Aerial Networks

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Copenhagen

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A FEW FACTS ABOUT OUR NETWORK

90%
4G GEO COVERAGE TODAY

>19,000
SITES ACROSS THE UK

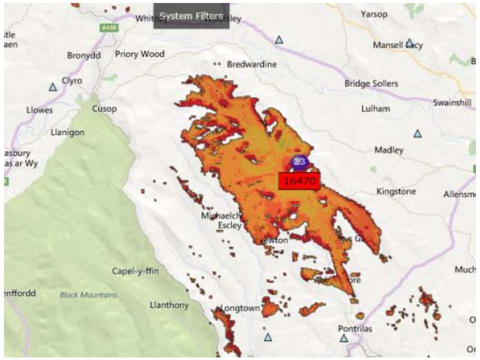
500
NEW SITES BUILT BY 2018

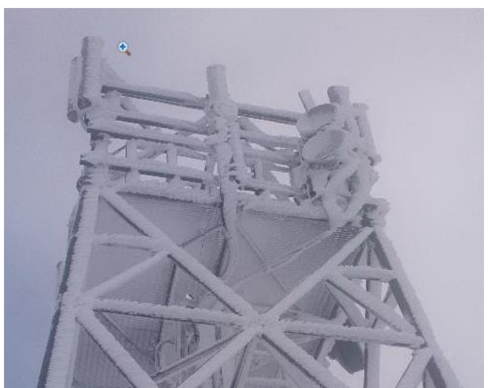
>100
4G SITES UPGRADED WEEKLY

1,500
POWER BACK-UP SOLUTIONS

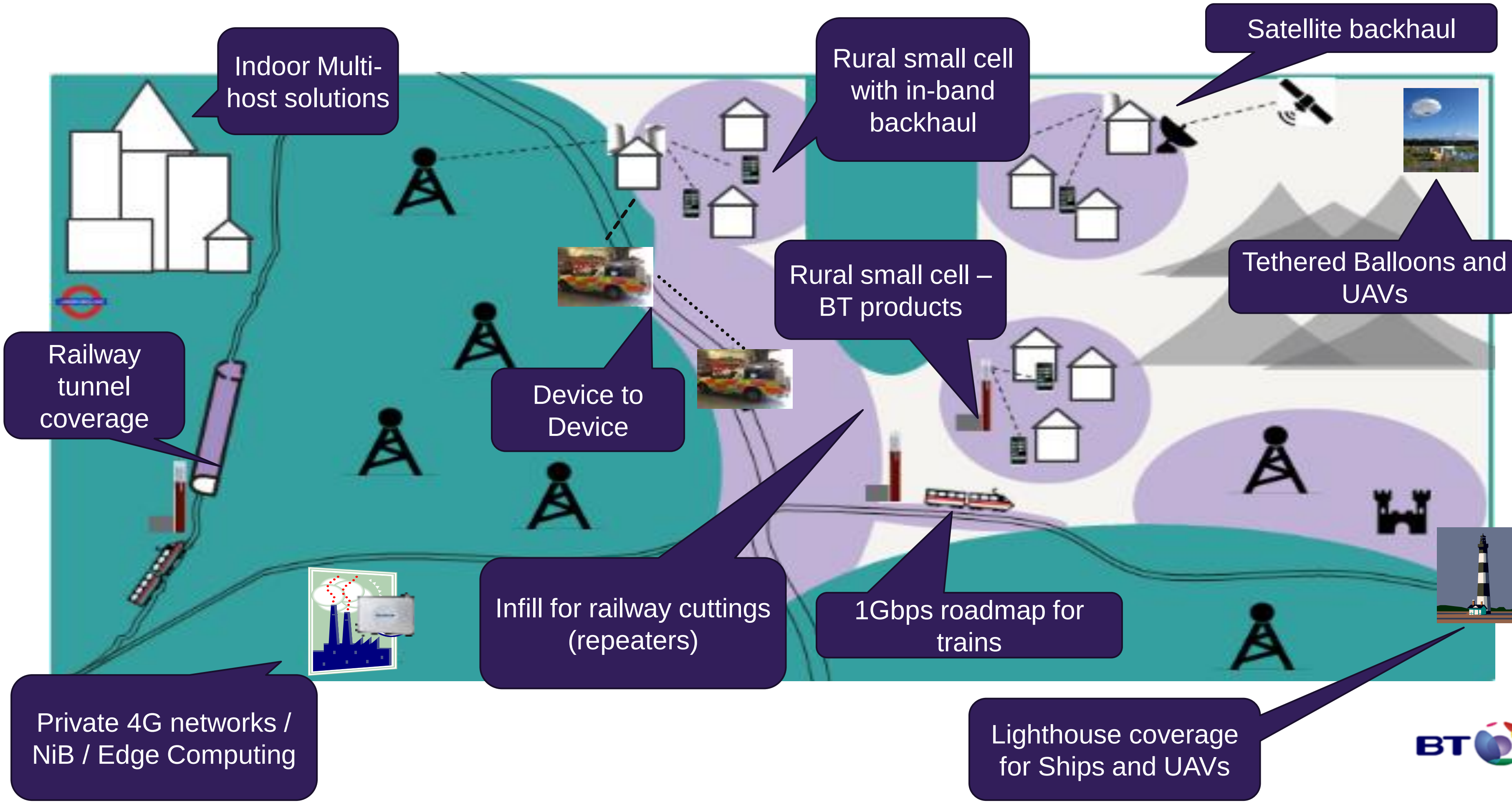
#1
MOST RELIABLE NETWORK

CHALLENGES


System Filters
Yarsop
Mansell Lacy
Bronydd
Priory Wood
Bredwardine
Clyro
Bridge Sollers
Llowes
Cusop
Lulham
Swainshill
Llanigon
Madley
16470
Kingstone
Capel-y-ffin
Black Mountains
Llanthony
Longtown
Pontrilas



WE ARE INNOVATING TO THE FARTHEST REACHES



