

SCOTTISH FUTURES TRUST

Infrastructure-free
High-Speed Digital Connectivity
On Railways



Photo credit and permission: Norman McNab

The Need:

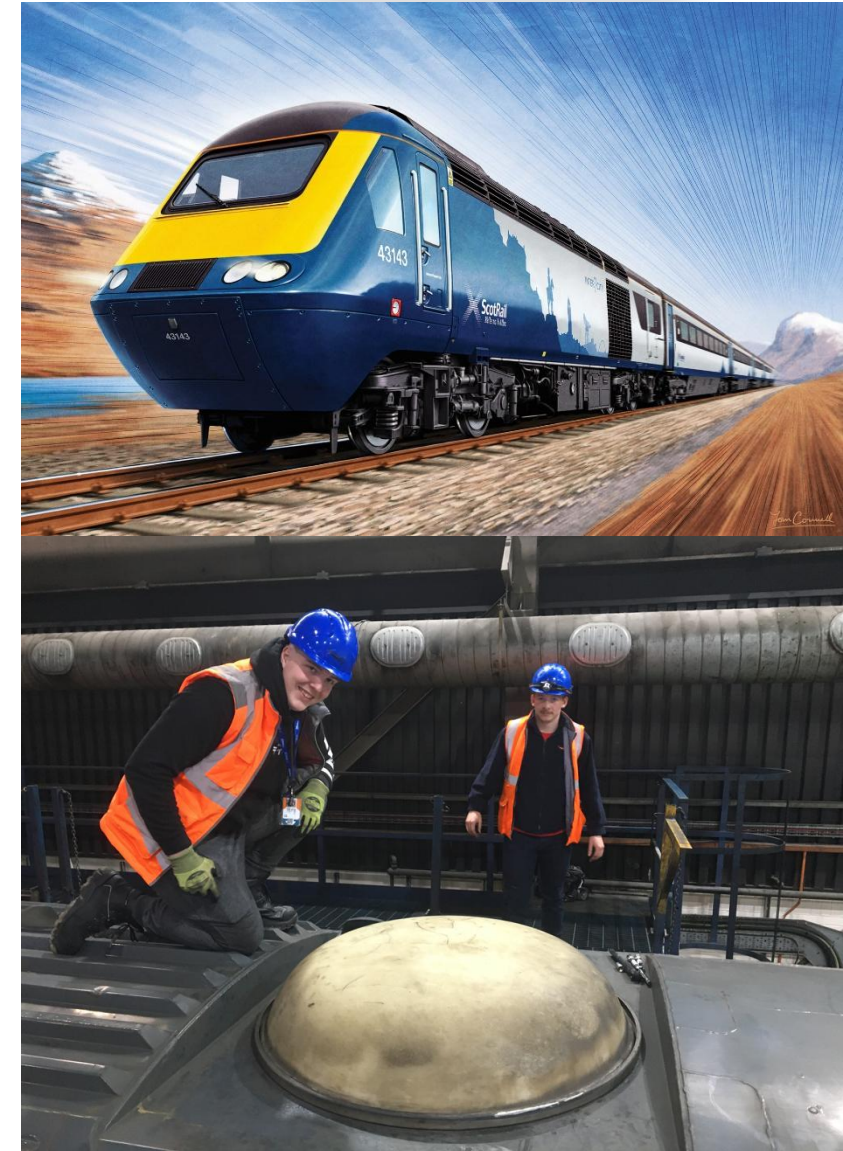
Reliable, Secure, High-Speed Digital Connectivity Provides:

➤ Improved Passenger Experience:

- Overall Higher Comfort and Attractiveness
- Productive Travel Time / Agile Working
- Live-Streamed Entertainment or Keeping Socially Connected
- Improved Passenger Information Services.
- Encourages Safer, Greener, Healthier Travel

➤ Connectivity for Railway Operational Uses:

- Connectivity for Staff (Voice & Data)
- In-Cab Signalling and Train Control
- GPS Tracking of Trains In Operation.
- Live Video Surveillance Access
- Fraud-resistant Revenue Systems for Tickets And Hospitality
- Train Telemetry & IoT (Diagnostics, Toilets, Passenger Counting, °C, ...)



