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FOR WHAT COMES NEXT

Challenges & Opportunities in 6G Satellite Communication Networks

Satellite Futures Summit 2025

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UKRI Engineering and Physical Sciences Research Council

Contents of Presentation

- Introductory context from UKSA
- EPSRC UK-India Future Networks Initiative
- University of Surrey 6G Innovation Centre & Project TUDOR
- LINO-6G project-ESA (Germany –UK)
- EPSRC Centre for Doctoral Training- FORT
- EPSRC Federated Telecoms Hubs
- Future Networks Roadmap
- SpaceEast Cluster Group
- Call for Expressions of Interest- UKI-FNI Workshop on PNT Harwell

Size and Health of the UK space industry 2024

UK SPACE AGENCY

£7.2bn GVA

The industry's direct contribution to UK GDP

£18.6bn sector income

Total space industry income in 2022/23

1,907 organisations

UK-based organisations with space-related activities

55,550 employees

Direct employees in the UK space sector

£5.8bn export income

Income generated from exports (31% of total)

3 in 5 expect growth

60% of survey respondents expect income to increase

Employment by region

London 33%

South East 17%

Scotland 13%

South West 8%

Rest of the UK 29%

Size and Health of the UK space industry 2024

Income by segment

- Space applications – DTH broadcasting 48%
- Space applications – other 25%
- Space operations 10%
- Space manufacturing 13%
- Ancillary services 3%
- In-space economy <1%

2x average UK labour productivity

£454bn, 18% of total UK GDP is supported by satellite services:-

- Earth Observation
- Meteorology
- Navigation
- Communications

70% with primary degree or higher
Survey respondents' employees with bachelor's degree or higher

1 in 4 female employees
Almost on quarter of employees from surveyed organisations were female

£1.1bn R&D expenditure
Total expenditure on R&D in 2022/23

Investment
£481m total invested into UK-based space organisations in 2022/23

UKI-FNI

UK-India Future Networks Initiative

Engineering and Physical Sciences Research Council

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https://www.ukifni.org/

University of East Anglia

University of Surrey

University of Southampton

UCL

King's College London

Indian Institute of Science

BT

IIT Delhi
Indian Institute of Technology Delhi

UKI-FNI

UK-India Future Networks Initiative

UKRI Engineering and Physical Sciences Research Council

UKI-FNI Management Board

UK Core Team:

- Prof Gerard Parr- University of East Anglia, Norwich
- Prof Rahim Tafazolli- Director of 6G Innovation Centre University of Surrey
- Prof Lajos Hanzo- Professor of Communications- University of Southampton
- Professor Steve Hailes- Chair of Wireless Systems, University College London
- Prof Toktam Mahmoodi- Chair of Wireless Systems- Kings College London

India Collaborators:

- Prof Rajesh Sundaresan- Dean of the Division of EECS- IISc Bangalore
- Prof Subrat Kar-Bharti School of Telecommunication Technology and Management- IIT Delhi
- Prof Brejesh Lall, IIT Delhi
- Dr Pamela Kumar, Chief Strategy Advisor (Telecom & Data)- IISc Bangalore

Further Indian & UK Companies in discussions.

UEA University of East Anglia

University of Surrey

Indian Institute of Science

King's College London

IIT Delhi Indian Institute of Technology Delhi

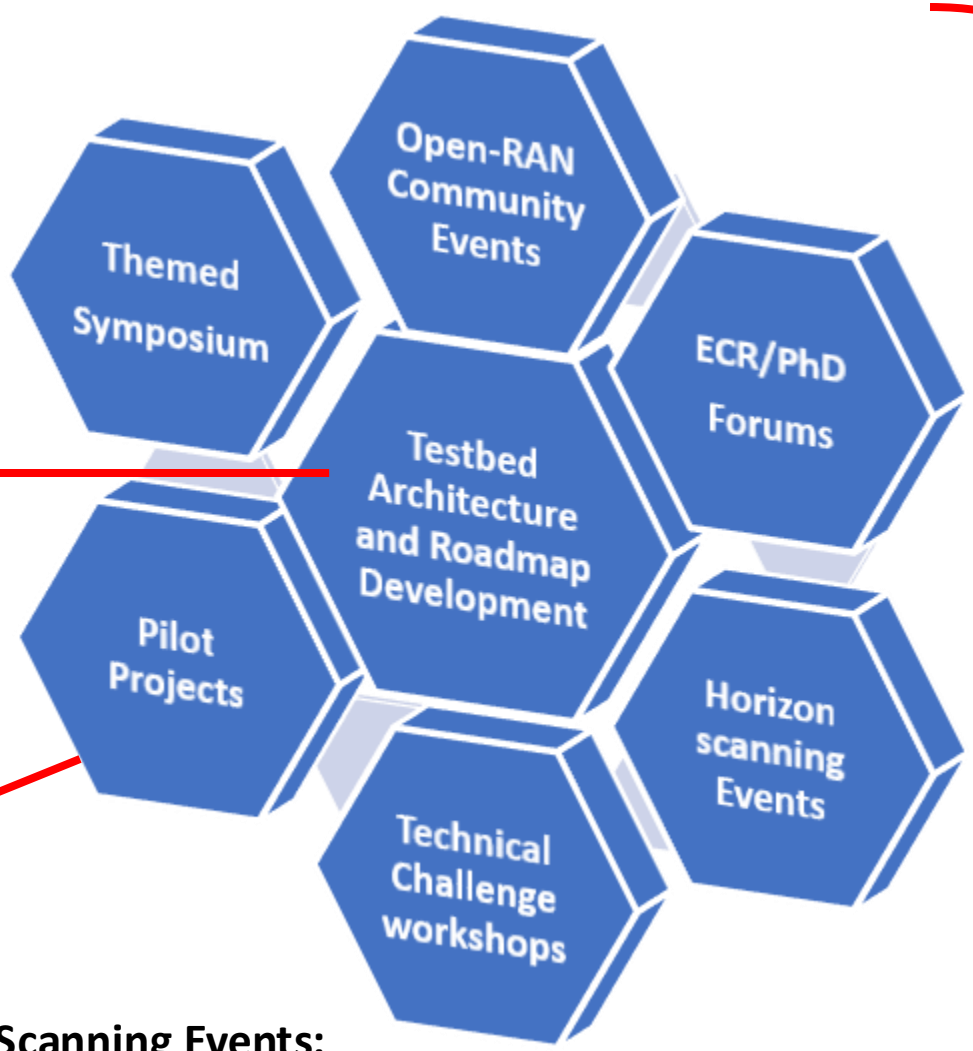
UCL

University of Southampton

UKI-FNI Programme of Activities

Leverging the 6GIC (Surrey)- IISc Bangalore Joint OpenRAN Testbed Pilot

Visiting Researchers



Promoting Diversity in the Skills Pipeline

Legal

Regulatory

Suggested topics for Technical Challenge and Horizon Scanning Events:

