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Next-Gen Rail Connectivity: The Role of Starlink in Rail's Digital Transformation

Authorised Starlink Reseller
The Clarus Networks Group

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A BRIEF INTRO TO CLARUS

- Formed in 2014
- Business critical communications in some of the world's most challenging environments:
  - Low Earth Orbit Satellite Communications
  - Starlink & Oneweb
  - Private 5G Networks
  - Bonded LTE Solutions
  - Cellular Coverage Technology
- Clients across Government, Energy, Maritime, Construction, Manufacturing, Utilities & Healthcare
- One of just a handful of distributors across the world to provide both Starlink & Oneweb
- Only company working directly with Starlink on rail certifications of the New Tile

ABOUT STARLINK

- World's First and Largest Satellite Constellation:
  - Over 6000 Starlink satellites in low Earth orbit
  - Supports streaming, IoT, video calls, and more
- Advanced Technology and Experience:
  - Combines advanced satellites with user hardware
  - Extensive expertise in spacecraft and on-orbit operations
- Low Latency Advantage:
  - Traditional satellite internet uses single geostationary satellites (35,786 km orbit)
  - High latency (600+ ms) limits streaming, large downloads, IoT, video calls
- Starlink's Low Earth Orbit:
  - Constellation at ~550 km orbit
  - Provides global coverage with significantly lower latency (~20 ms - plan for reducing latency further)
  - Expected speeds of up to 220 Mbps download and increase with additional constellations

Locomotive Tile to Satellite

Ku Band
RX 10.7 – 12.7 GHz
TX 14.0 – 14.5 GHz

Satellite to Earth station / Gateway

Ka Band
Up / down 26.5 – 40.0 GHz

E Band
Down 71 – 76 GHz
Up 81 – 86 GHz

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As your managed Starlink service provider, we offer a host of added services and features to ensure the most effective, enterprise grade solution is delivered including:

Service	Included	Description
API Integration	Yes	Clarus have direct API integration with Starlink for the activation and management of all services and equipment.
24/7 NOC Support	Optional	We offer 24/7 prioritised technical support and assistance.
Global Service Coverage	Yes	Service is offered in any location globally where there is Starlink coverage.
Customer Management Portal	Yes	View and manage all your Starlink services and equipment from our centralised management portal.
Range of Service Plans	Yes	Lower and higher bandwidth tariffs available depending on use case.
Interconnect Services	Optional	Cross connect, IPsec, site to site VPN
Multi-Channel Bonding	Optional	Bond multiple services including Starlink, 4G, 5G and fibre for higher performance and resilience.
Technology Integrations	Optional	Integrate your service with our private 5G, enterprise WiFi and SD WAN technologies.
Global Installation Services	Optional	Our network of installers has global reach so can install anywhere, whether on-land or at sea.

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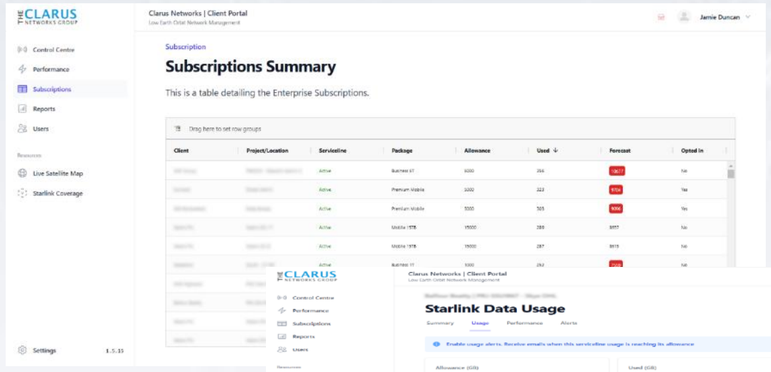
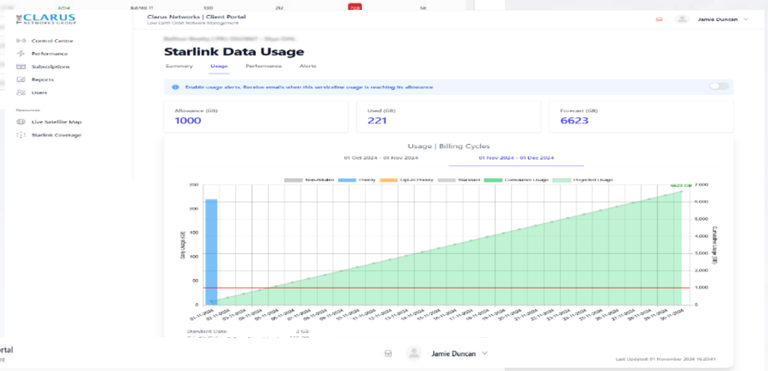
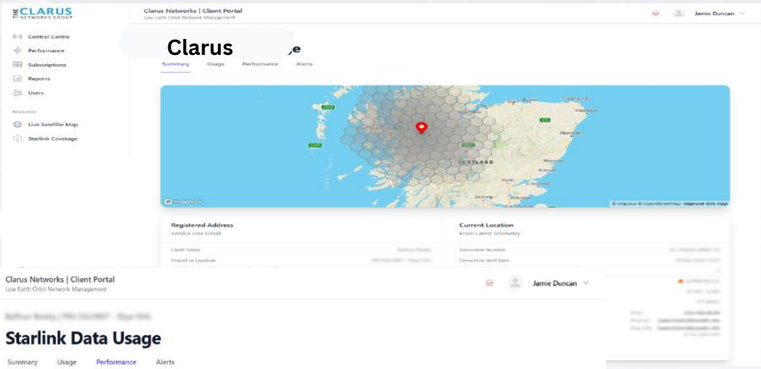
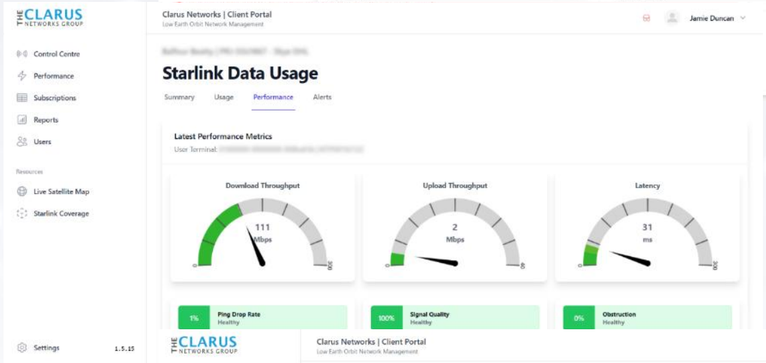
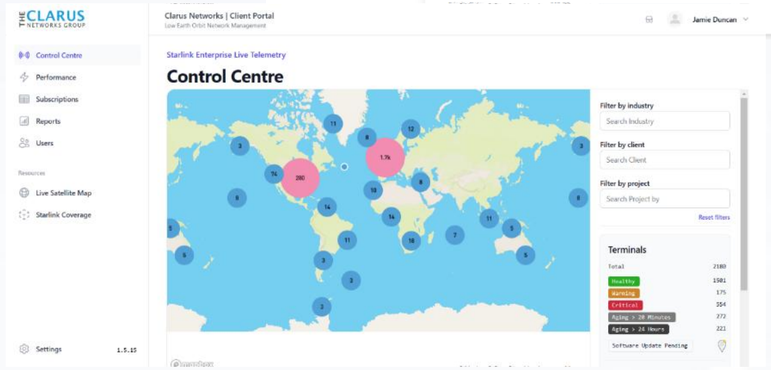
In addition to Starlink's portal, Clarus has developed a bespoke management platform for our customers that provides enhanced insights, including predicted data usage, real-time alerts, active/inactive Starlink, network statistics, pooled data management and more. **Please contact us for a demo.**