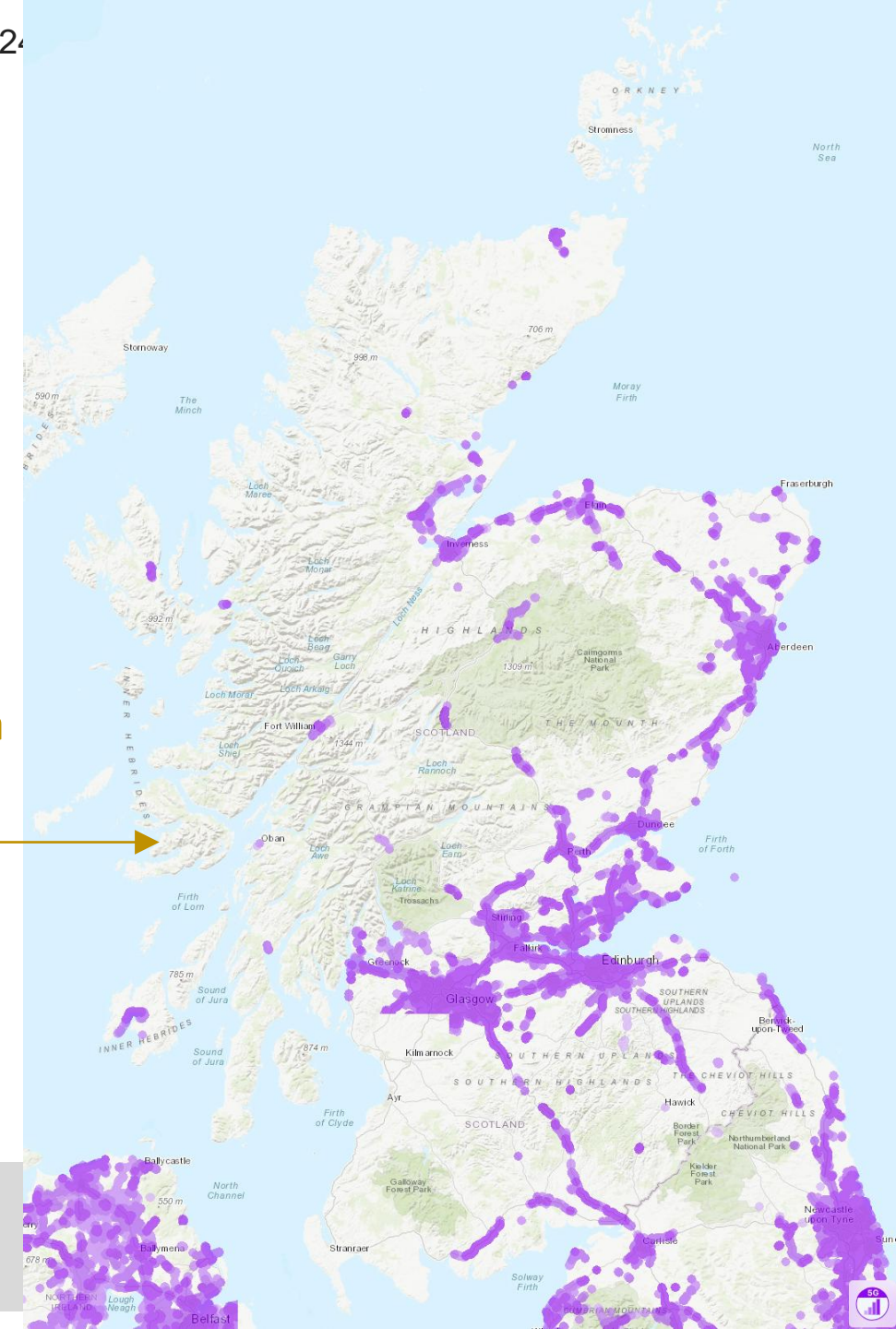
The Problem(s):

Obtaining reliable, secure digital connectivity in the railway corridor is challenging because:

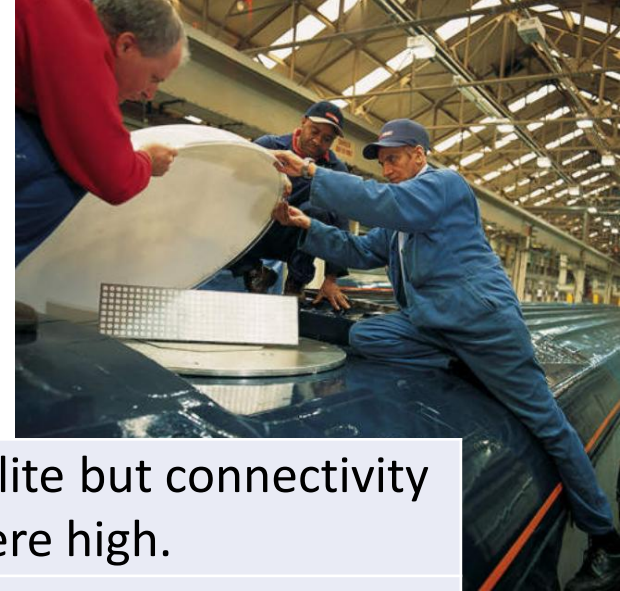
- **RURAL** – Coverage spotty and 4G capacity is lower.
- **TOPOGRAPHY** – Railways take the low road (plus frequent obstructions, deep cuttings, tunnels)
- **USER DENSITY** – Overwhelms limited capacity 4G networks
- **NOT COMMERICALLY VIABLE** – High-capacity C-Band 5G has a shorter range; extra infrastructure not viable in rural areas
- **FAST SPEEDS** – with frequent handovers cause problems
- **PENETRATION** – Train carriage designs block radio
- **COST** – better coverage = higher data costs. Oops! ☹️



Required Additional Trackside Infrastructure
Is not Commercially Viable



The Recent Past:

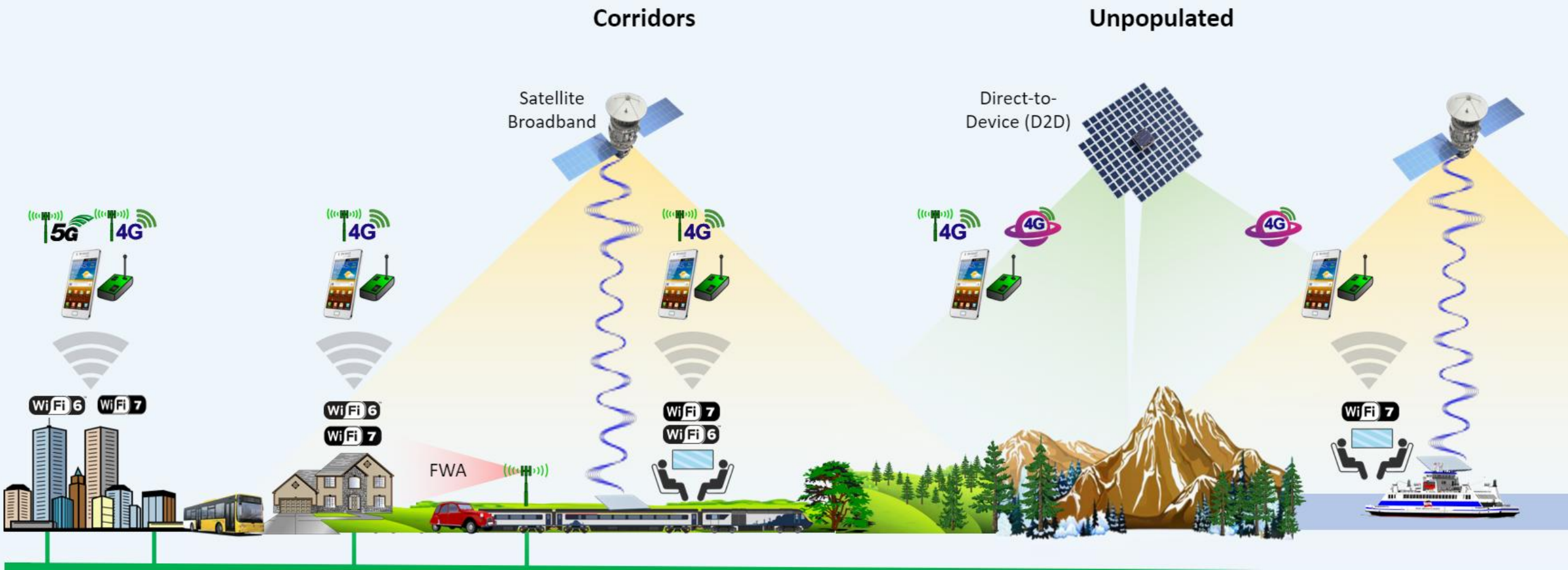


- 2004 – GNER install Wi-Fi with connectivity via 3G and geostationary (GEO) satellite but connectivity was limited by the high latitude, with slow throughput, and data costs were high.
- 2012 – ScotRail install free customer Wi-Fi based on 3G onto E&G Class 170s.
- 2013 – Fit out on other ScotRail fleets begins, and 4G is introduced.
- 2015 – Scotrail Abellio Franchise commits to fitment of Wi-Fi on all trains.
- 2016 – Project Swift delivers trackside infrastructure and ‘okay’ connectivity over a 10 mile stretch of the E&G, but capital and expected maintenance costs shown to be high.
- 2018 – 3G/4G fit out of all ScotRail fleets is completed.
- 2018 – ScotRail move to procure private LTE network on the E&G and Dunblane/Alloa routes, but use of Network Rail masts is not authorised, costs are high & project stalls.
- 2019 – FirstGroup/Evo and Blu Wireless partner on mmWave 5G Wi-Fi on SW Trains.
- 2019 – Panasonic select Radwin FiberinMotion train-to-ground wireless for new Merseyrail trains.
- 2021 – Cellnex UK awarded 25-year Network Rail contract for connectivity on Brighton Mainline
- 2023 – Low-earth orbit Connectivity Being Investigated by both LNER and ScotRail, and CGI/NYMR

Connectivity "Tool Bag"