Testbed Arch Design	**6G Open RAN**	**5G Open Core**	**MEC computing design**	**Network Automation and dynamic slice management**	**Short-range sensing network Communication and sensing**
Security and privacy	Equipment procurement/deployment/testing	Reconfigurable Intelligent Surfaces (RIS)	Designs of Large Scale tests and optimisation		

UKI-FNI
UK-India Future Networks Initiative

Research & Innovation
Areas of Interest across UKI-FNI Project

Security Resilience of Interfaces and components For NTNs	Maintaining SLAs across TN- NTN Boundaries	Interoperability of Open-RAN components from different vendors	Supporting Competitiveness in the marketplace for new services	TN-NTN Services Deployment costs (green field v brown field)
Scalability & Performance under large-scale use-cases	Systems and Component Energy Efficiency	UK-India Testbeds for research experiments and industry benchmarking	Impact on business models	PoC/MVP Commercialisation Opportunities
Tools and Methods to Monitor Resilience of UK-India Sub-Sea Telecoms Cables	Intelligent Network Management and Real-time Resource Allocation	**Promoting the Telecoms Skills Pipeline**	Patents, IP and Technical Standards contributions	Systems integration with legacy systems

Research & Innovation (TRL1-4)

Skills Pipeline (all TRLs)

Commercialisation and Standards(TRL 5-9)

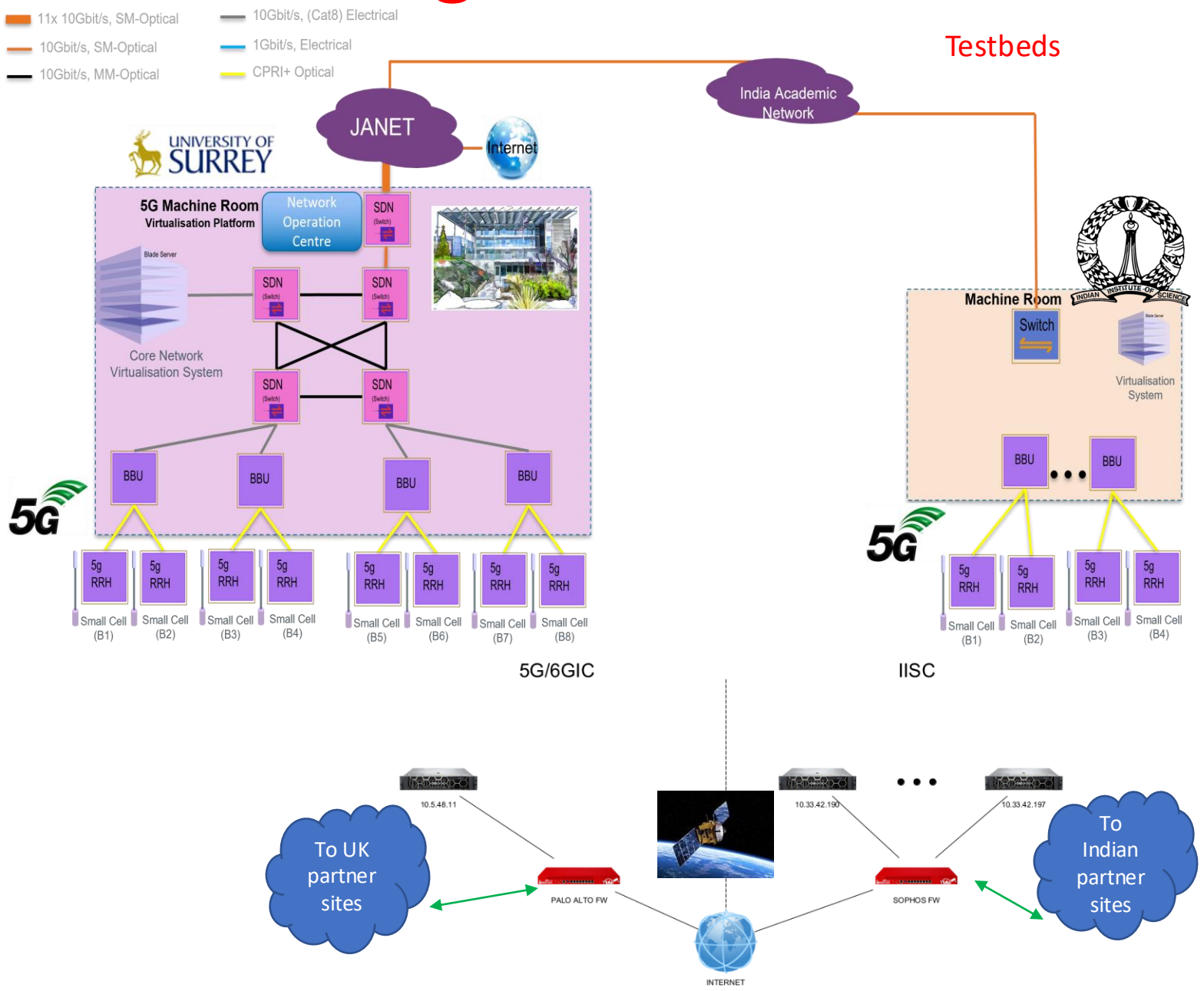
UK-India Testbed- 6GIC- IISc Bangalore

The current UKI-FNI project has designed and deployed an initial early stage UK-India Testbed to support the design, deployment and operation of initial field trials of new Open-RAN systems, management software and components in diverse regulatory regimes.

The testbed connecting India and UK to support the development advanced layer 1-4 algorithms and test innovative solutions in hardware, software and protocols that will support the future integration of high-speed mobile systems with metro and core optical and satellite communications networks.

This testbed will enable researchers to test the performance of new emerging Open RAN technology and beyond applications based on latency, bandwidth, quality of experience, signalling and various traffic, safeguard policy and national security interests.

It will give researchers, the ability to test and give initial verification/validation insights into new algorithms and hardware before they are piloted in live commercial networks.