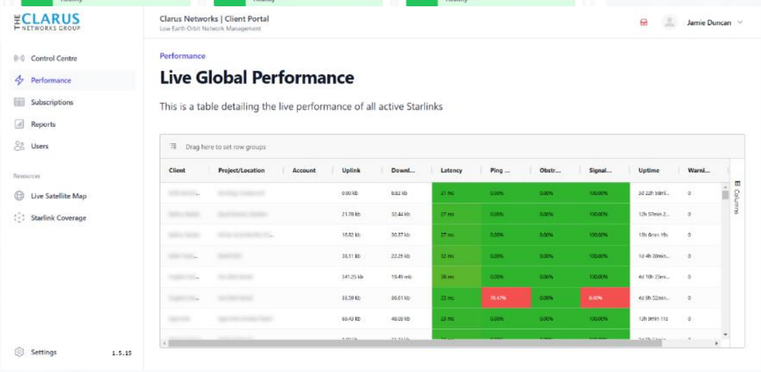












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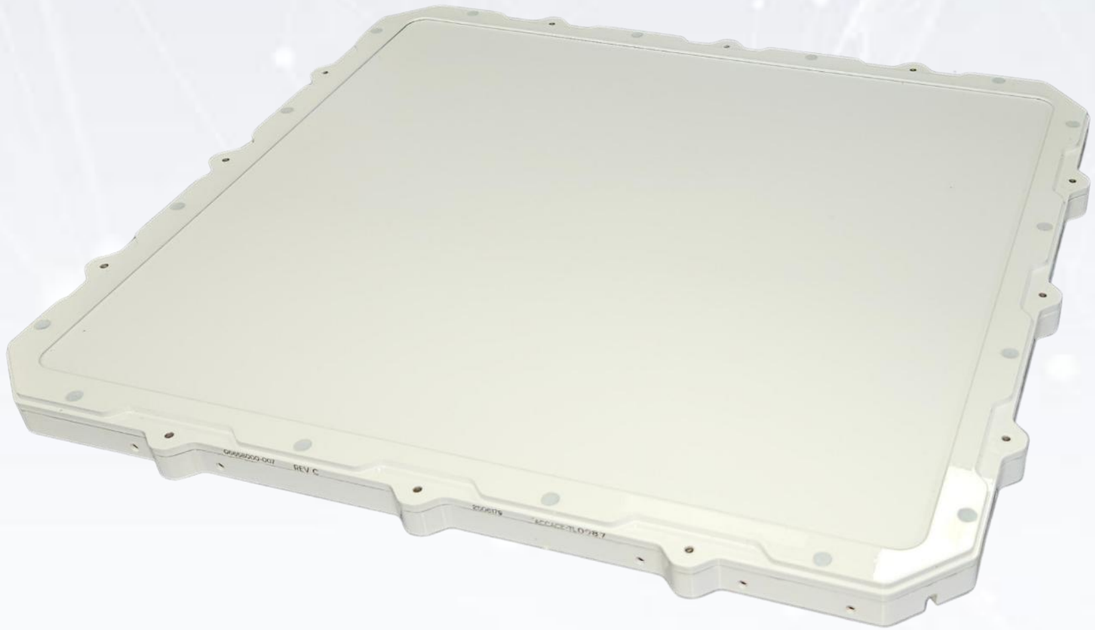
STARLINK Rail Tile and PSU



