are likely to increase for many spectrum uses. This will lead to **growing competing demands** for key spectrum resources	Adopting technologies that enable more efficient use of spectrum will be crucial, but the there will still be increased pressures on spectrum, especially in concentrated geographical locations	As there is no unused spectrum across many frequencies, the growth in competing spectrum demands will need to be addressed by a mix of **spectrum re-purposing** to higher value uses and greater use of spectrum sharing
Our strategy	We will continue to **combine the use of market mechanisms possible and effective and regulatory action where necessary**. When we do take action we seek to retain flexibility in order to create options, rather than dictate solutions We will place a growing emphasis on four aspects of how we manage spectrum: • Exploring new forms of spectrum sharing and extending sharing across new bands • Maintaining our increased focus on understanding the coexistence challenges associated with changes in spectrum use • Promoting improvements in radio performance standards to reduce future coexistence issues • Increasing the quantity and quality of information on spectrum use we make available We will also **continue to play a leading role in international spectrum debates** where this is most relevant to good outcomes in the UK		

Ofcom's new Growth Duty (2024) needs both spectrum for innovation but also innovation for spectrum management

UK Digital and Technologies Sector Plan (2025):

"Ensuring spectrum availability to support ACT by working with international counterparts ahead of the World Radio Conference 2027 and collaborating with Ofcom to promote efficient, innovative spectrum allocation and regulation, which continues to support the development and deployment of ACT. "

Spectrum research questions and needs

Spectrum research questions

How to support **continued growth** in spectrum usage:

- Growth in data consumption
- Wider diversity of uses : Public, private, NTN
- Increased societal reliance on critical national infrastructure – security and resilience needs
- New and higher spectrum bands

Enable **denser spectrum sharing** between adjacent networks and heterogeneous services, including sharing by frequency, time, location and power

How to ensure **spectrum usage more closely reflects actual usage**, ensuring efficient assignment while delivering the necessary protections against harmful interference and investment certainty

To address these questions researchers need

Real-world spectrum interactions

Open data on the characteristics of spectrum usage

Operation *at scale* for credibility:

- Geographical
- Temporal
- Computing (inc. AI) infrastructure
- Connectivity
- Traffic

To emulate and test advanced system concepts in realistic – and preferably real - environments

We are seeking to galvanise and support the UK research and innovation community to better meet these needs via JOINER and the Future Telecoms Hubs

Introducing JOINER NSF

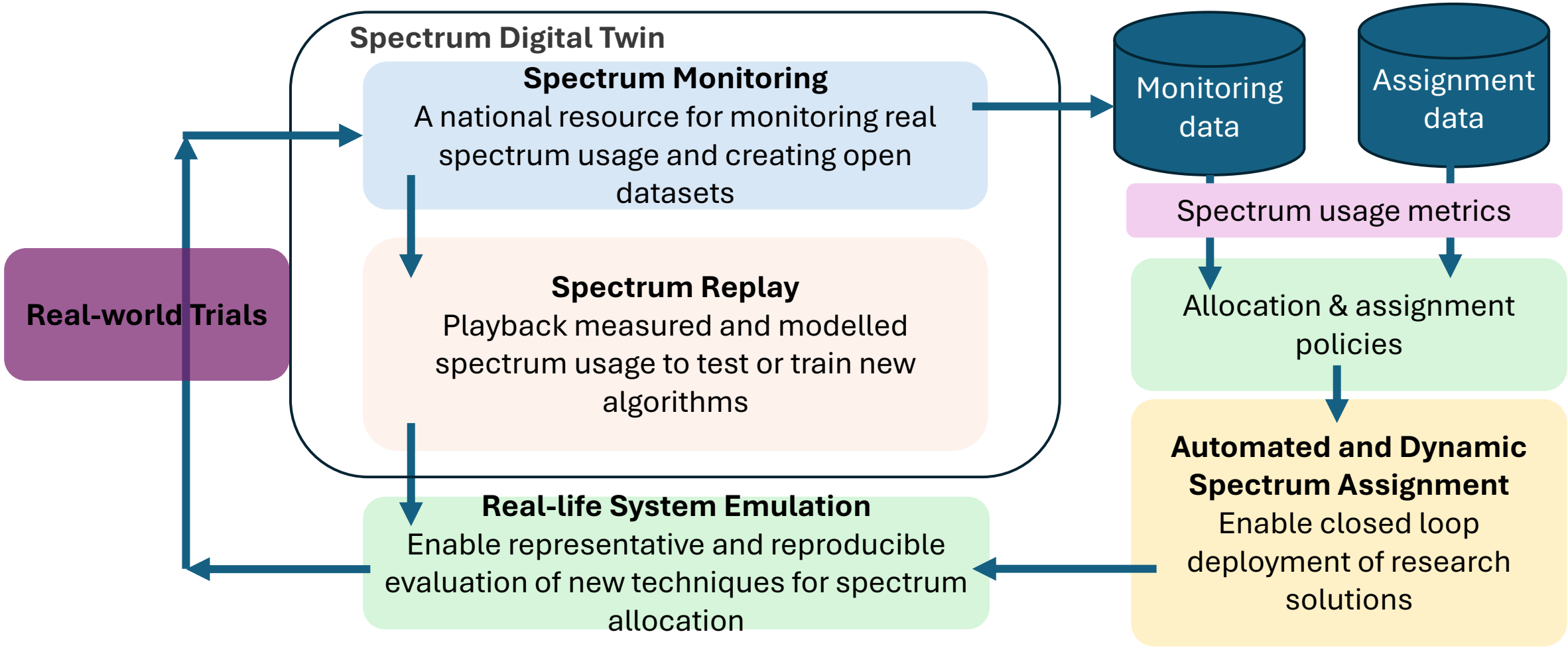
JOINER-National Spectrum Facility (JOINER-NSF) is a facility hosted by JOINER to meet the needs of spectrum access innovation researchers and developers.