ICS
Home of 5/6GIC

Rahim Tafazolli CBE,
Regius Professor
FREng, FIEEE,FIET,FCIC
Fellow WWRF,
Fellow AIAA

5»6G INNOVATION CENTRE
UNIVERSITY OF SURREY

Approach to 6G (Professor Rahim Tafazolli- Surrey)

Physical & Digital Worlds

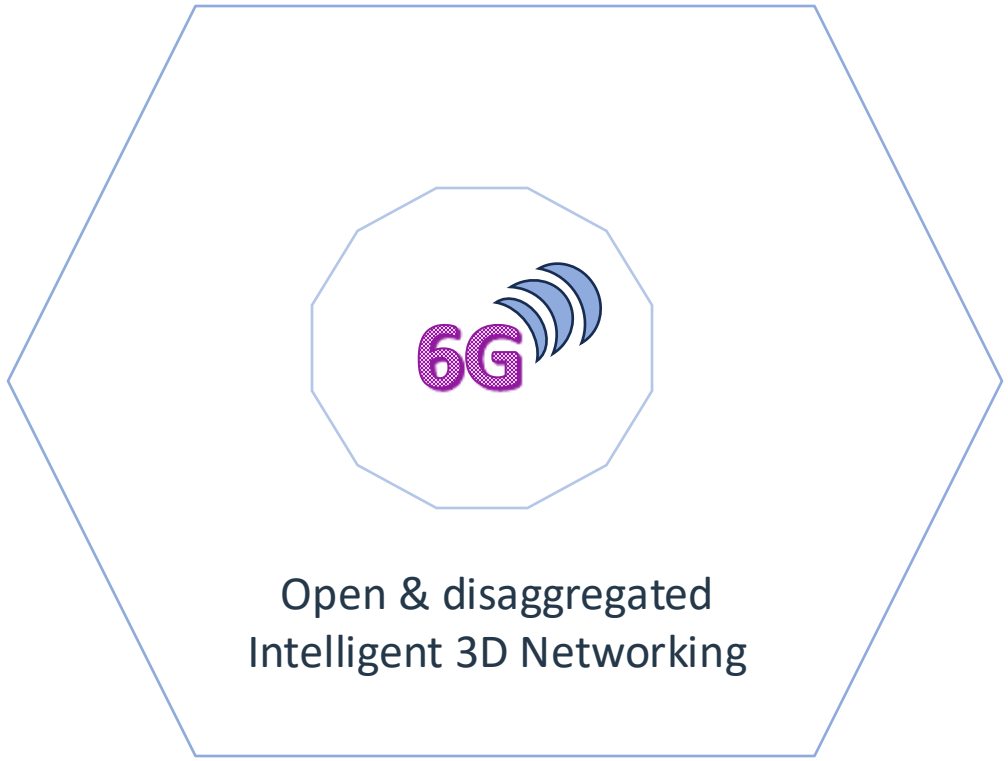
- New Services, (interactivity between the two worlds)
- Synchronisation
- Sub-cm Positioning
- XR
- Edge Computing

Intelligence & Communications

- Cost reduction
- Auto-Management
- New Services

Sensing & Communications

- Ambient intelligence (User, Objects, Network)
- Positioning
- ..



Space & Terrestrial

- Universal Connectivity
- Digital Inclusion
- Energy Efficiency
- Sat Direct to HH, D2D

Fixed & Mobile

- Indoor
- Outdoor
- RIS
- Energy Efficiency

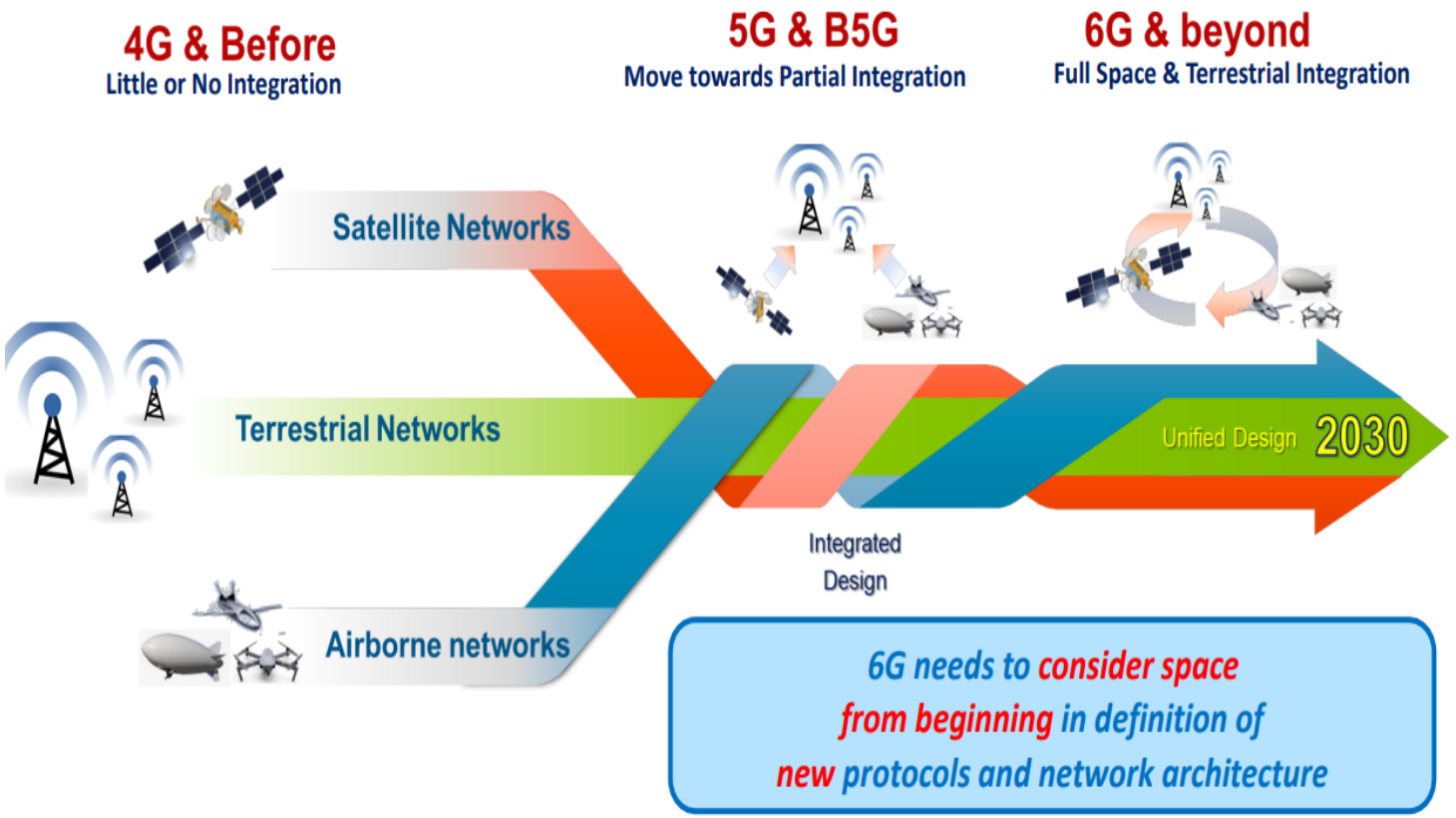
IT & Telecom

- Virtualisation
- Cloud
- Cost effective upgrades/Reconfiguration

NTN TIME SCALES: 5G → 5G+ → 6G

5G 6G INNOVATION CENTRE
UNIVERSITY OF SURREY

In-line with 3GPPP Standards timescales From Release 17 to Release 20 ,…….