Antenna	Electronic Phased Array
Performance	40-220Mbps downlink 8-25Mbps uplink <99mS latency
Field of view	140°
Weight	13 kg
Dimensions	629mm x 565mm x 36mm
Power Input	49V DC proprietary
Connector	Souriau UTO 1210
Environmental rating	EN 50155 OT 4 / IP68 & IP69K
Env. Salt Mist Testing	EN IEC 60068-2-11, Test Ka
Operating Temperature	-40°C to +70°C
Flammability Rating	EN 45545-2 R7 HL2
Electromagnetic Comp.	EN 50121-3, EN 50121-4
Maximum speed	350km/h (TBR)
Vibration	EN 61673 Cat 1, Class A&B
High Voltage	EN 50163, 29kVAC, 5 minutes
High current	EN50388-1, 15KA AC/01.20s, 100KA DC/0.040s

PSU Weight	3.6 KG
Dimensions	384mm x 205mm x 58mm
Power draw	110-150W Avg, 400W Peak
PSU Input	110-240V AC, 6.3A, 50-60Hz
Environmental rating	EN50155 OT4/IPO
Flammability rating	EN45545-2
Electromagnetic Comp.	EN 50121-3-2, EN 50121-4
Vibration	EN 61673:2010 Cat1, Class A&B
Power Input Connector	M12 S-Code Male
Data Output Connector	M12 X-Code Female
Antenna Connector	Souriau UTO 1210 Female

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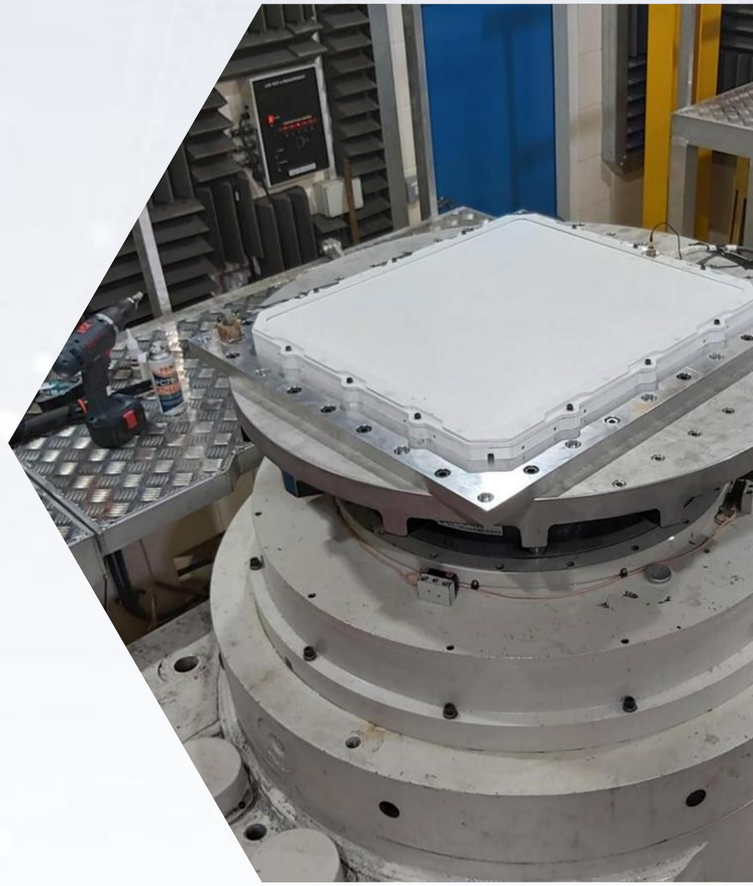
RIGID TERMINAL “TILE” CERTIFICATION

- **Objective:**
  - Achieve EN50155, EN50121, EN45545 (and associated reference standards) certification for the Starlink Rigid Terminal specifically for rail applications.
- **Collaboration with SpaceX:**
  - Direct partnership with SpaceX engineers to ensure the antenna meets rigorous standards.
- **Technical Focus:**
  - Design and development tailored to withstand high-speed rail travel and harsh environmental conditions.
- **Certification Process:**
  - Comprehensive testing phases, including environmental, performance, and safety tests.
  - Iterative design improvements based on test results and feedback.
  - Attestation Statement to support Compliance testing
- **Outcome:**
  - Reliable, high-speed connectivity for rail applications.
  - Enhanced safety and operational efficiency through certified, robust equipment.



