Satellite Services: Integral to 5G and Emerging Applications

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On behalf of:
United States Telecommunications Training Institute
9 November 2022

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The mobile satellite company™

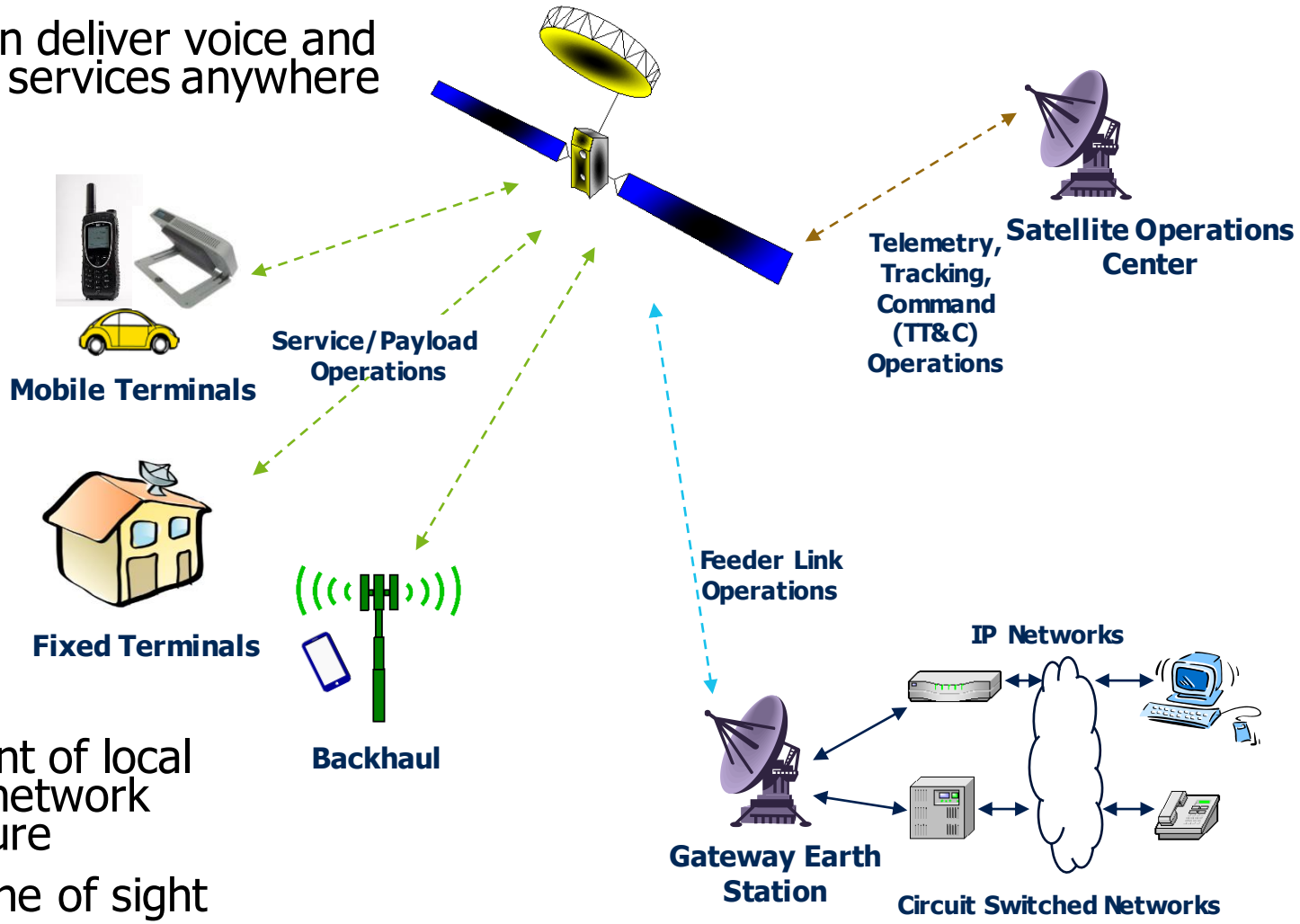
Agenda

- Satellite Background
- Inmarsat Network, Software Defined Networking, Cloud and SATCOM 101
- Enabling the Connected World
- 5G & Satellite
- Agriculture and Rail Use Cases
- Conclusion & Policy Recommendations