In-Building Urban Built-Up Transport Corridors Rural Remote Unpopulated At Sea



Optical Fibre Density

Public and Private Networks

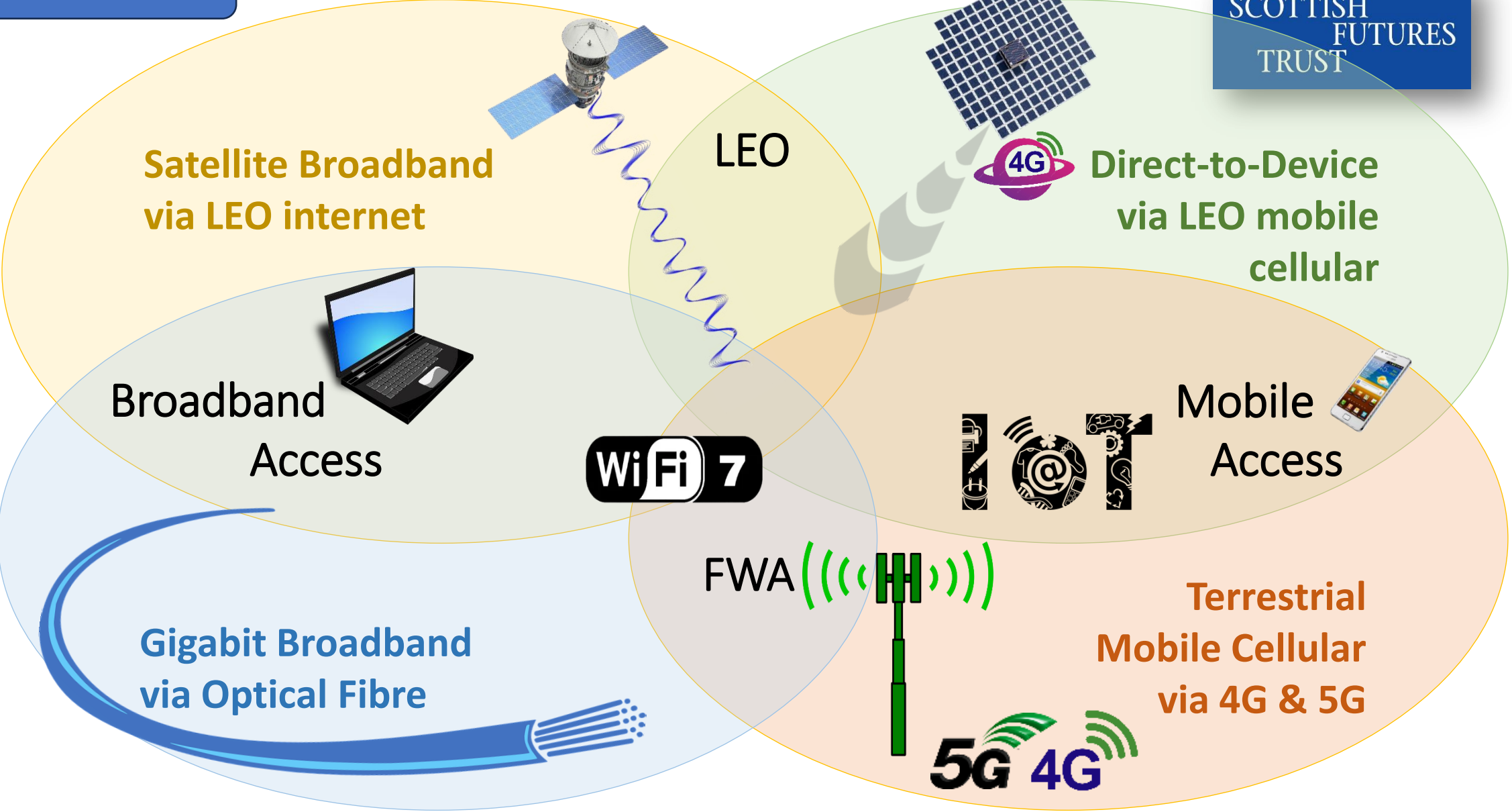


Connectivity "Tool Bag"



Space

Terrestrial



Satellite Broadband via LEO internet

LEO

Direct-to-Device via LEO mobile cellular

Broadband Access

Mobile Access

WiFi 7

IoT

FWA

Terrestrial Mobile Cellular via 4G & 5G

Gigabit Broadband via Optical Fibre

5G 4G

Fixed Technology

Mobile Technology

A Promising Solution:

High-Speed Broadband from LEO Space

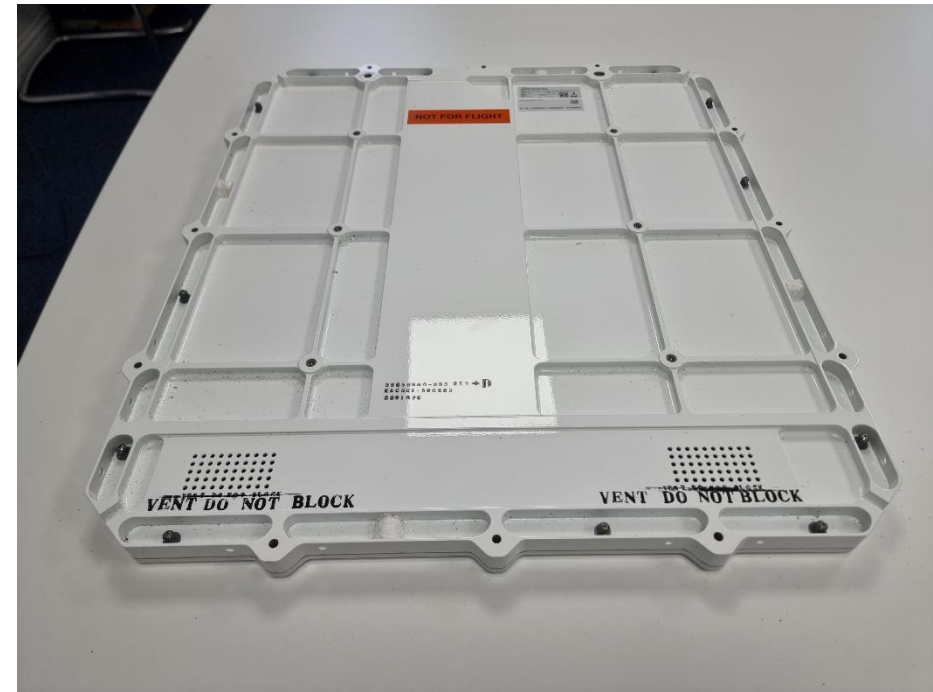
- Up to 500 Megabits/s on the move.
- Uses electronically-steered flat panel antennas.
- No trackside infrastructure required, except in tunnels
- Good fit for providing connectivity to rural transport
- Can interface with existing on-board Wi-Fi systems and to improve or replace cellular connectivity.
- Is likely to be a component in FRMCS



Standard High-Performance Terminal



Roof-Integral High-Performance Terminal (IP67 + EN 50155)