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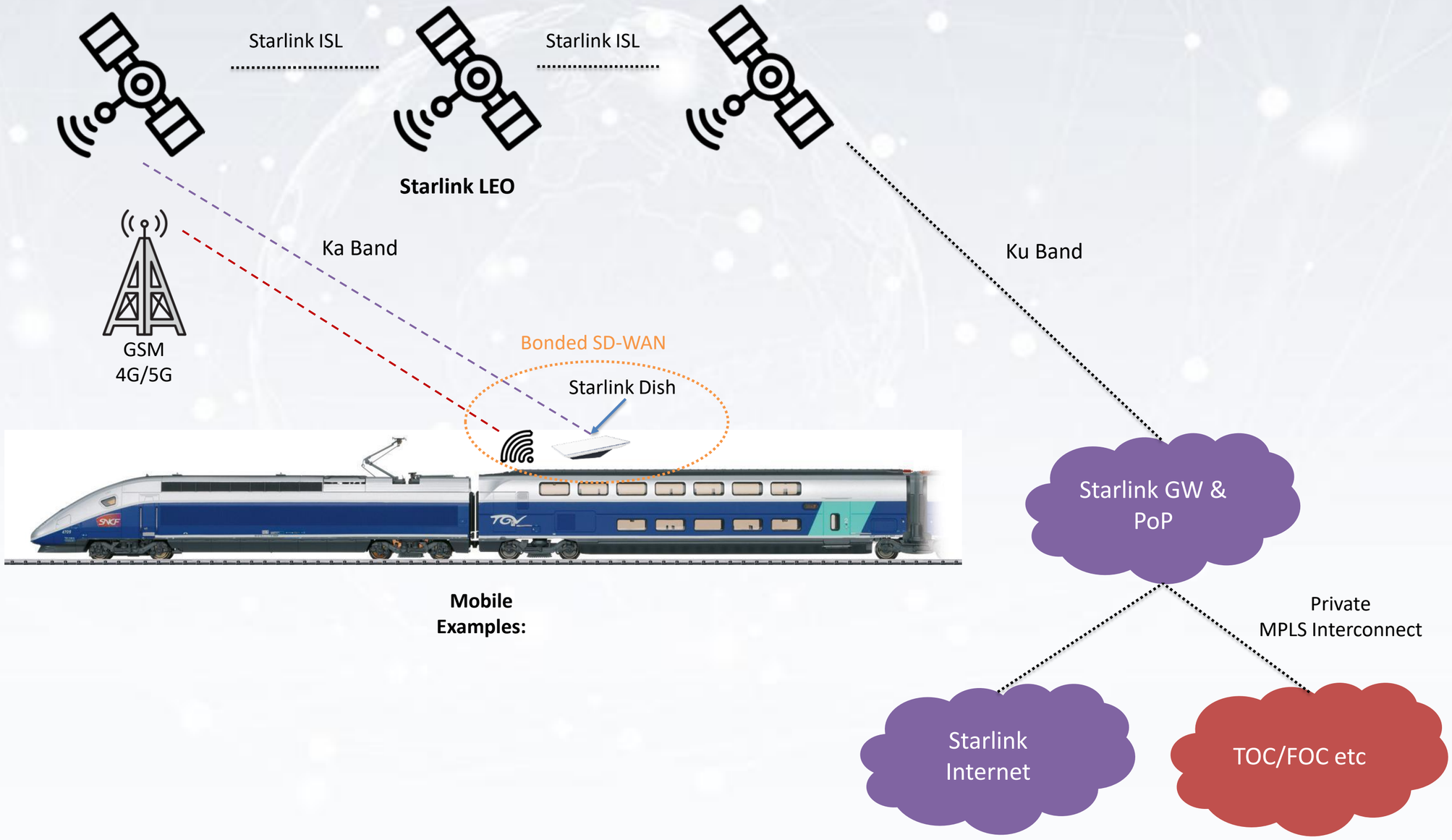
Integration with Existing or future Wi-Fi

- **Existing Wi-Fi**
  - Current Wi-Fi utilises mainly MNO (EE, Voda etc.....) networks and occasionally Private Trackside Networks
  - The Former is main reason for the poor user experience of Passenger Wi-Fi on TOC trains
  - The Latter is a dedicated network, but the costs associated with deployment are excessive
- **Starlink Integration**
  - Existing Wi-Fi providers would treat Starlink as an external WAN – i.e. the same as the existing MNO. Instead the data is delivered via Ethernet
    - Either directly into the MCG/CCU or via the main vehicle backbone
    - Basic Config update for the Aggregation software – i.e. treat as a standard MNO, use as a primary or secondary service etc
  - API can be provided to integrate with existing Monitoring solutions or can be supplied standalone using Clarus monitoring tools
    - Data Consumption
    - Signal Noise Ratio
    - Availability
    - System Health
- **Installation**
  - Simple Installation – Mechanical Design to mount antenna on Train roof
    - Basic Interface plate – mono-bolt etc fixing (minimise water ingress risk)
    - Shroud to shield cables – ensures 25KV protection maintained.