Spectrum access innovation here includes specifically:

- Spectrum management solutions to enable more efficient use of the radio spectrum and deliver spectrum abundance for diverse future radio spectrum users, ensuring that spectrum access is not a limiting factor on the UK's economic and societal potential
- Approaches to spectrum sharing amongst heterogeneous spectrum-using services
- Multidisciplinary spectrum innovation spanning engineering, economics, policy and regulation
- Increased interference resilience for spectrum-using services, particularly from dissimilar services.
- Automated techniques for monitoring, managing and assigning spectrum for challenging spectrum scenarios
- Providing low-friction access to spectrum for UK researchers across all research domains (not limited to spectrum-related research)

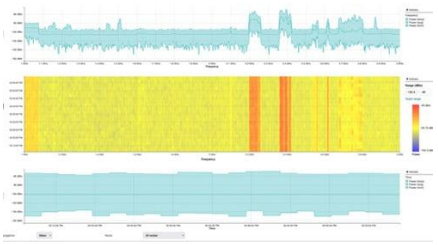
While there is a large body of research and other facilities and testbeds aimed at spectrum efficient solutions for individual systems, JOINER-NSF focuses particularly on what might be called 'spectrum science', i.e. the overarching role of radio spectrum management to better allocate and assign spectrum amongst diverse services.

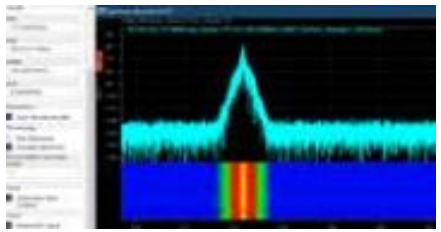
JOINER NSF Functions

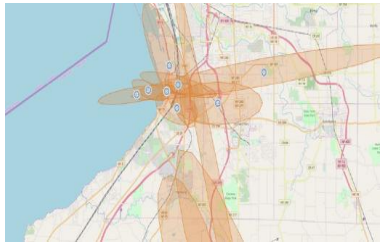


Monitoring Solution – by CRFS

- **RFeye 100-8 Node Plus**
  - 10 MHz to 8 GHz frequency range
  - 100 MHz RF bandwidth
  - Sweep rate 27 - 378 GHz per second (for RBW 3.8 kHz – 15.6 MHz)
  - IQ data and **spectrum occupancy data**
  - Local storage of 4 TBytes SSD on the Node Plus can store 100MHz IQ data for up to 2 hours
- **Rfeye Site Real time Spectrum and Geolocation Software**
- **Rfeye Deepview Forensic signal analysis**
- **Rfeye Mission Manager –** at NOC
  - Job schedule management
  - Intuitive visualization
  - Automated reporting
  - Automated geolocation







