



Experience the commitment®

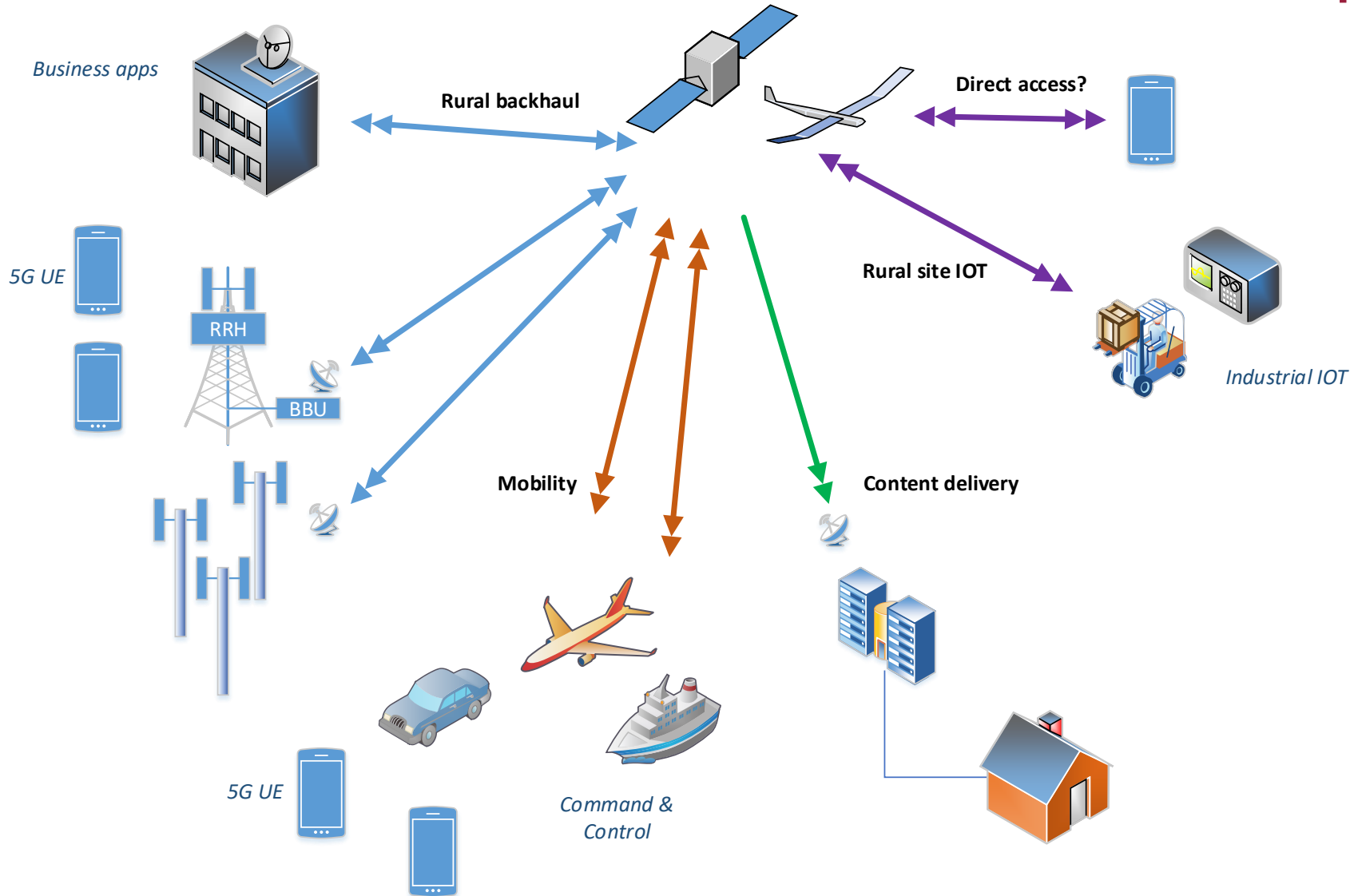
# Opportunities for blending terrestrial and non-terrestrial technologies

CW Technology & Engineering Conference:  
5G, Satellites & Magic MIMO

Dr. Jaime Reed  
Director  
26<sup>th</sup> September 2019



# How can Non-Terrestrial Networks support 5G



CGI is building network management systems for some of the top satellite operators, now we are looking to the next generation!