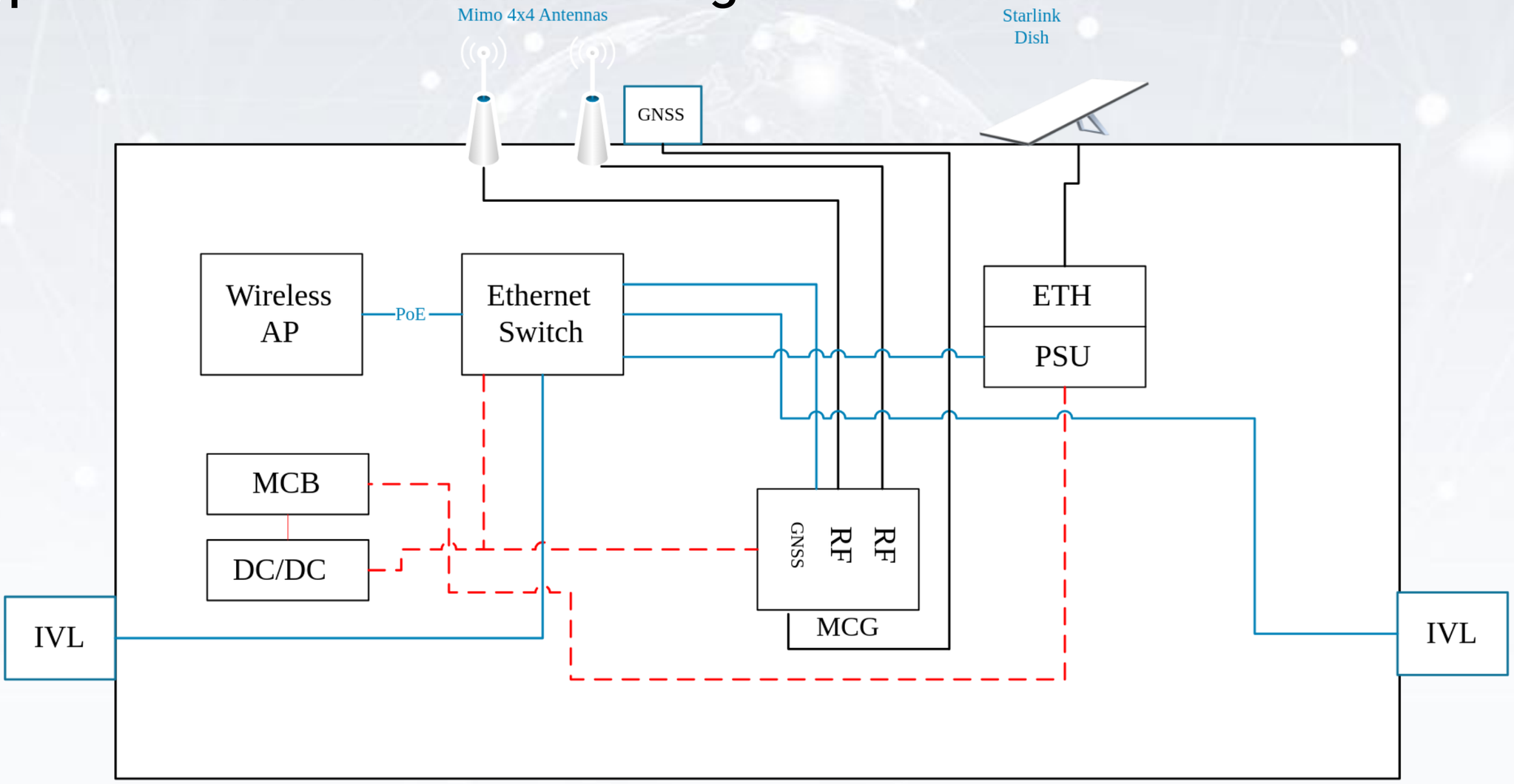
Tunnels and Cuttings

- **Cuttings**
  - Starlink Network is due to expand to up to 15,000 Satellites by the end of 2025
  - 140 (+70/-70) Degree Tile viewing angle increase availability and helps cope with Deep Cuttings and Urban Canyons.
    - Will see drop off in Bandwidth, but will improve as the constellations increases and the technology evolves
    - But the ideal deployment will see Starlink complimenting or being complimented by MNO and Private Trackside networks (see previous slide)
- **Tunnels**
  - Currently Starlink would not be available in tunnels – unless a Wayside terminal and a repeater system was used along the tunnel length
  - Instead, the onboard connectivity would drop back onto MNO or another Private Trackside Network, with Starlink being reacquired after the vehicle left the tunnel