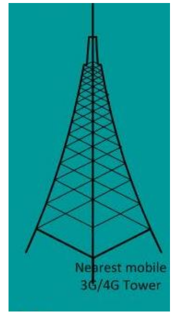
“AirMasts”- Angels in the Blue Sky

“AIRMASTS” DEPLOYMENT SCENARIOS

Scenarios	Drone	Balloon	NIB	Full Network Access	Backhaul		Battery in Air	Power on Tether	Data to air
					4G Inband Backhaul	Satellite Backhaul			
Very fast deployment, low endurance, limited subscribers	✓		✓				✓		
Fast deployment, high endurance, limited subscribers	✓		✓					✓	✓
Slow deployment, high endurance, unlimited subscribers		✓		✓		✓		✓	✓
Low costs to run, good deployment footprint, high endurance		✓		✓	✓			✓	✓

THE AIRMAST SETUP

2600 MHz LTE
2400 MHz WiFi
2100 MHz 3G
1800 MHz 4G
800 MHz 4G



1800 MHz 4G
2100 MHz 3G
800 MHz 4G

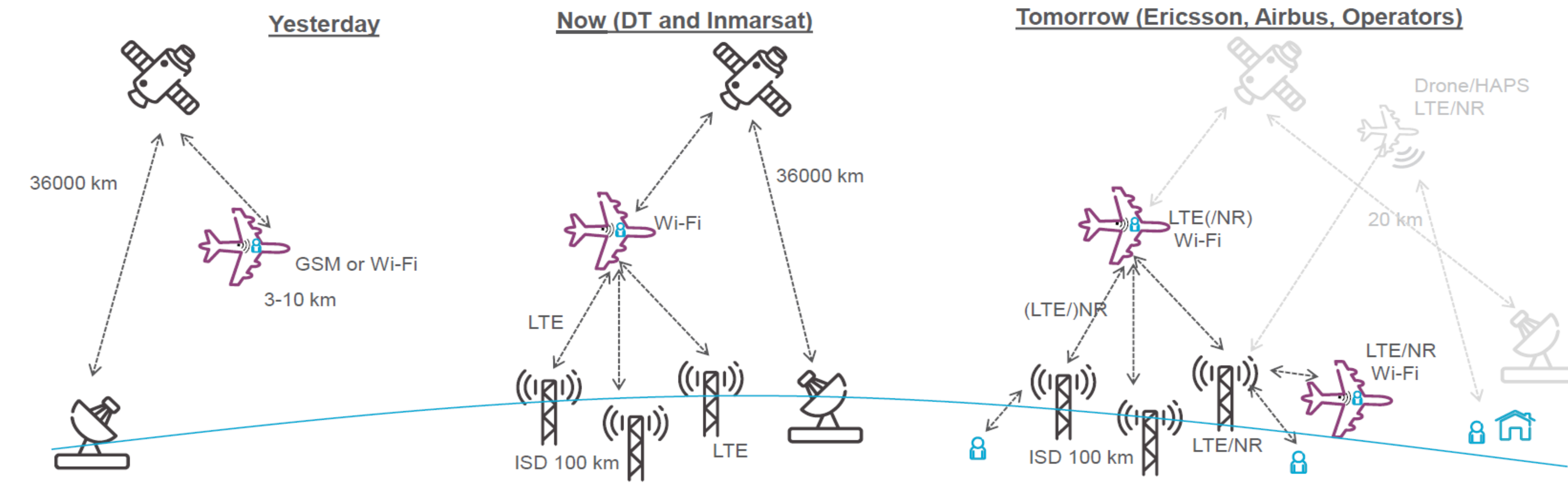
3.4 GHz 5G
3.5 GHz LLB
26 GHz mm
28 GHz mm
32 GHz mm