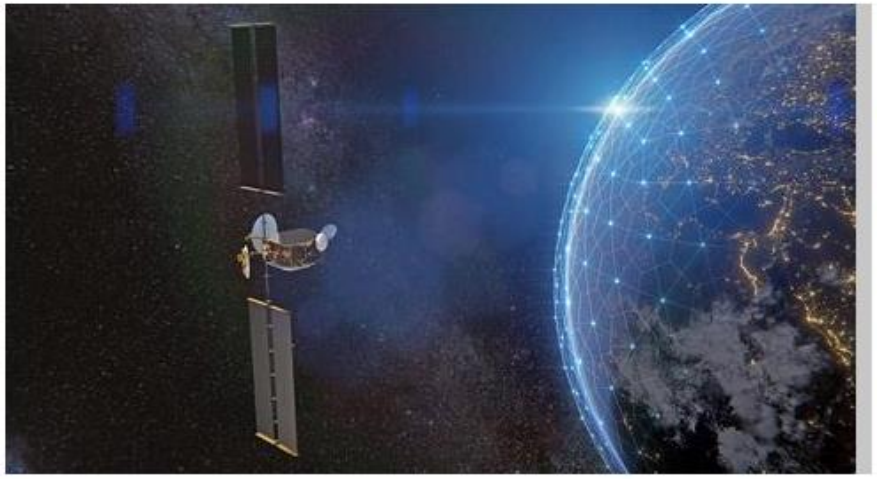
- 3GPP NTN standards Rel17/18
  NR-NTN and NB-IoT-NTN
- Ecosystem developing with chip manufacturers.
- Several new IoT satellite constellations emerging
- Rel 19 studies with processing satellites

5G – interworking
5G+ --Integration
6G-- Unified

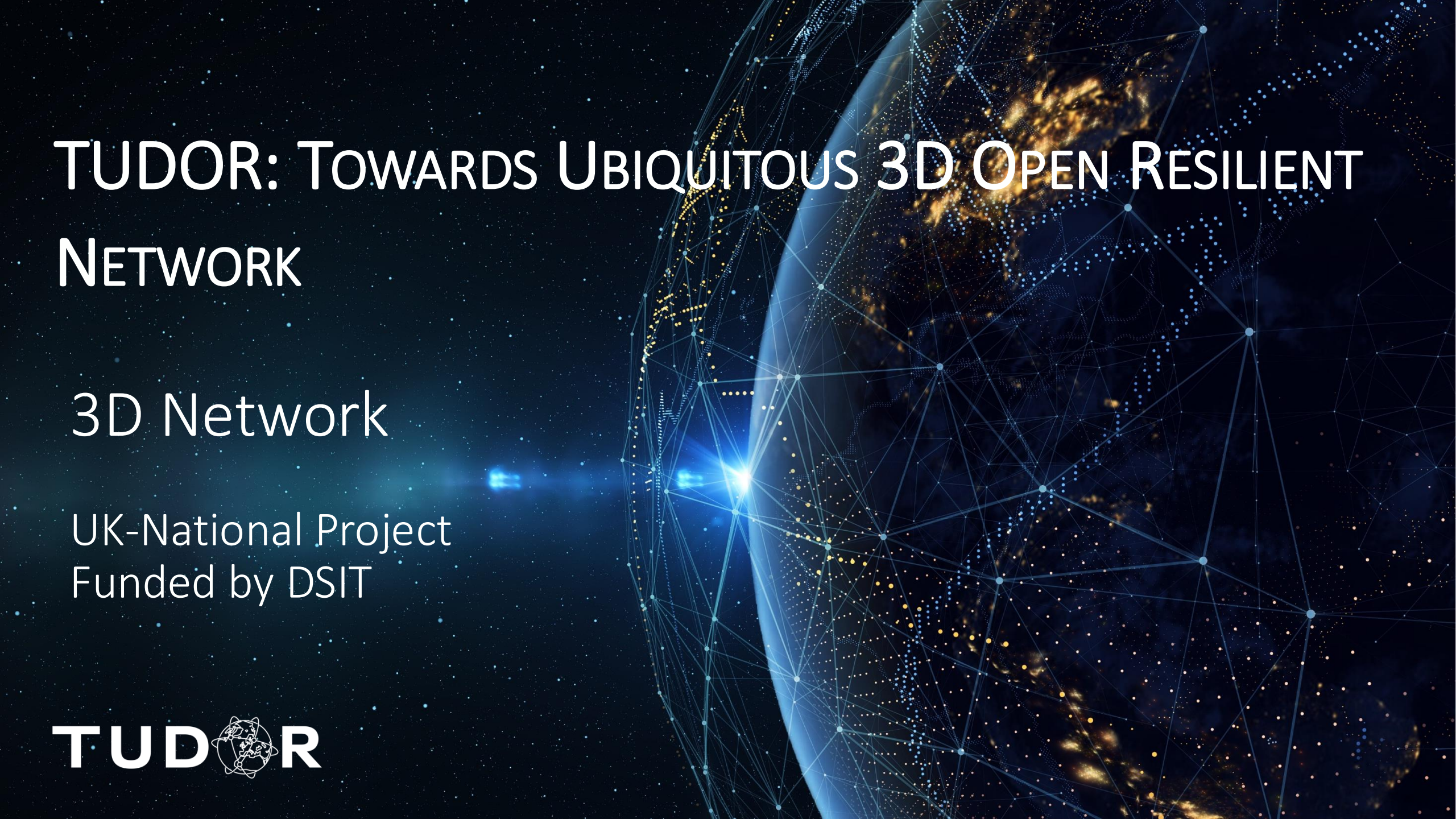
CURRENT AND UPCOMING SATELLITES

- **GEO/MEO satellites: up to 0.5Tb/s**
  DSP transponders/Beam shaping/ muti-spot beams

- **LEO constellations Operational**
  - Starlink: 8800+ satellites, **Direct-to-User Terminal (D2UT)** model, 1900 Gen2 satellites
  - Eutelsat OneWeb: 650 satellites
  - GlobalStar: 24 Satellites, emergency& iMessages,