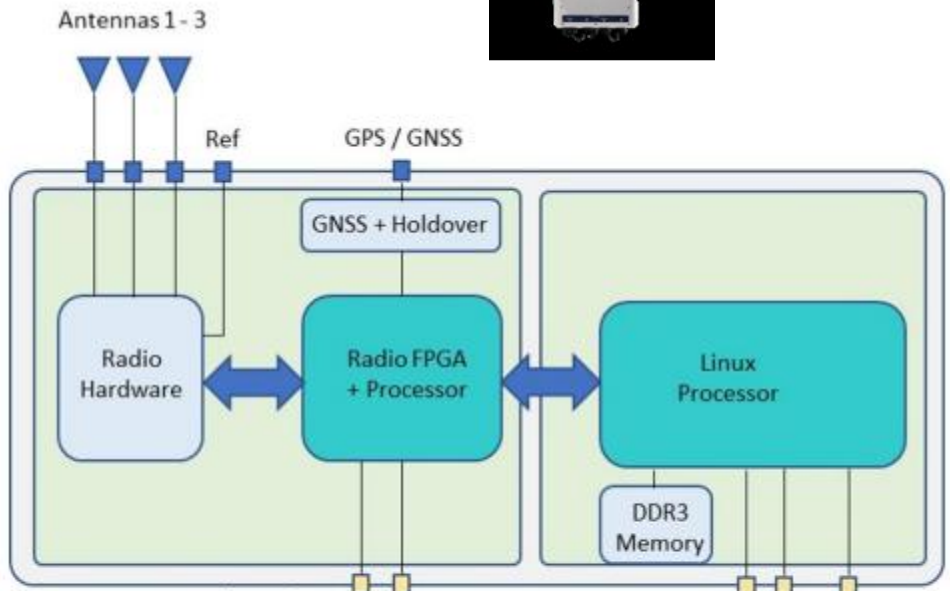
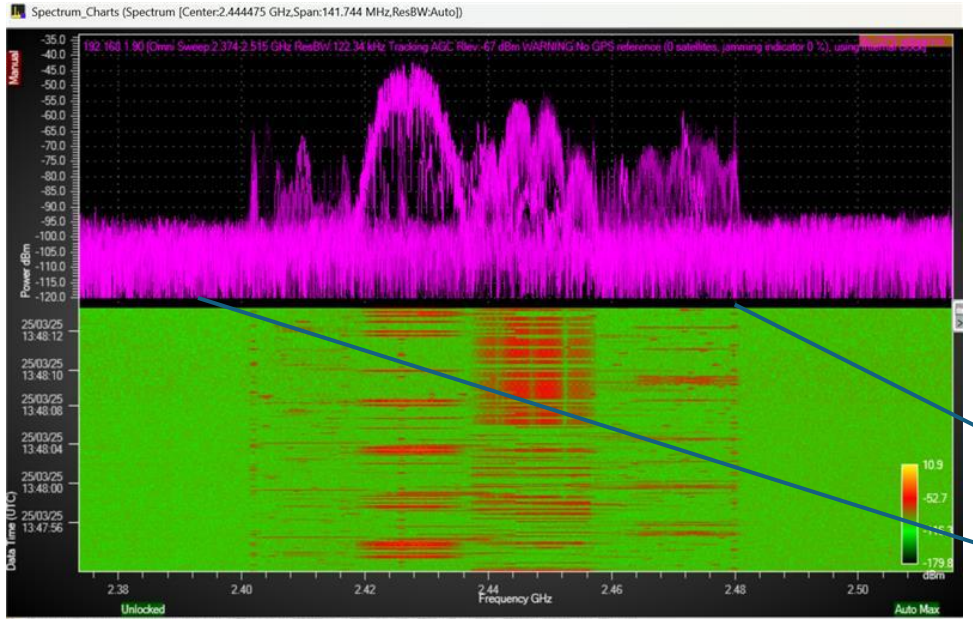