NIB

EE/BT Core

Vertical Hetnets: Today and Tomorrow

ICARO-EU 2017 project



- *Delays, capacity issues*
- *High cost: satellite link + complete separate GSM mobile network*
- *Special ground mobile network interference protection*

- *Delays, capacity issues*
- *High cost: satellite link + LTE air-to-ground network on non-mobile frequency*

- *Higher capacity/reuse with NR beamforming for air-to-ground links*
- *Lower costs and seamless connectivity through integration with ground mobile networks*
- *Managed radio networks interference*

The Potential for Nb-IoT/LTE-M Command and Control

Low power, Low cost, High Coverage – ideal for RPAS

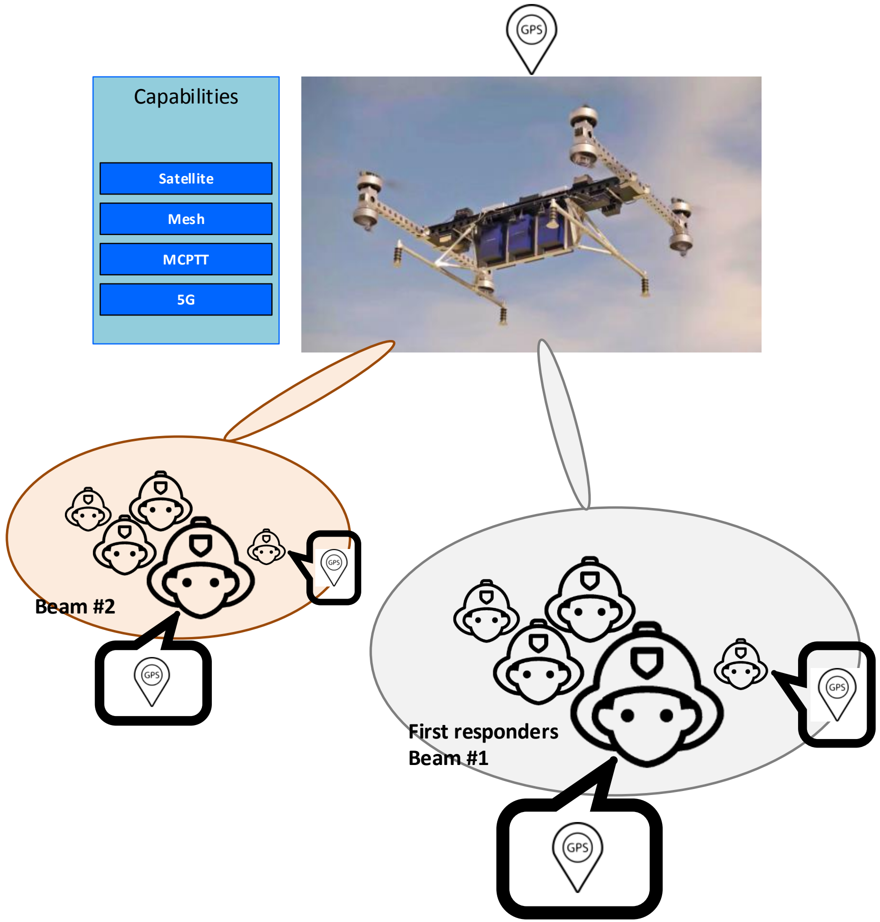
- 3GPP Rel 12 brings Cat 0 with low complexity, 1Mbps UEs
- 3GPP Rel 13 brings LTE-MTC and NB-IoT: less bandwidth and wide coverage (up to 20dB) for lower data rates and battery life up to 10 yrs – modules expected <5USD
- Flexible switching between Nb-IoT (140kbps) and LTE-M (1Mbps)
- Easy macro network upgrade: RAN SW upgrade only
- Narrow-Band should solve the Uplink Interference problem
- Potential uses for RPAS:
  - Air traffic control of RPAS over 4G
  - Co-ordination between Macro and micro drones
  - Collision avoidance between 2 RPASs
  - Secure communication between RPAS and commercial planes