NTNs (satellites or HAPS) can help deliver ubiquitous 5G for a wider range of locations and applications helping to drive business growth

# What are the opportunities?

**Coverage expansion:** Total revenue potential of connecting those without cellular coverage could be ~\$20-30Bn per year; in context that's only +2-3% of global cellular revenues

**Security and resilience:** NTN could help augment the overall network reliability and security by offering flexible redundant routing & security overlays

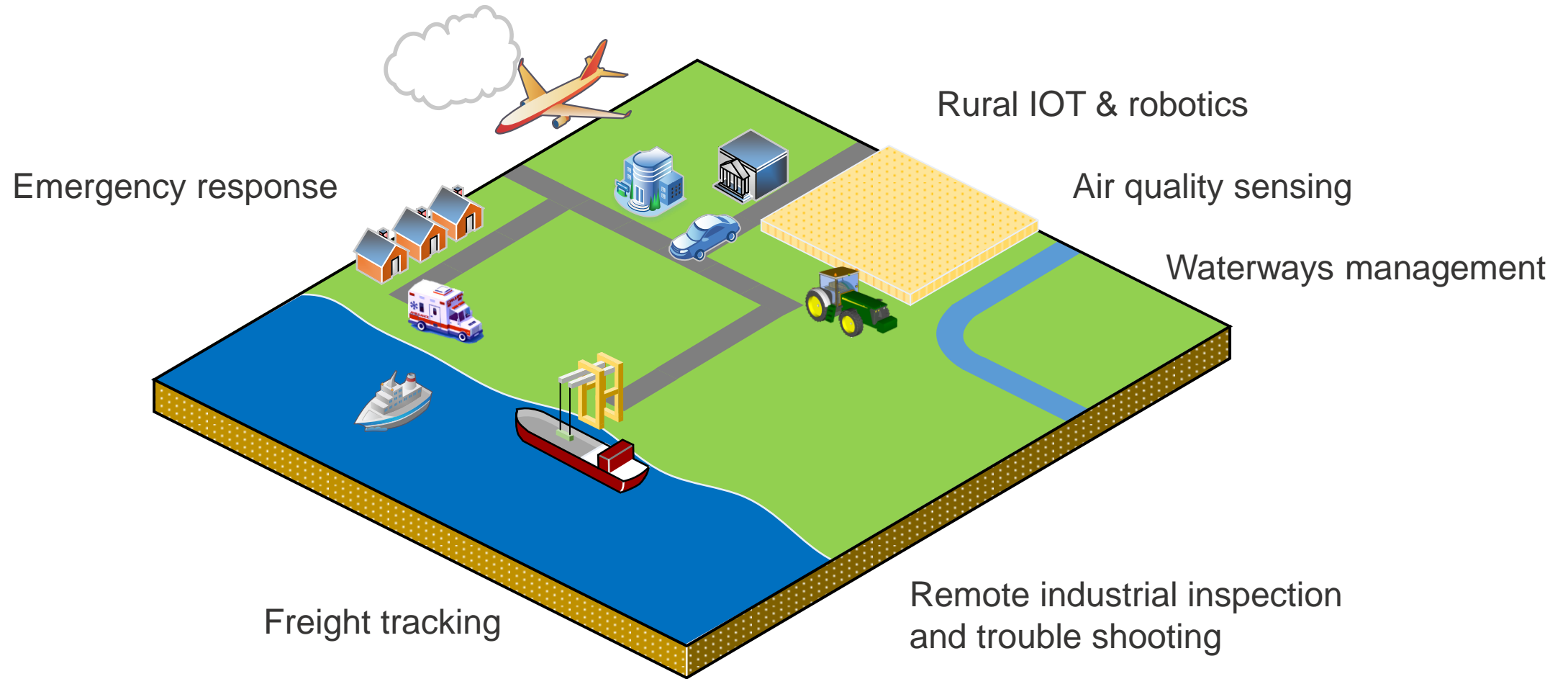
**Cost reduction:** NTN could help reduce the overall cost of deployments

**Use cases expansion:** help access new vertical sectors which the cellular industry can't today (by making them technically or economically viable, e.g. for planes/ships)

**Offloading the network:** by efficiently distributing content, especially for live events; drop-in solution to rapidly expand capacity of existing cell sites