Satellite Background

Satellite system architecture

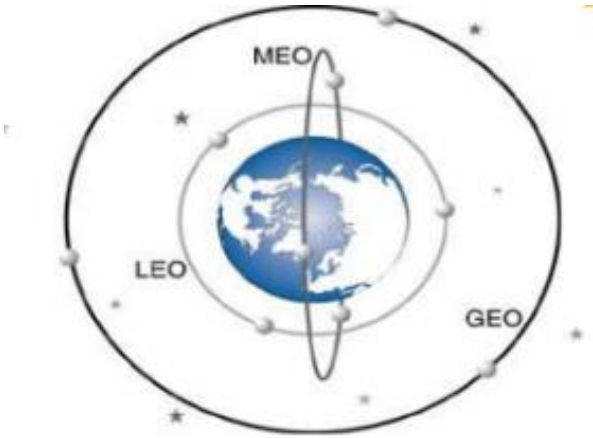
- Satellite can deliver voice and broadband services anywhere



- Independent of local terrestrial network infrastructure
- But need line of sight
- Great distances = sensitive receivers

Satellites by Orbit

- Geostationary earth orbit (GEO)
  - Satellites orbit at 22,300 miles (35,700 km) above the equator and rotate at the same speed as the earth's rotation
  - 3 satellites can cover most of the globe
  - Inmarsat, Intelsat, SES, Echostar, Thuraya
- Medium earth orbit (MEO)
  - Satellites are closer to users on Earth (5000-15000 miles) (8000-24000 km)
  - 10-18 are required for continuous coverage
  - GPS, O3b
- Low earth orbit (LEO)
  - Satellites are closest to users (300-1000 miles) (480-1600 km)
  - At least 40-70 satellites are required for full coverage
  - Iridium, SpaceX, OneWeb



Credit: Satellite Industry Association

Fixed Satellite Services (FSS)

- Data/Telephony Communications
- Internet Trunking
- Internet Backbone Connectivity
- Video Services/DBS/DTH
- Corporate Network Services
- Connecting "Unfibered"/Low Teledensity Locations
- Middle-mile/backhaul
- Cable Distribution/ Restoration/ Redundancy

From "Satellites are Critical Infrastructure," Satellite Industry Association, 2006

Mobile Satellite Services (MSS)

- Anytime, anywhere telecom, critical to security and safety

- Remote data telemetry monitors infrastructure
  - Utilities –oil/gas/water pipelines, electrical distribution
  - Trains/trucks – location/status monitoring

- Remote telephony
  - Remote areas
  - Emergency/Disaster Response
- Maritime/Aeronautical communication
  - Lifeline for ships/planes
  - Emergency communications
  - Tracking dangerous shipments
  - Broadband commercial and government services

From "Satellites are Critical Infrastructure," Satellite Industry Association, 2006

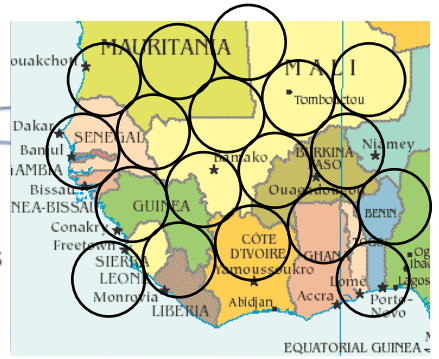
Different Frequency Bands Enable Different Solutions

Increasing Frequency

Increasing Miniaturisation

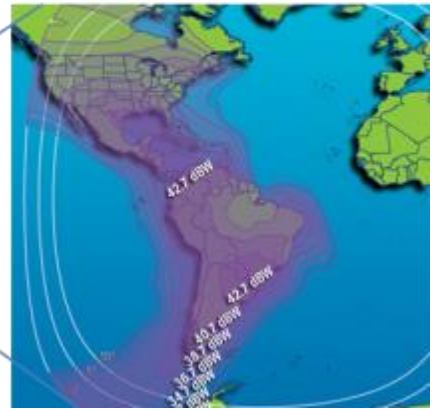
Frequency Range (GHz)	"Band"	Utilisation
18 to 40	Ka	High Data rate comms
12 to 18	Ku	Continental Broadcasting
8 to 12	X	Military in-theatre
4 to 8	C	Global broadcasting
2 to 4	S	Mobile Broadcasting
1 to 2	L	Mobile

Ka-band – 0.5 degree beams



Ku-band – 3 degree beams

C-band – 8 degree beams



Source: Avanti Applied Technologies

Satellites Currently Deliver

Worldwide coverage with ubiquitous network and products

- Same interface globally.
- Land, sea, and air mobile services, including safety services for maritime and aeronautical users.
- Mobile broadband network available anytime, anywhere.