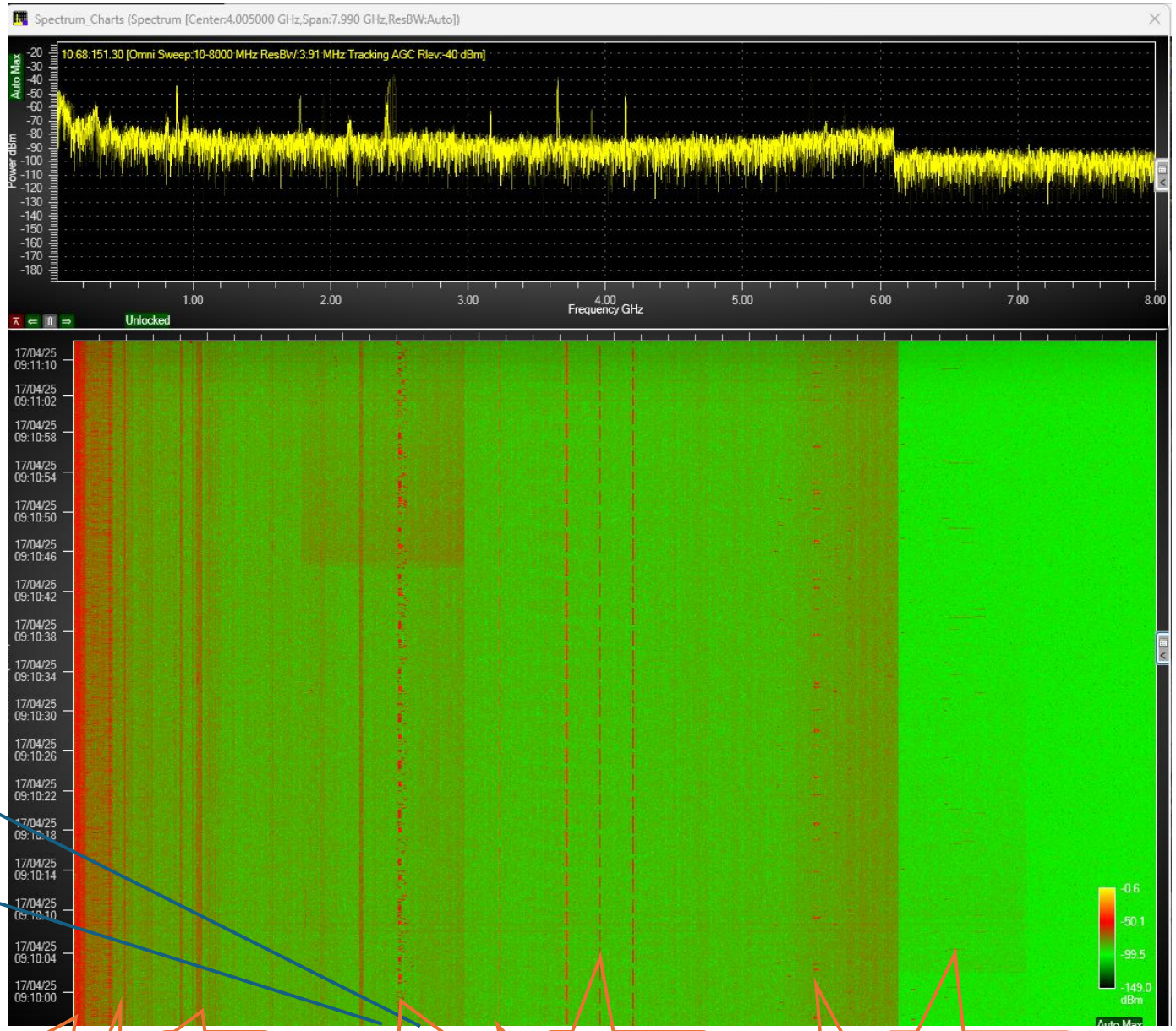