- **LEO constellations upcoming**
  - Kuiper: 3,236 satellites, D2UT model
  - Telesat: 198 satellites, B2B model
  - Rivada: 600 satellites, **User Terminal-** UT2UT
  - AST SpaceMobile: 6 Satellites (launched), D2UT
  - Iridium(66) , Lynk(5) , Omnispace(2), Skylo(virtual),..(SMS, Voice, IoT)



TUDOR: Towards Ubiquitous 3D Open Resilient Network

3D Network

UK-National Project
Funded by DSIT

TUDOR

CONSORTIUM

TUDOR

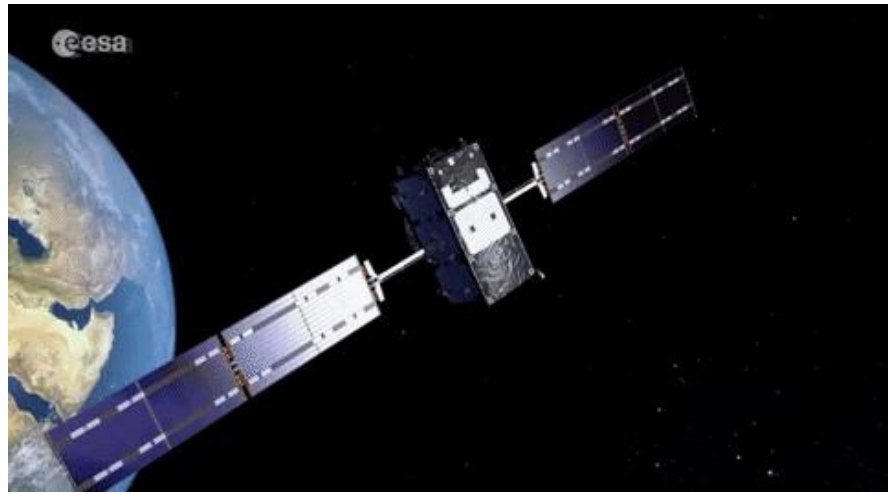
5G INNOVATION CENTRE
UNIVERSITY OF SURREY

BRINGING TOGETHER 25 WORLD-LEADING ORGANISATION FROM UK UNIVERSITIES, INNOVATIVE EQUIPMENT VENDORS, MAJOR NETWORK OPERATORS AND SYSTEM INTEGRATORS FROM BOTH SPACE AND TERRESTRIAL SECTORS

LINO-6G project-ESA (Germany –UK)

6G satellite precursor - STERLING in-orbit laboratory

- A 16U CUBESAT WITH FLEXIBLE ON- BOARD PROCESSING IS BEING DESIGNED AND DUE FOR LAUNCH Q1/2 2026
- KA BAND GATEWAY IN ERLANGEN AND S BAND TERMINALS IN ERLANGEN AND AT SURREY
- POSSIBLE ADDITIONAL UK GATEWAY AT HARWELL TO BE ADDED.
- PAYLOAD CAN BE OPERATED BENT PIPE OR REGENERATIVE PROCESSING
- INITIAL TESTS ON NTN-NR END-TO END AND WITH ON-BOARD GNB
- HANDOVER BETWEEN SATELLITE AND TERRESTRIAL PLANNED
- ADDITIONAL TESTING OF INTERFERENCE MITIGATION.
- AFTER INITIAL TESTING THE SATELLITE WILL BE MADE AVAILABLE TO OTHER EXPERIMENTERS



- See- https://connectivity.esa.int/projects/6g-lino

SOME KEY CHALLENGES FOR NTN IN D2D IN 3D 6G NETWORK

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- Flexible air interface to allow Unified NTN and TN.
- Full Duplex Radio with RIS for self-interference cancellation
- High mobility NTN within 6G Unified architecture, traffic steering , avoiding signalling storms
- Optimum placement of Network functions in space and ground for seamless mobility between the NTN & TN (Cellular, WiFi)
- Autonomous Networking (AN): AI/ML in satellites for (Radio, Net Slicing, Net Management, security)
- Managing Interference and spectrum sharing: NTN-TN (Cellular, WiFi) and between LEO constellations
- Optical Inter-satellite Links (OISL), agile Beamforming Network (BFN), multibeam and tracking antenna (ground station, vehicle, satellite and UE)
- SPACE MIMO, Detection algorithms, Phase array Antenna, Time/Frequency synchronisation
- Integrated payload for PNT, Sensing and communication , Wireless Time/Frequency Transmission
- Design new constellation for Direct to HH & PNT
- Sat for UAV/HAPS control Beyond LoS

CDT-FORT

Future Open SecuRe NeTworks (FORT)