**Network slicing:** Including NTN can increase the range of options for CSPs to sell in slices & expand B2B possibilities

# Example use cases we are looking at



# What are the challenges?

## Latency

- Round trip light time to GEO 270ms compared to LEO (1100km) 20ms (10° elevation) excluding switching and terrestrial routing
- Typical experienced 4G RTT ~30-40ms. LEO satellites could meet user's needs, although ~1ms latency for 5G still needs MEC

## Bandwidth

- Bandwidth for LEO constellations <10Gbps per satellite whereas for upcoming GEO's >500Gb
- Currently need ~10Gbps minimum to displace microwave links for single cell – need for C-RAN ~1Tb/s
- Intelligent traffic based routing and pooling LEO and GEO could meet both latency and bandwidth needs

## Physical

- General comment “if I can get power to a site then I can get a fibre”, ignores the fact that the cost of installing a fibre can be very high (power is far more ubiquitous).
- Fibre provisioning cost can be up to \$50-100k/km but only in a very small subset of locations (few % max).
- However, satellite installation can be problematic due to field of view and need for antennas.

## Coverage

- Satellites have unrivalled coverage however the coverage is not equally distributed or allocated. In fact capacity may be highly constrained in some geographies.

# What are the challenges?

## Spectrum

- Satellite spectrum is limited, is it future proof? Constant challenge to maintain satellite spectrum protection.
- Licensing process is easier than for p-p microwave links.

## Reliability & availability

- Satellites can have system reliability >99.9%, sufficient for all applications
- Perception that weather is still a problem but generally no longer the case

## Cost

- Today's VHTS have a break-even of about \$4-5K/Gbps/mo compared to \$0.5-1K for a rural 1Gb fibre lease in the UK.
- Market dynamics likely to reinforce a trend towards telco level pricing for SatCom (NSR) but need to develop pooling approaches to achieve this

## Provisioning

- The satellite industry prefers long term lease arrangements. Provisioning can take weeks to months.
- Key issue is CAPEX versus OPEX nature of pricing however on-going maintenance, leasing and access costs for microwave P2P can be significant so a detailed site-by-site (or region-by-region when aggregating for a beam) approach is required



# CGI Carnot overview

- **Carnot** is a tool kit we are developing to help support customers looking to add capabilities for geospatial data management and NTN/heterogeneous network planning to a new or existing planning capability – [this will enhance CGI's capability to integrate future heterogeneous network systems for our customers](#)
- Key value propositions:
  - Determine the cost effective solution to deliver connectivity over wide areas (regional/national)
  - Explore and quantify NTN based solutions
  - Analyze use cases, not just coverage
  - Manage geospatial datasets including high-resolution data, including exchanging potential cell locations with hosts
- A toolkit which enables users to simulate 5G deployment in a representative digital environment:
  - 3D network design including rural constraints
  - Optimization of heterogeneous networks including NTN (mobile, satellite...) & cost analysis
  - RF simulation & network emulation
  - Integration and data management for the various geospatial inputs
  - Include time domain e.g. vehicles
- Also working on multi-domain orchestration for satellite based communication networks using AI