BEAMFORMING

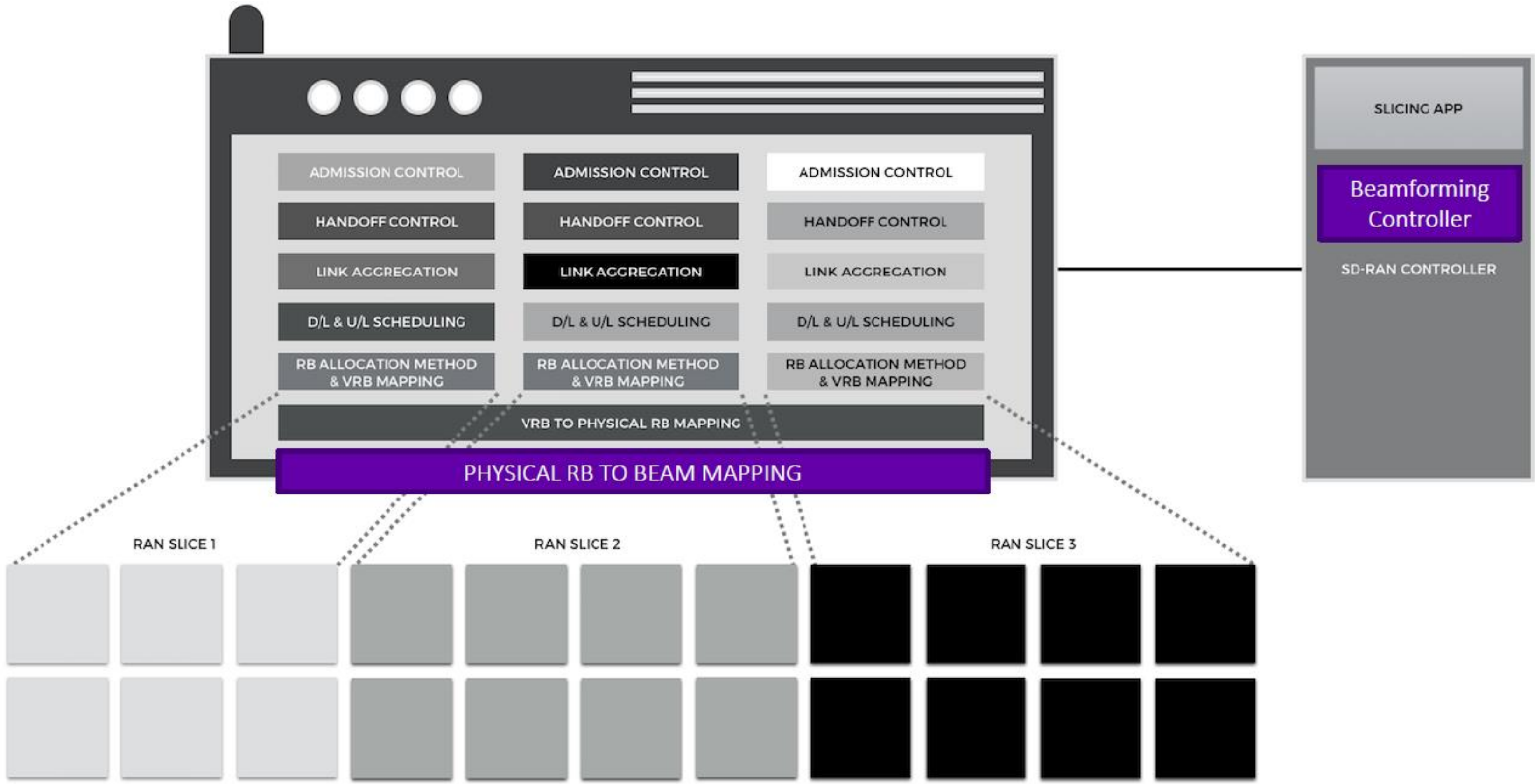
- **Airbones have limited power**
  - Efficient power transmissions and reception is required
  - Minimize computational power

- **Beamforming is suitable to reduce transmitted power**
  - Efficiently cover a first responder or first responders groups
  - Backhaul links between terrestrial and/or satellite networks
  - Airbone mesh network