Status – Architecture

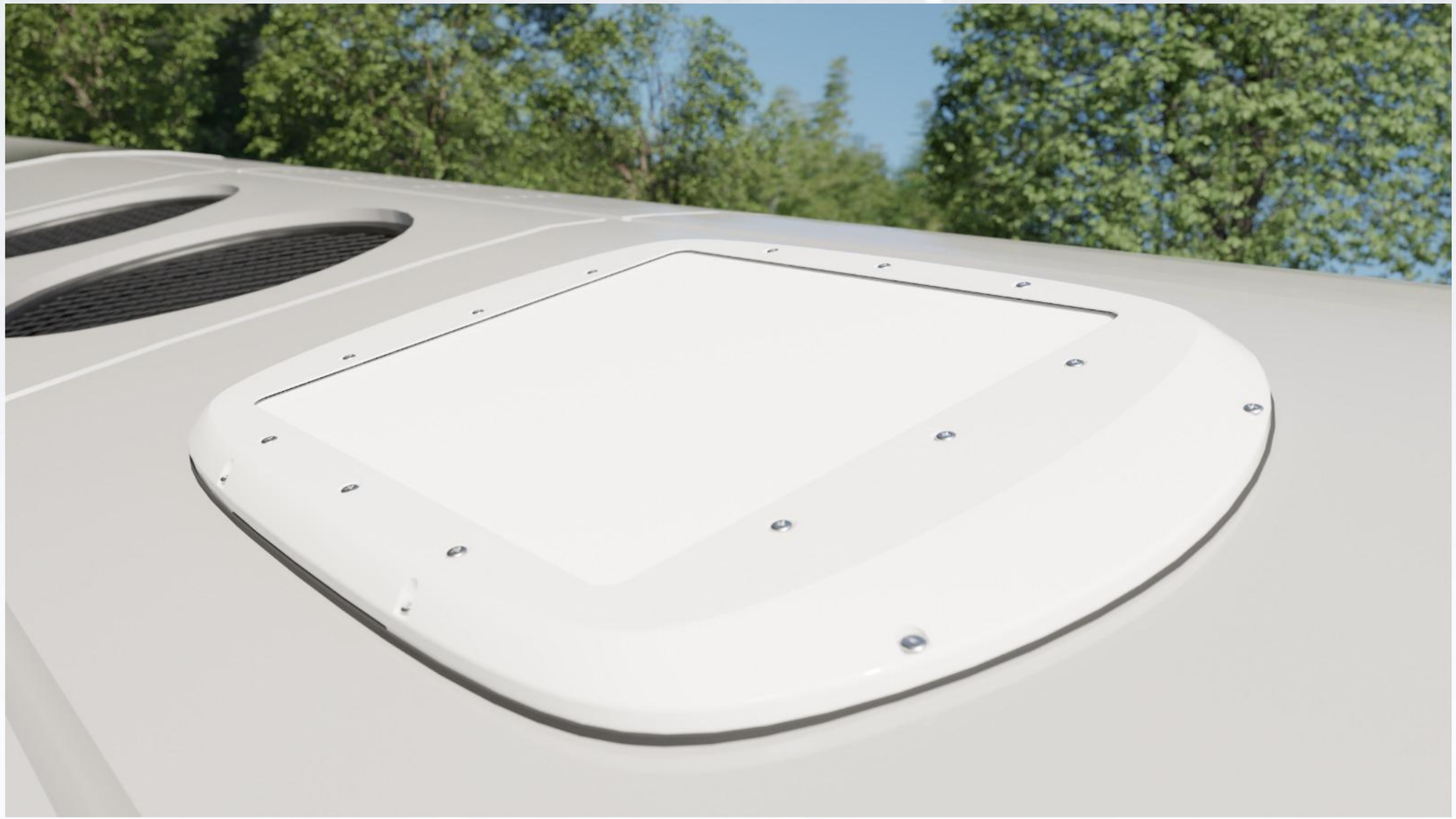


Typical Onboard Architecture – Integration with WiFi

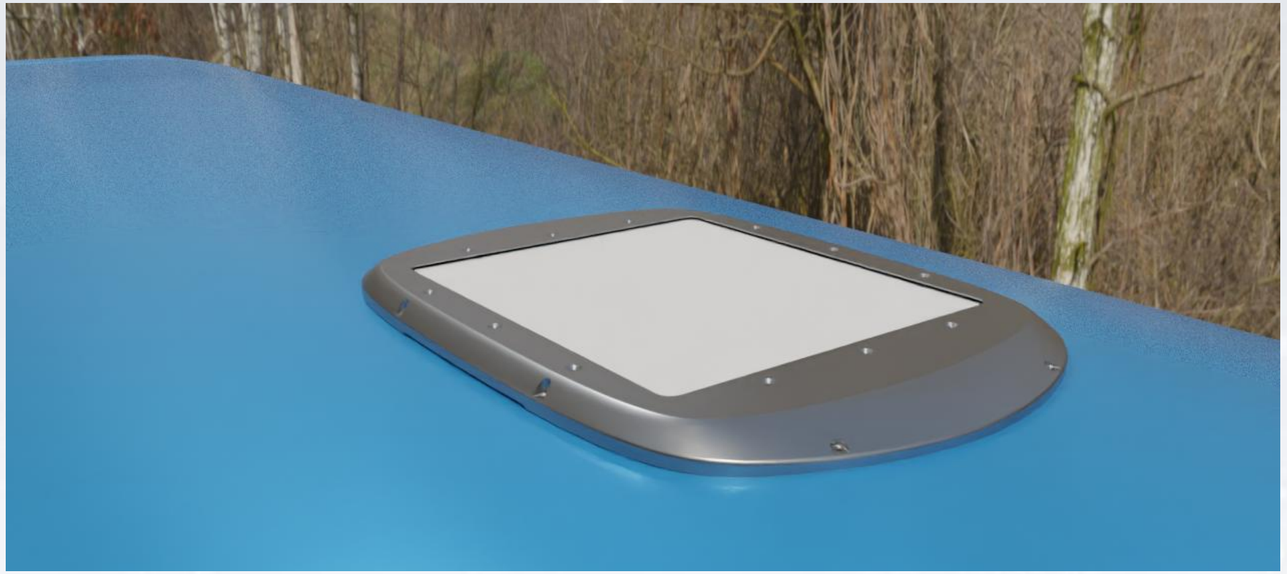


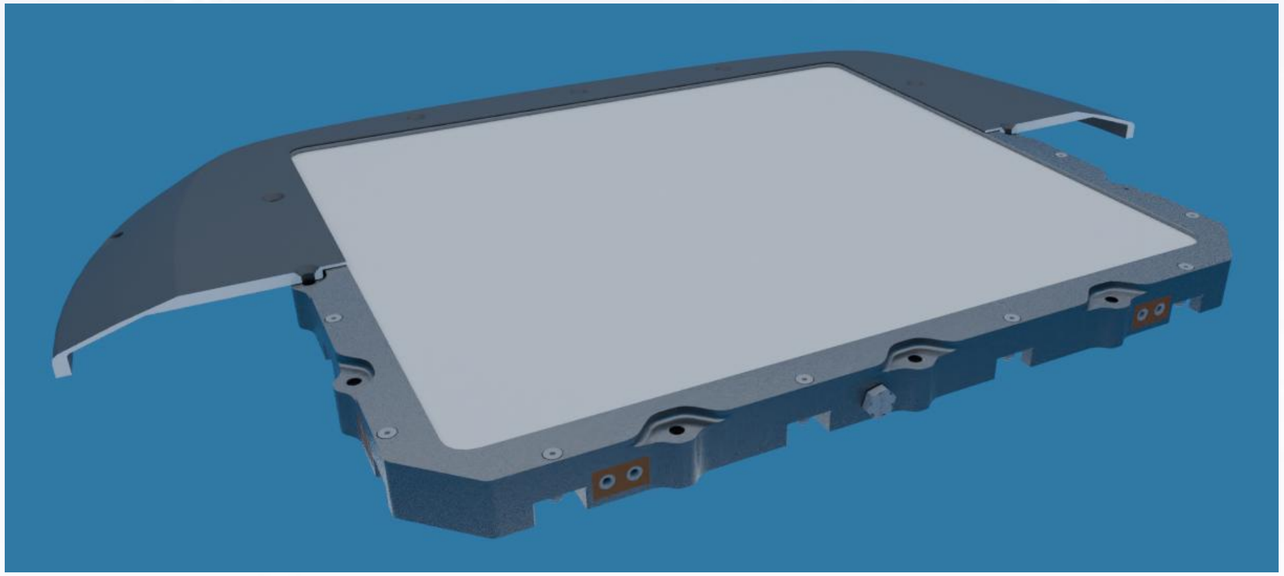
Starlink Tile & Shroud