A Promising Solution:

**OUT
NOW!**

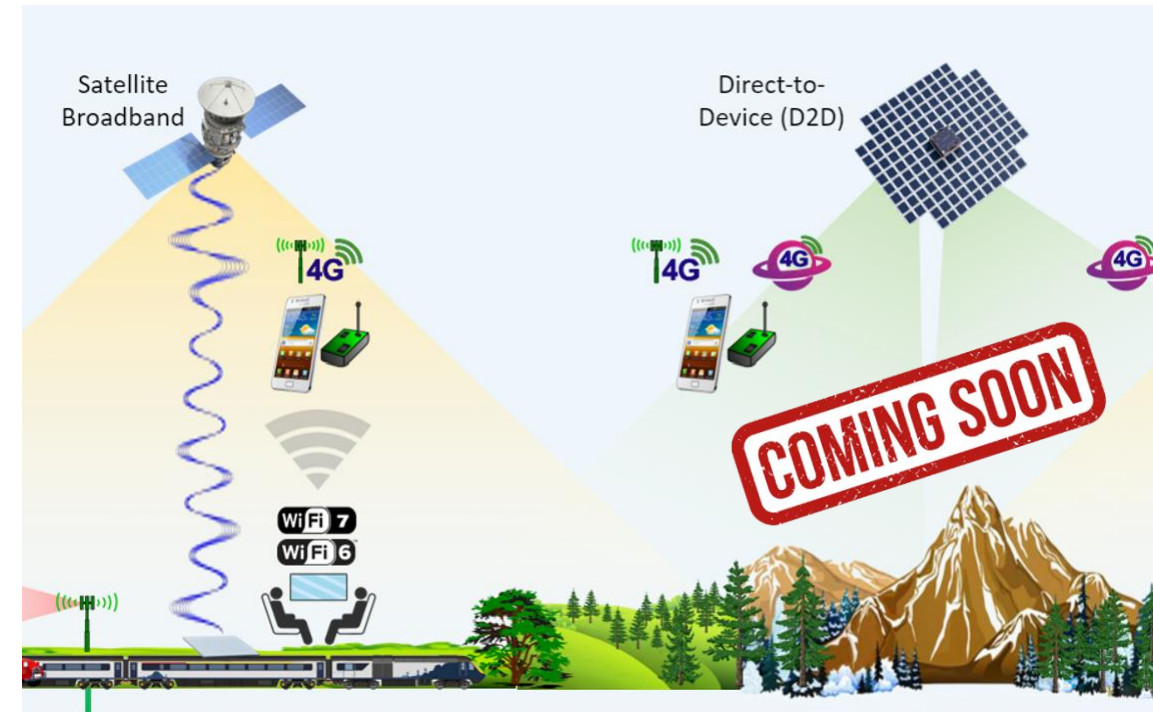
Broadband Connectivity from Low-Earth Orbit Space

- Circumvents trackside infrastructure issues, such as availability of fibre, power and structures.
- Only the train needs fitted, rather than requiring both train and trackside infrastructure.
- Potentially represents the only realistic, cost-effective way of connecting trains in rural areas.

In addition to LEO Broadband:

COMING SOON

- Direct-to-Device (D2D) is Complementary Technology Being Tested by several companies
- Enables standard 4G/5G connectivity directly from Cell Towers in Space
- Likely be available in a few years across the UK



Three Current UK Satellite Initiatives

LNER

- Testing due to begin in the coming weeks

Orkney Ferries

- Project started
- Trial due to begin in early summer

ScotRail

- Development work underway
- Anticipated service start late 2024

Funded by:

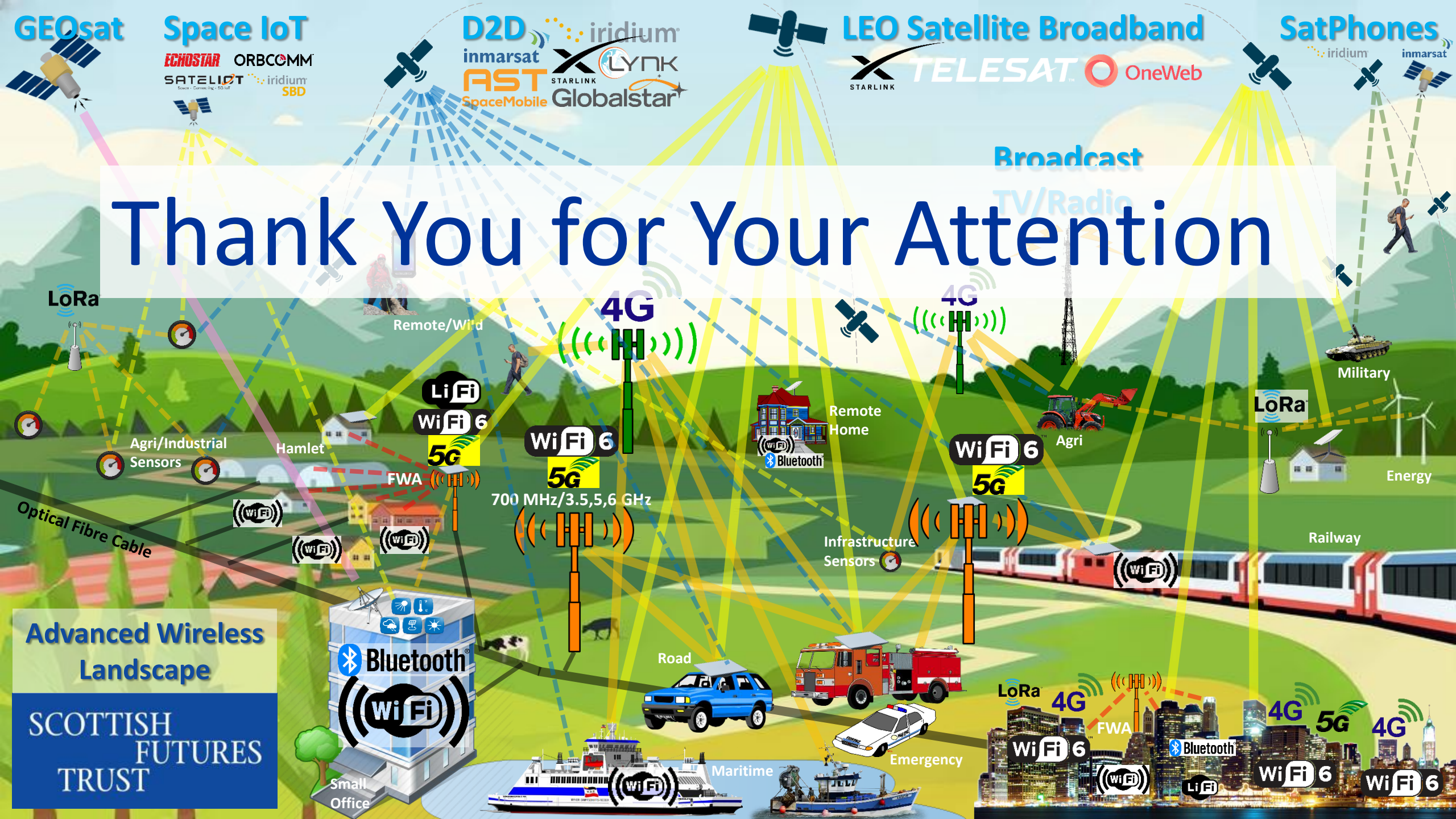


Partner:



Supported by:





Thank You for Your Attention

Advanced Wireless Landscape

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GEOsat
Space IoT
ECHO STAR ORBCOMM
SATELIOT iridium SBD

D2D
inmarsat
AST STARLINK
SpaceMobile Globalstar

LEO Satellite Broadband
STARLINK
TELESAT OneWeb

SatPhones
iridium inmarsat

LoRa

Remote/Wild

4G
(((H)))

4G
(((H)))

Agri/Industrial Sensors

Hamlet

LiFi
WiFi 6
5G

WiFi 6
5G
700 MHz/3.5, 5, 6 GHz

Remote Home

WiFi 6
5G

Agri

LoRa

Military

Energy

Optical Fibre Cable

FWA
WiFi

Infrastructure Sensors

Railway

Advanced Wireless Landscape

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Bluetooth
WiFi
Small Office

Road

Maritime

Emergency

LoRa
4G
WiFi 6
FWA

Bluetooth
WiFi 6
LiFi

4G
5G
4G
WiFi 6
WiFi 6