Regius Prof Rahim Tafazolli, CBE
FREng, FIEEE, FIET

5G INNOVATION CENTRE
UNIVERSITY OF SURREY

CDT FORT

QUEEN'S UNIVERSITY BELFAST

CSIT CENTRE FOR SECURE INFORMATION TECHNOLOGIES

Surrey Centre for Cyber Security SCCS

Funded by UKRI Engineering and Physical Sciences Research Council

Funded by UKRI Engineering and Physical Sciences Research Council

Industry Partners

Complete Eco-system

aws

AMPLIPHAE

ANGOKA

AWTG

BAE SYSTEMS

BT

Codasip

VIAVI Solutions

Hewlett Packard Enterprise

hp

intel

interdigital

KEYSIGHT

kyndryl

NPL

NVIDIA

OneWeb

THALES

ROLLS ROYCE

CATAPULT Satellite Applications

Virgin media O2

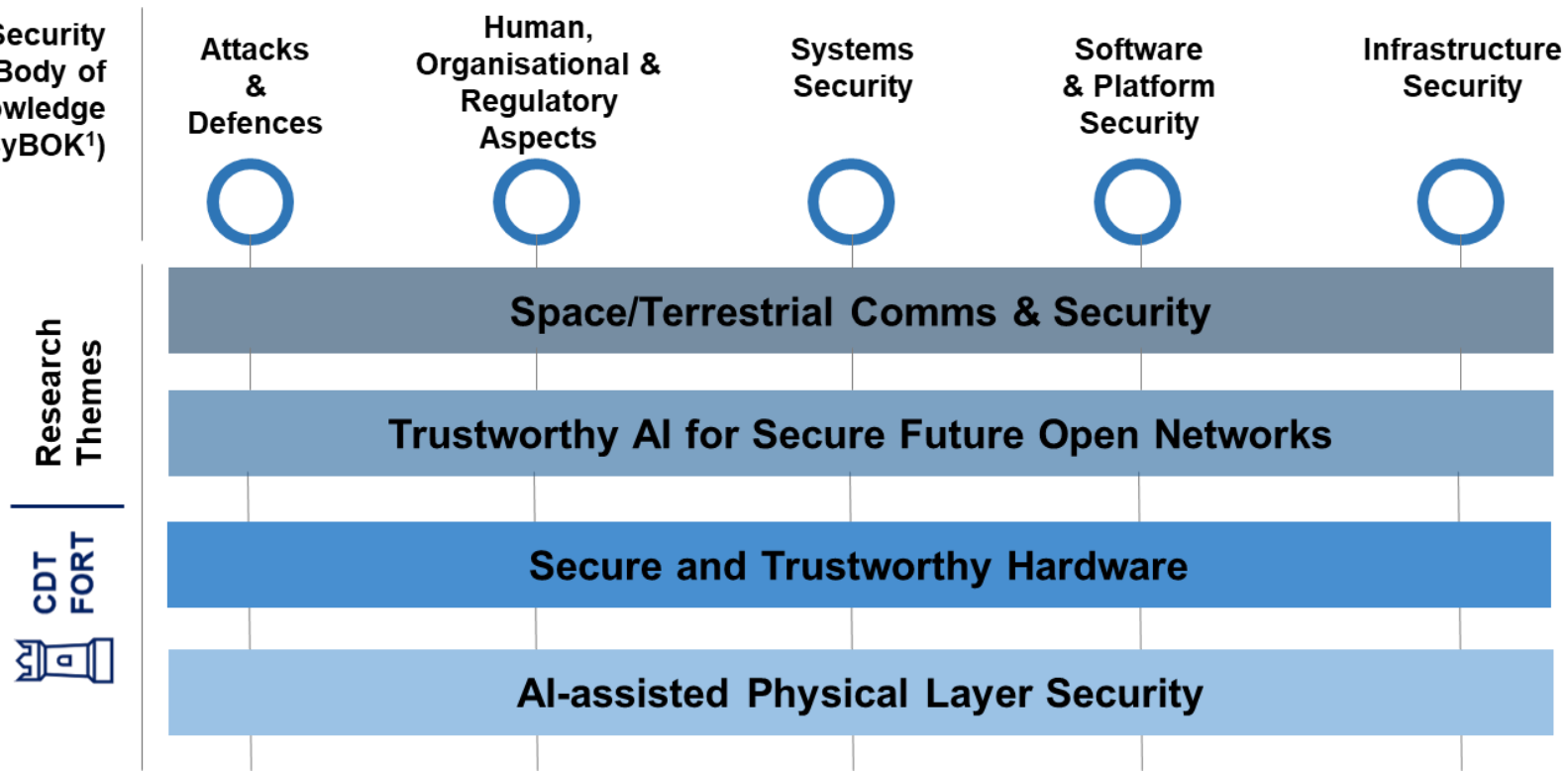
esa

5G INNOVATION CENTRE, UNIVERSITY OF SURREY | CDT FORT | QUEEN'S UNIVERSITY BELFAST | CSIT CENTRE FOR SECURE INFORMATION TECHNOLOGIES | SCCS

Funded by UKRI Engineering and Physical Sciences Research Council

TECHNICAL PROGRAMME

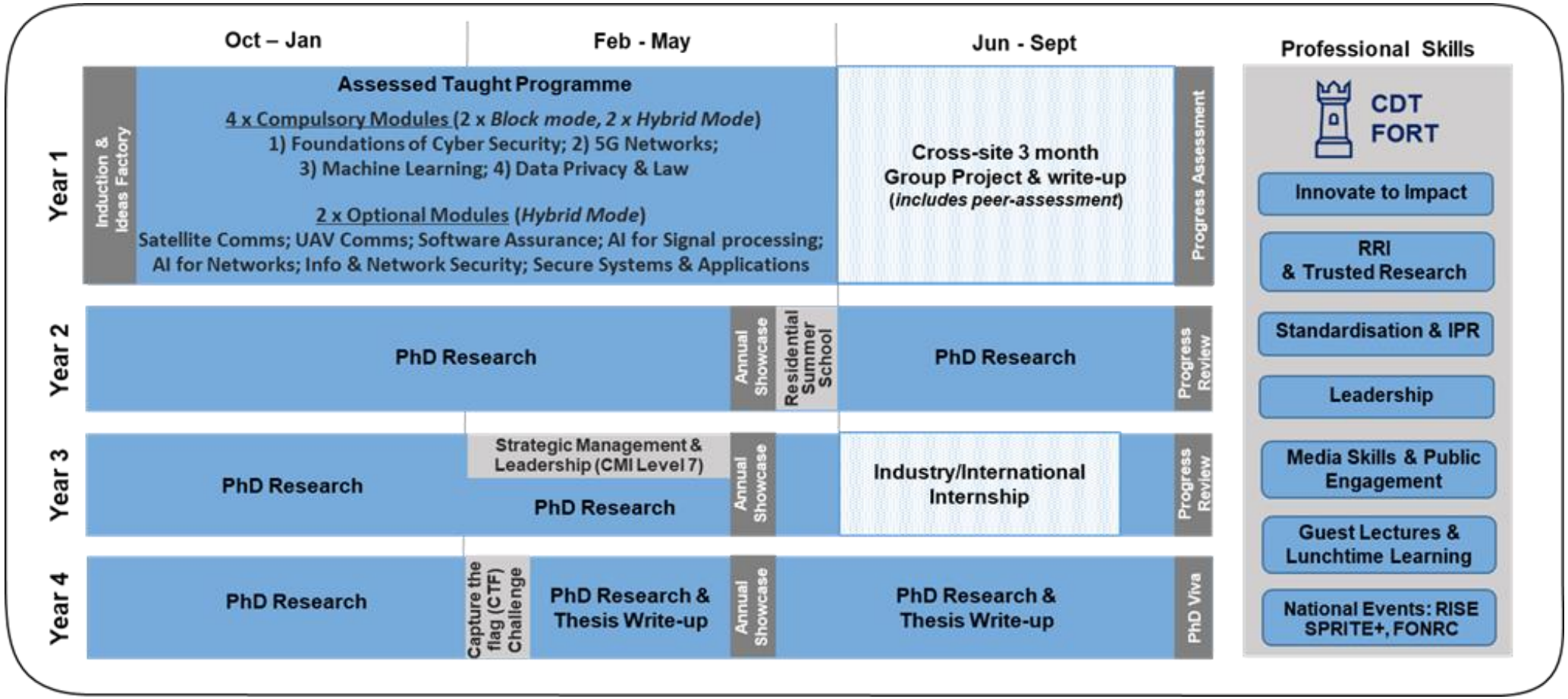
RESEARCH AND TRAINING



Open 3D Network: Terrestrial and Non-Terrestrial Integrated wireless System

Funded by UKRI Engineering and Physical Sciences Research Council

Professional Skills



UNIVERSITY OF CAMBRIDGE

IMPERIAL

UNIVERSITY OF OXFORD

University of BRISTOL

TITAN
NETWORK OF NETWORKS HUB
PLATFORM DRIVING THE ULTIMATE CONNECTIVITY

Led by
Prof Harald Haas

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

CHEDDAR
Communications Hub for Empowering Distributed clouD computing Applications and Research

Led by
Prof Julie McCann

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

HASC
HUB IN ALL-SPECTRUM CONNECTIVITY

Led by
Professor Dominic O'Brien

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

JOINER
An experimentation platform for future connectivity.