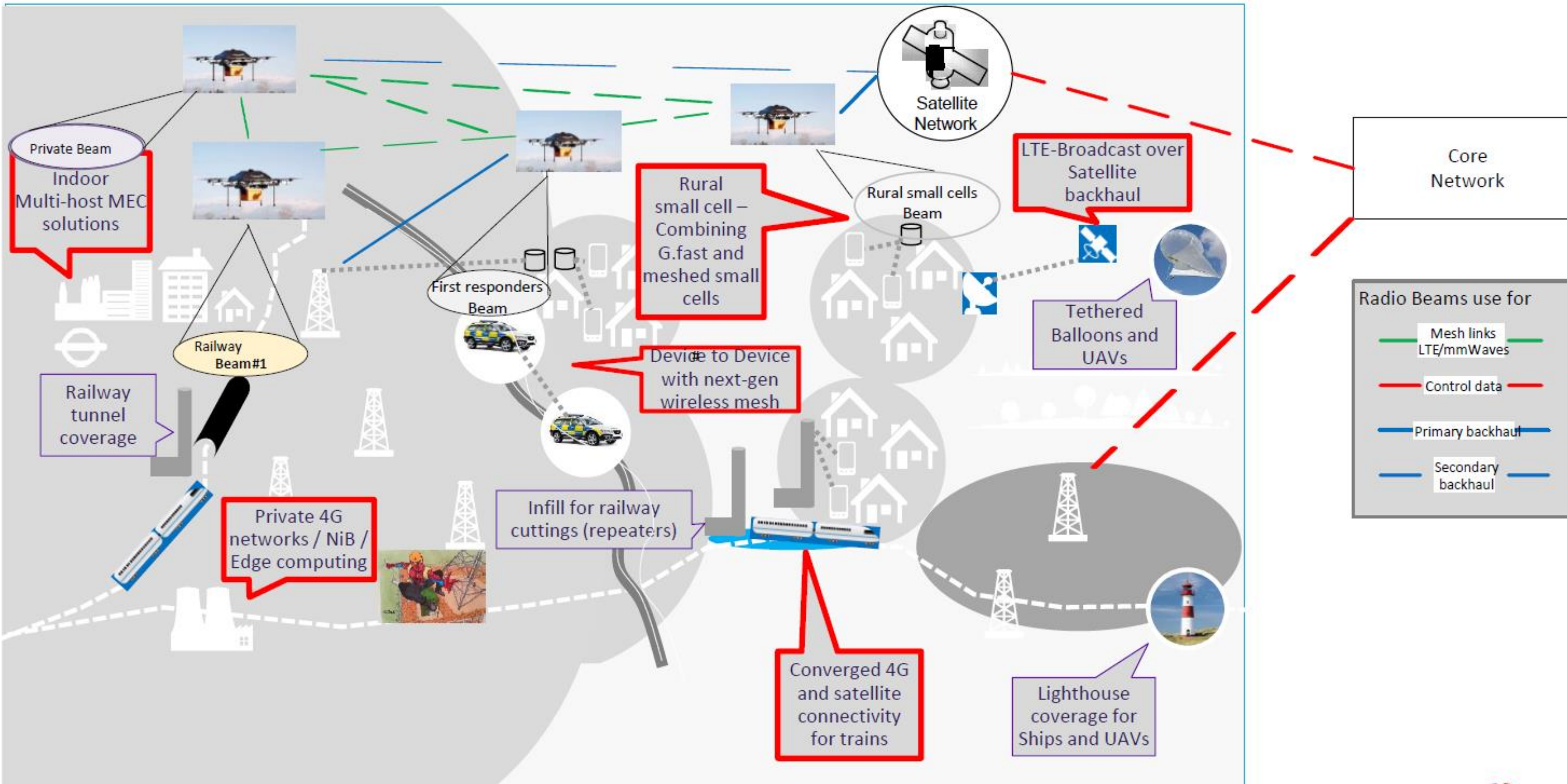
- **Challenges**
  - Efficient beamforming with reduced computational power;
  - Beam management including activate/deactivate beams;
  - Dynamic & Rapid Beam tracking.
  - Analog/Digital/Hybrid/Holographic tradeoffs



NETWORK SLICING with BEAMFORMING



Coverage on demand – meshed airborne small cells BVLOS: connecting the farthest reaches



SUMMARY

Airmasts + Dynamic Beamforming + RAN Slicing + NbIot/LTE-M

supports a holistic end-to-end slicing architecture

Bring maximum potential for 5G to market

Our work so far is very encouraging but some challenges and questions remain

Multi-domain e2e orchestration

Guaranteeing performance and quality of slices to support stringent application needs

Converged multi-access slices

Multi-operator federated slicing

Beamforming trade-offs – Digital Vs Analog Vs Hybrid Vs Holographic

For services that will need to interoperate across networks, operators and at scale, we still need to work together

Collaborative research projects

Standards

Join the TIP group

BT