Small portable devices that are easily set up and get online

- Ku-band offerings - currently available regionally, offering high-speed capacity.
- Ka-band offerings - Currently available globally, offering even higher-speed capacity.

Inmarsat Network, Software Defined Networking, Cloud and SATCOM 101

Presenter: Victor Chao, Director IP Networks

Getting Started

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15 GEO Satellites in commercial service

43 Years of service since foundation in 1979

31 Satellite Access Stations worldwide

- AVIATION
- ENTERPRISE
- MARITIME
- GLOBAL GOVERNMENT
- US GOVERNMENT

1,800 Staff in 22 countries, across 33 sites

99.9+% Network Reliability

158 Countries with access to our services

1,368 Trusted partners worldwide

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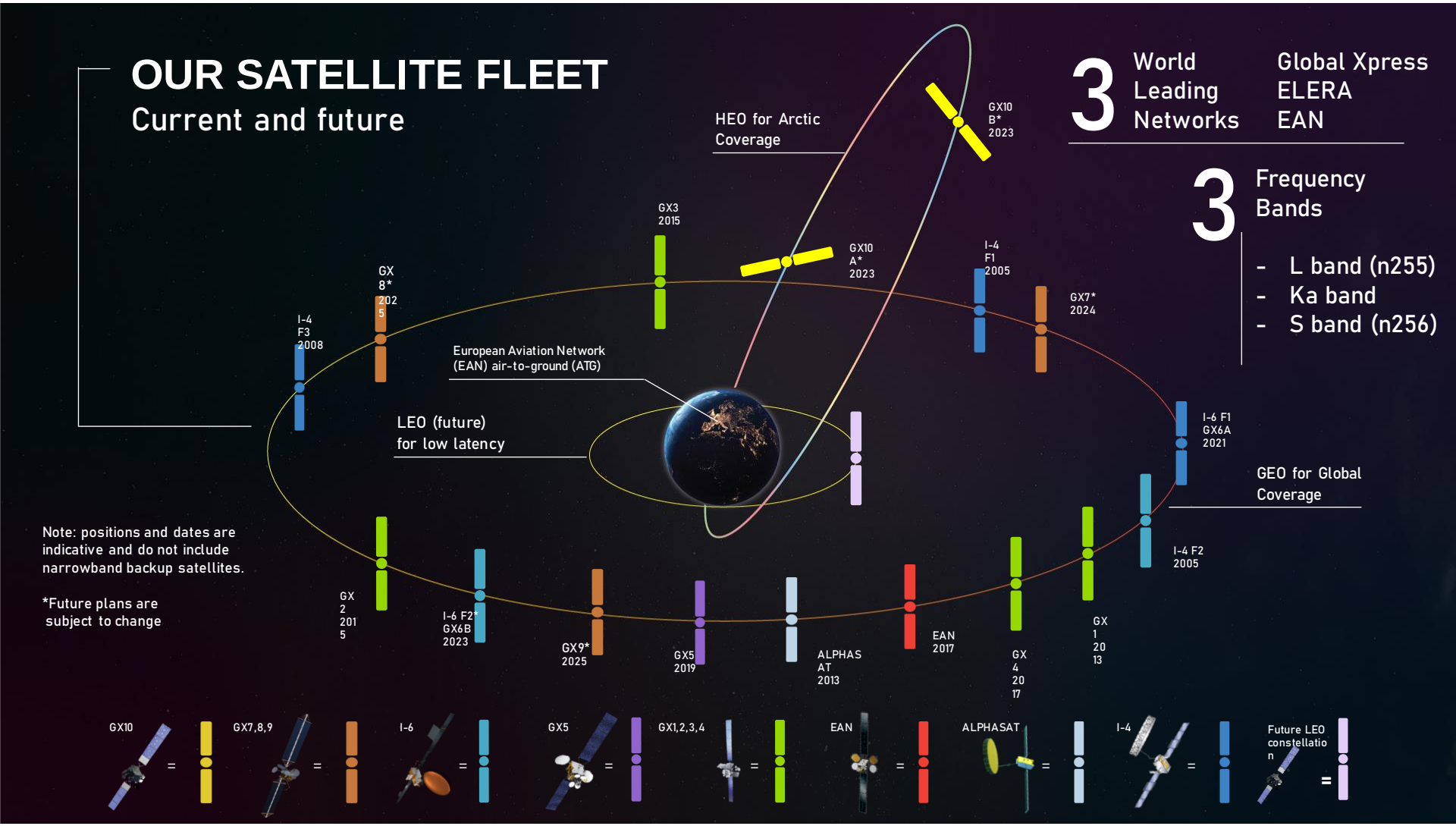
Getting Started