Figure1: Node 50-8 / 100-8 architecture

Example spectrum capture

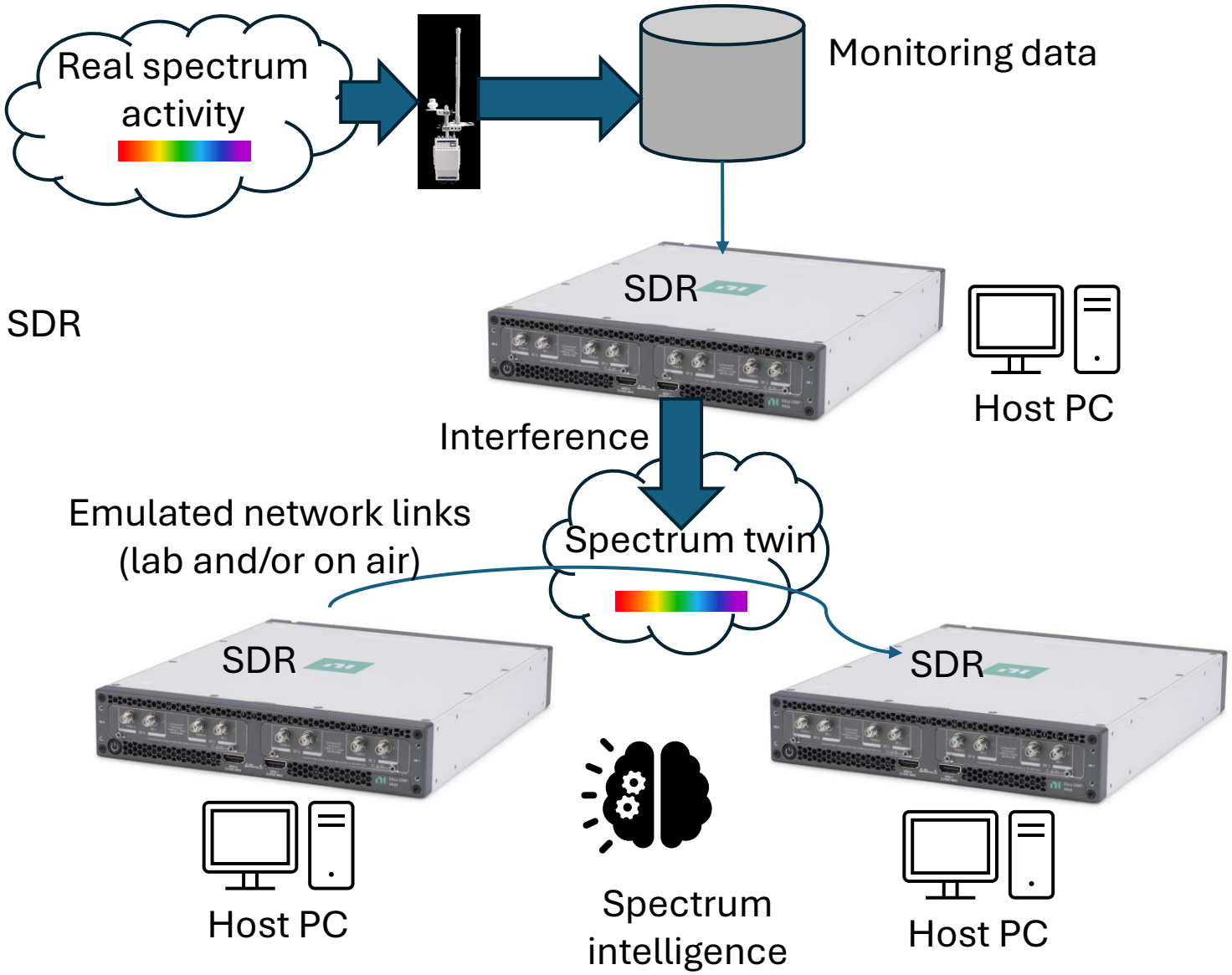




Spectrum Playback and System Emulation

Emulation and replay hardware

- Emerson (National Instruments) X410 USRP SDR
- Frequency range is 1 MHz – 8.0 GHz
- Simultaneous 4 channels TX and 4 channels RX
- Instantaneous 400MHz bandwidth
- FPGA support



Example spectrum research topics enabled by JOINER NSF

Interference Resilience
- Interference and noise resilient receivers, waveforms and protocols
- Coexistence Mechanisms for Heterogeneous Networks

Interference Management and Mitigation
- Anomaly Detection
- Predictive Interference Avoidance

Sharing techniques
- Spectrum Monitoring and Compliance
- Harmonised Spectrum Sharing Frameworks

Radio wave propagation prediction and channel modelling for spectrum management
- New bands
- New coexistence scenarios
- Higher precision and automation
- Enhancing models via ML and measured data

Automated and Dynamic Spectrum Allocation and Optimisation
- Acting on network and usage data without comprising security
- Flexible spectrum assignment while maintaining incentives to invest
- Open standard interfaces

Regulatory and Policy Research
- Incentivising Efficient Spectrum Use
- Working within international spectrum allocation policies while not being limited by them
- Frameworks for AI Regulation in Spectrum Management

Non-exhaustive examples only: additional topics welcome