Starlink Tile & Shroud



Starlink Tile & Shroud





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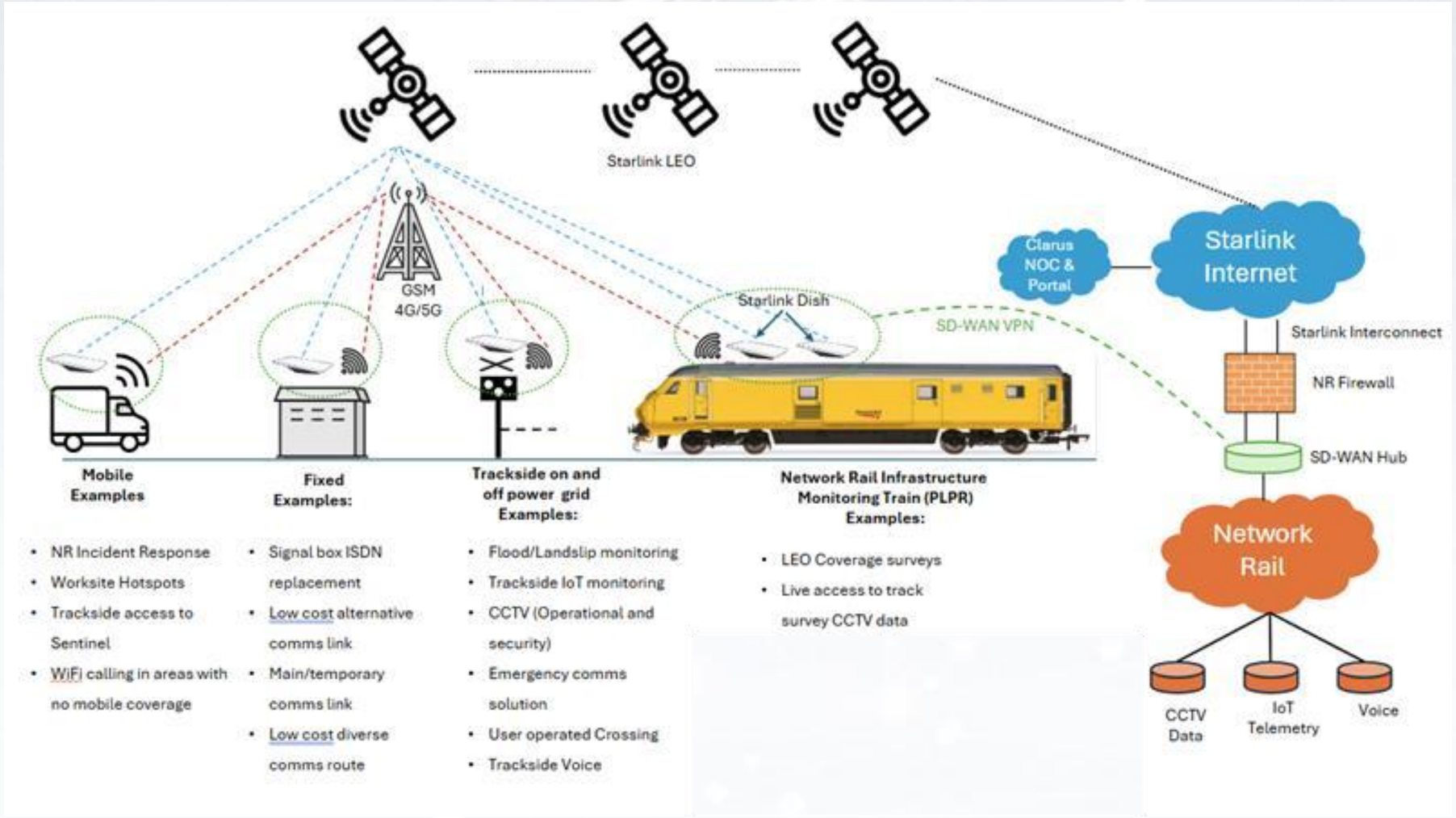
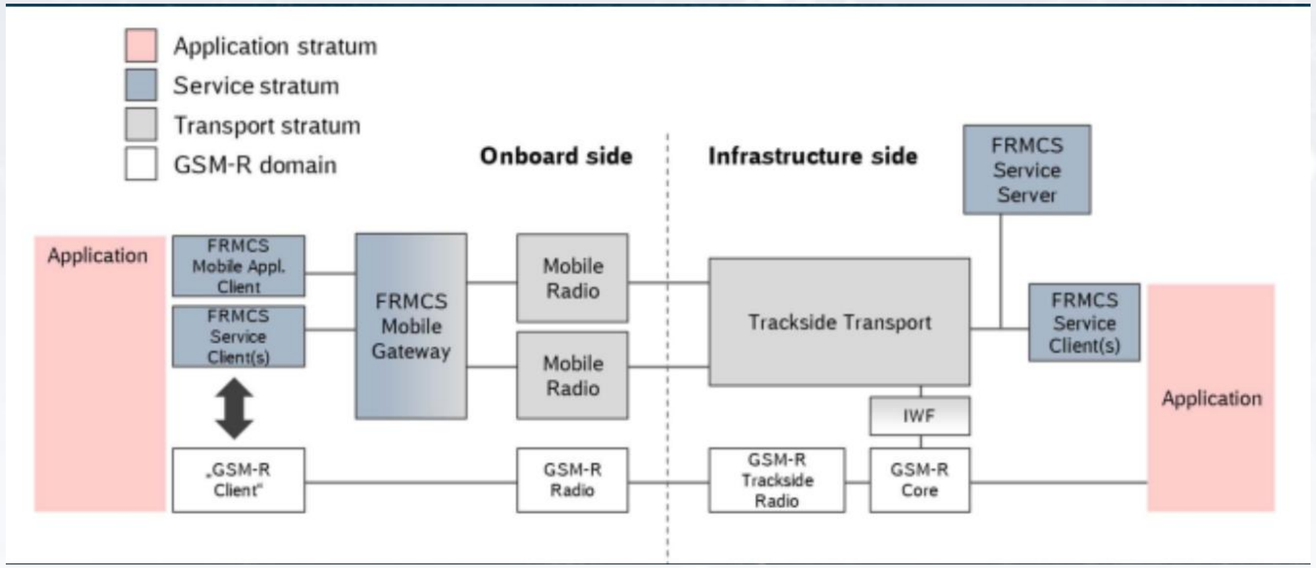
Potential Applications – One Comms Bearer. Various Options