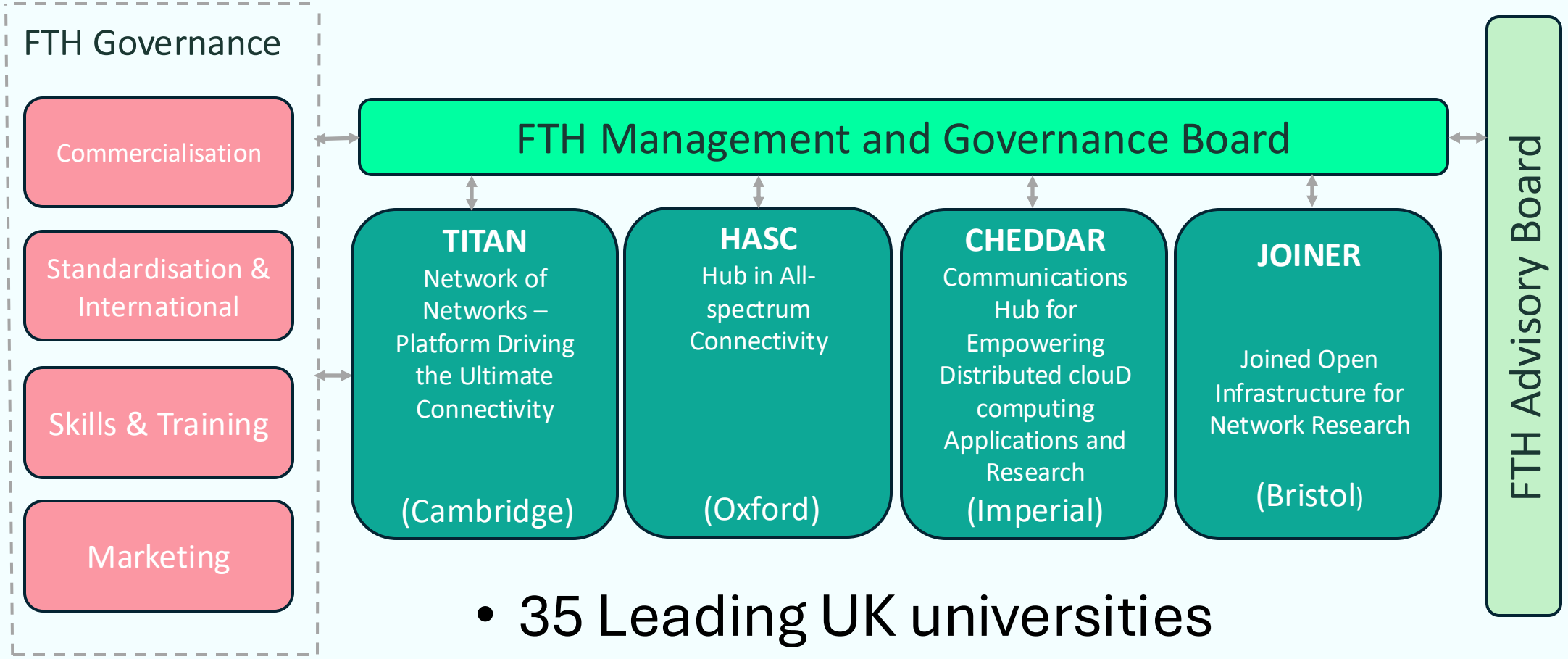
Led by
Prof Dimitra Simeonidou

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

Federated Telecoms Hubs (FTH)

Federated Telecoms Hubs

Federated Telecoms Hubs Structure



- 35 Leading UK universities
- FTH: Research + Translation

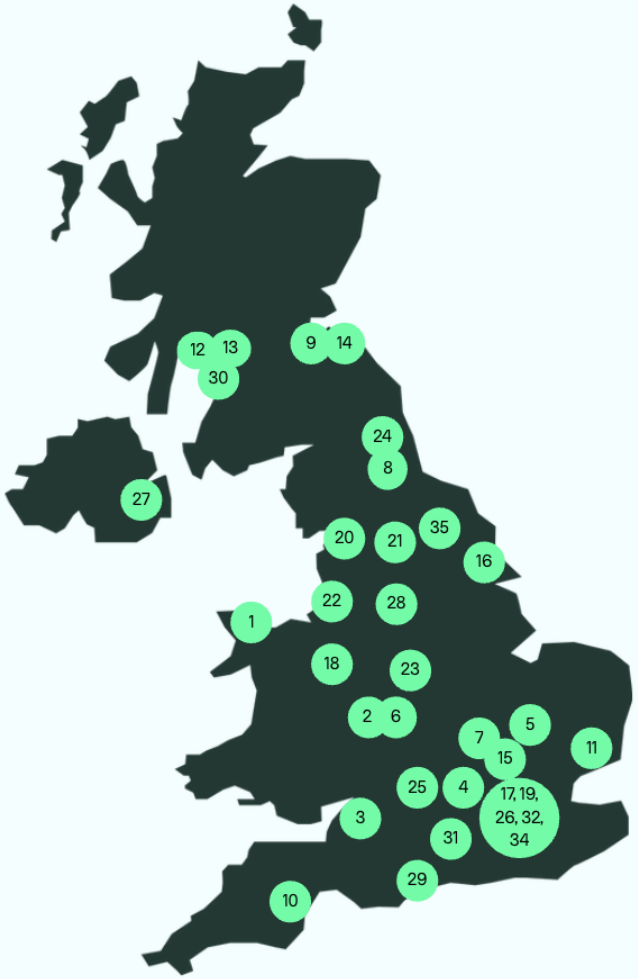
Federated Telecoms Hubs

Engineering and Physical Sciences Research Council

Department for Science, Innovation & Technology

One of Europe's Largest Research Consortia

1	Bangor University
2	Birmingham City University
3	University of Bristol
4	Brunel University
5	University of Cambridge
6	Coventry University
7	Cranfield University
8	Durham University
9	The University of Edinburgh
10	University of Exeter
11	University of Essex
12	The University of Glasgow
13	Glasgow Caledonian University
14	Heriot-Watt University
15	University of Hertfordshire
16	University of Hull
17	Imperial College London



18	Keele University
19	Kings College London
20	Lancaster University
21	University of Leeds
22	University of Liverpool
23	Loughborough University
24	Northumbria University
25	University of Oxford
26	Queen Mary University of London
27	Queen's University Belfast
28	University of Sheffield
29	University of Southampton
30	University of Strathclyde
31	Surrey University
32	UCL
33	University of Warwick
34	University of West London
35	University of York

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UK-India Future Networks Initiative

Future Telecoms Roadmap (Edition #1)

Our UKI-FNI Project has generated a First Edition of a Future Telecoms Roadmap Report.