Existing  
radio  
planning  
workflow

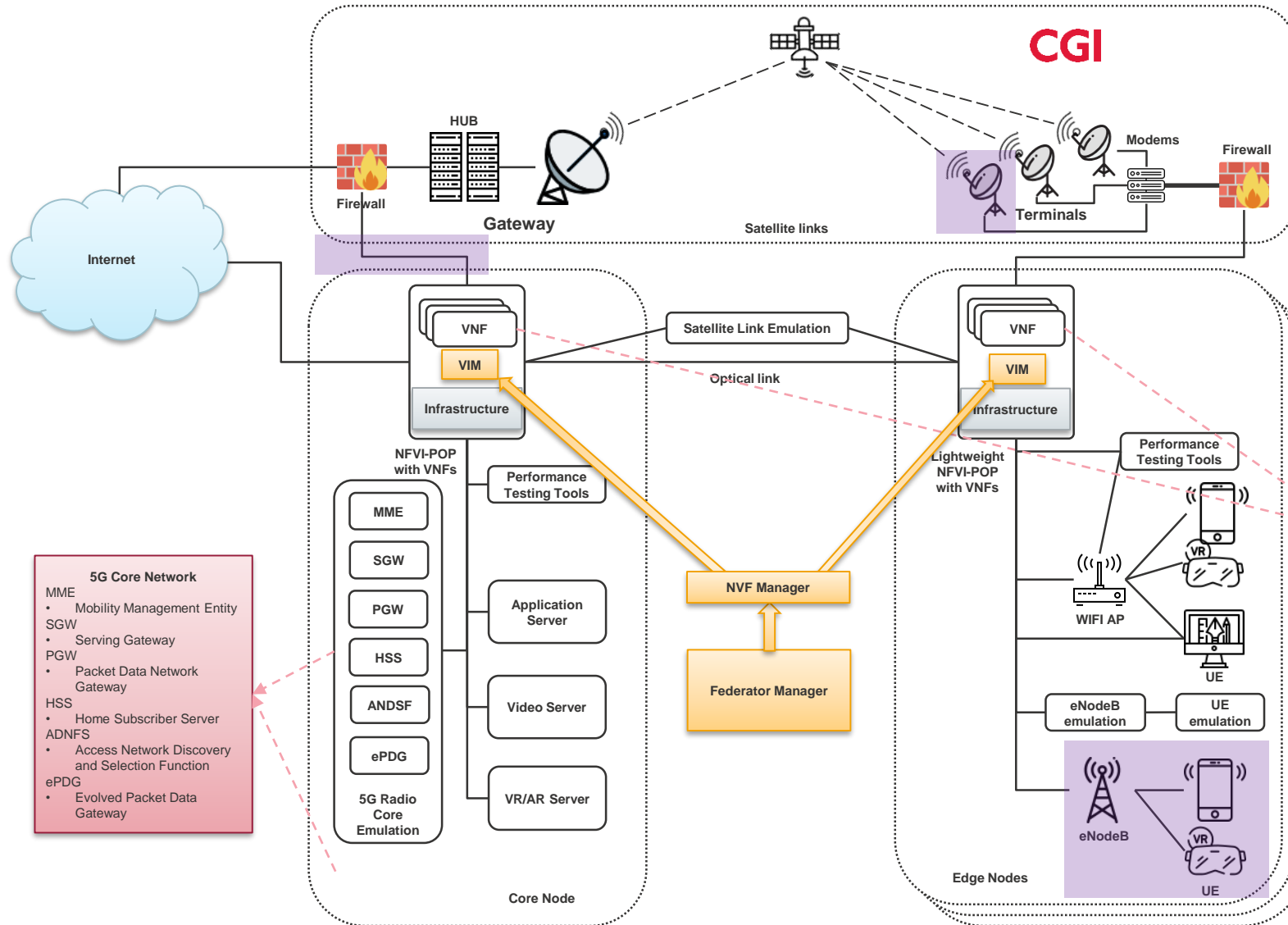
NTN radio  
planning

Use case simulation

Geospatial data management

Carnot system

# CGI 5G Accelerator: Test Bed Phase



The 5G accelerator is being designed to support the development of business use cases using NTN based heterogeneous networks

- 5G Core Network**
- MME
    - Mobility Management Entity
  - SGW
    - Serving Gateway
  - PGW
    - Packet Data Network Gateway
  - HSS
    - Home Subscriber Server
  - ANDSF
    - Access Network Discovery and Selection Function
  - ePDG
    - Evolved Packet Data Gateway

- VNF**
- vRouter
    - Virtualized Router
    - Netconf support
    - DPDK Acceleration
  - vWOC->WAN Optimization
    - TCP Acceleration
    - Deflate
    - Data Redundancy Elimination
  - vHYA
    - Traffic distribution on multiple link
  - vUTM\_>
    - Firewall
    - Virus detection
  - vWCache
    - Virtualized WEB Cache

## Initial business focussed use cases:

- Streaming video
- Remote collaboration, incl. AR
- Virtual reality
- IoT sensor network



# Key takeaways

- CGI is working to develop an end-to-end capability for 5G and satellites so that we can help integrate future systems for our customers, looking to develop win-win scenarios with partners
- We already have familiarity with COTS products (including SDN etc.) but need to develop “glue” and bespoke components (where necessary) to offer a full spectrum capability to support NTN
- Characteristics of GEO, MEO, LEO, and HAPS platforms are all complimentary the technical capability is emerging but can it be deployed at a cost effective level? Further technology development is needed.