Potential Additional User Cases – Multiple Initiatives

- Supports 5G Architecture for FRMCS - multi-bearer approach, non 3GPP and 3GPP solutions – Future



- Comms Bearer for CCS - SAIRCC follow up – Integration of Satellite and Terrestrial Railway Control Networks
  - Objective: To develop and validate the5G NR air interface over satellite for railway control communications @ control and management plane (i.e. necessary functions for the integration of satellite and terrestrial railway control networks)
- IoT – Monitoring of Freight and Cargo

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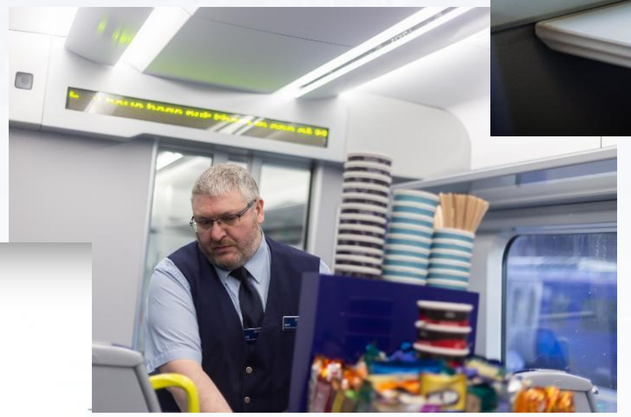
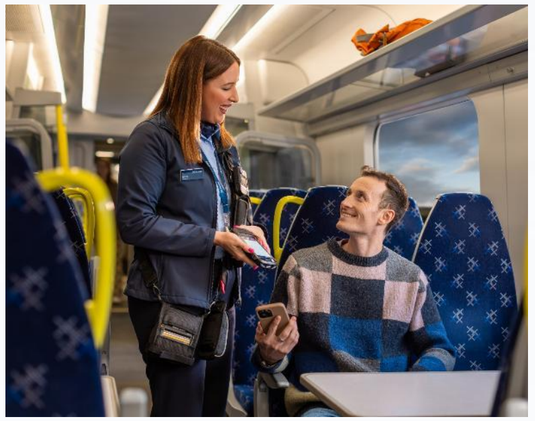
North Highlands Trial





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North Highlands Trial

- Multi agency project
- Six ScotRail class 158 trains will be fitted to test starlink connectivity for a six month trial on Inverness to Wick and Thurso; Inverness to Kyle and Inverness to Aberdeen routes
- Public transport operator benefits
  - Passenger Digital Connectivity
  - GPS tracking
  - Wi-Fi calling
  - Card retail systems
  - Transition of on-train status data (toilet availability, seat occupancy, available bike spaces)
  - Incident recovery (CCTV retrieval, passenger welfare, technical information)
- Public sector and community benefits
  - We've deliberately chosen a challenging area for the trial! Opportunity to gain first hand knowledge, experience and data without expensive track (or road) side infrastructure.
  - Opportunity to promote Inverness as a railway centre of digital specialism.
  - Integration between different modes of public transport becomes easier.

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