It is provided as a Full Report for download or as a web-based flip-book for ease of navigation.

Access is available on request to https://www.ukifni.org/roadmap-request/

In this full report, we will be examining the evolving 5G/6G landscape and the integration of Terrestrial and Non-Terrestrial Telecoms systems through three specific vectors:

•The Global Standards Developing Organisations (SDOs) that help to regulate and formalise this space.

•Country-specific and international developments within 5G and 6G.

•Trends, developments, and new technologies as seen through academic journaling and research work.

It is a living document which will be added to periodically to reflect new and emerging trends in Future Telecoms Globally.

We welcome contributions to the next edition

Report Cover

Executive Summary

Introduction

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 7

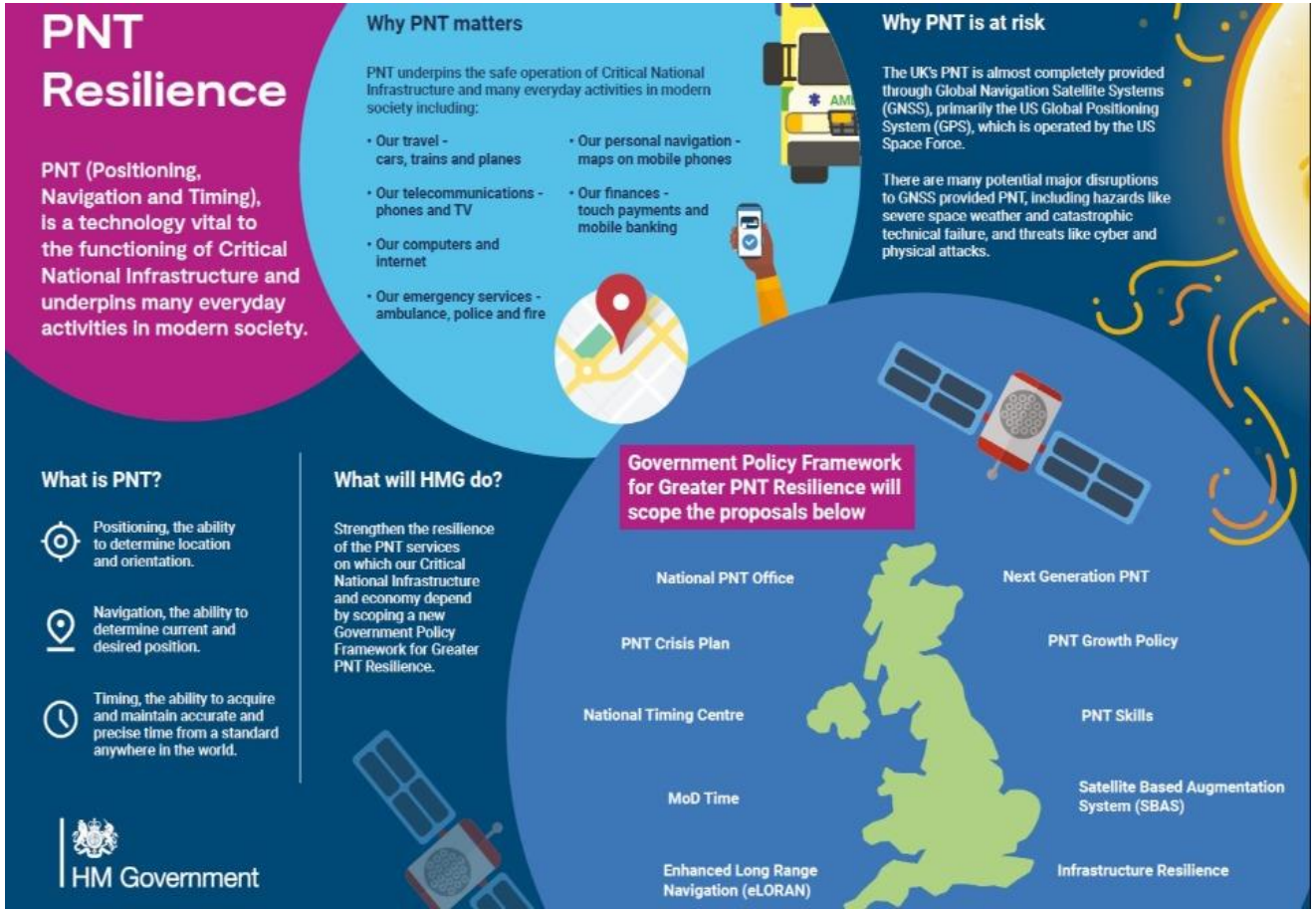
Chapter 8

Chapter 9

SPACE EAST

https://spaceeast.co.uk/

Call for Expressions of Interest



Ref- https://www.gov.uk/guidance/positioning-navigation-and-timing-overview

Our UKI-FNI Team is considering organising a Joint UK-India Symposium with ESA in Harwell (June 2026) on the theme of:-

"***Enabling Terrestrial & Non- Terrestrial Networks Resilience in Support of PNT Services***".

Example Topic Areas to consider:-

- GPS-Free Networks
- Clock Management and Recovery across Fixed & Free-space Boundaries
- Clock Data Security
- Space 6G Communications for TN-NTN Services
- Use Cases from Transport, FinTech, Energy and Telecoms on Clock Loss Mitigation

If you are interested to speak or participate then get in contact- email me at g.parr@uea.ac.uk

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Thank you for your attention

For further details on the UKI-FNI Project or to explore collaboration opportunities, please contact me at:-

g.parr@uea.ac.uk

Project web-site - https://www.ukifni.org/

For further details of University of Surrey 6G Innovation Centre please contact:

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For further details on Federated Hubs:

Professor Harald Hass- University of Cambridge

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