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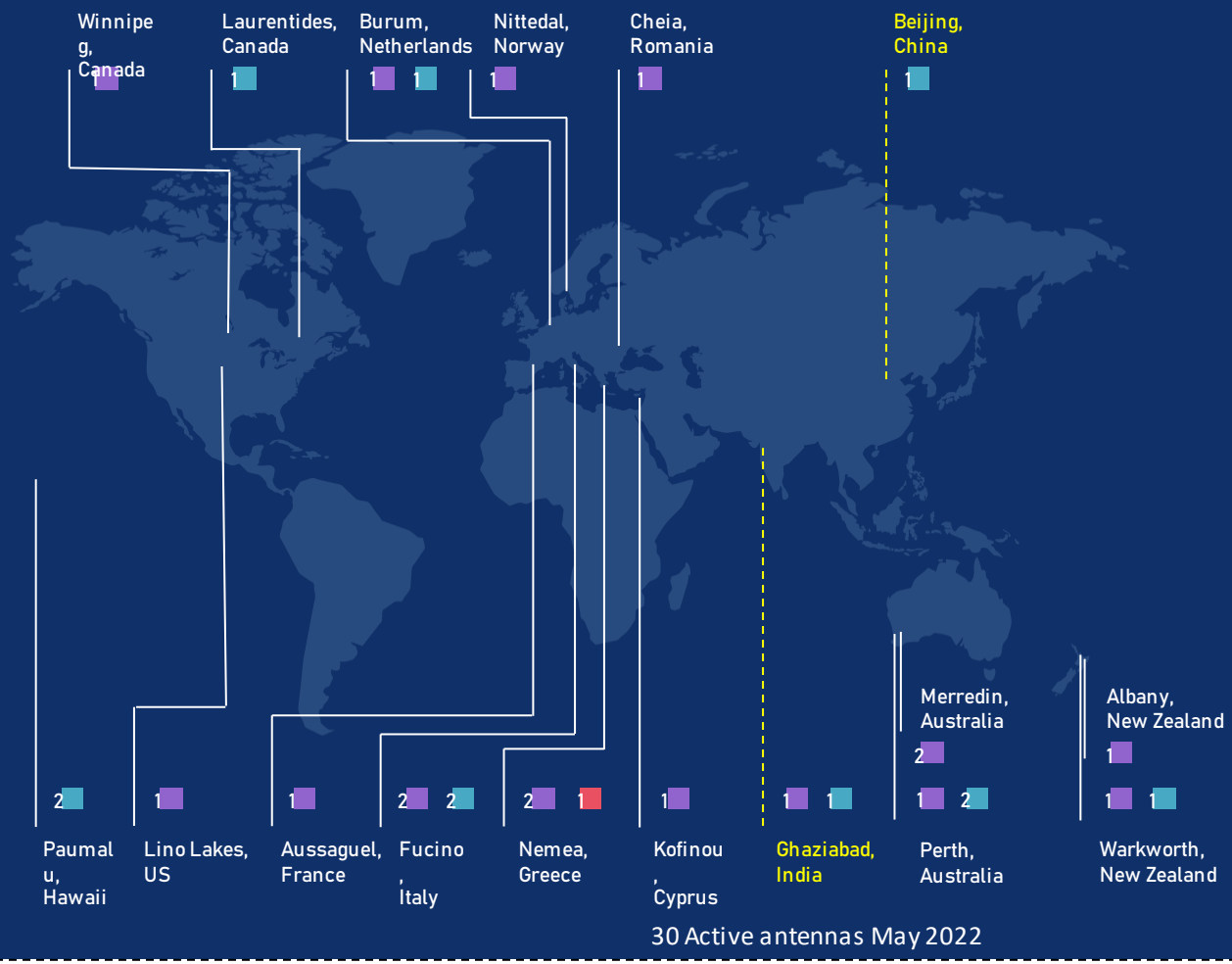
OUR GROUND STATIONS

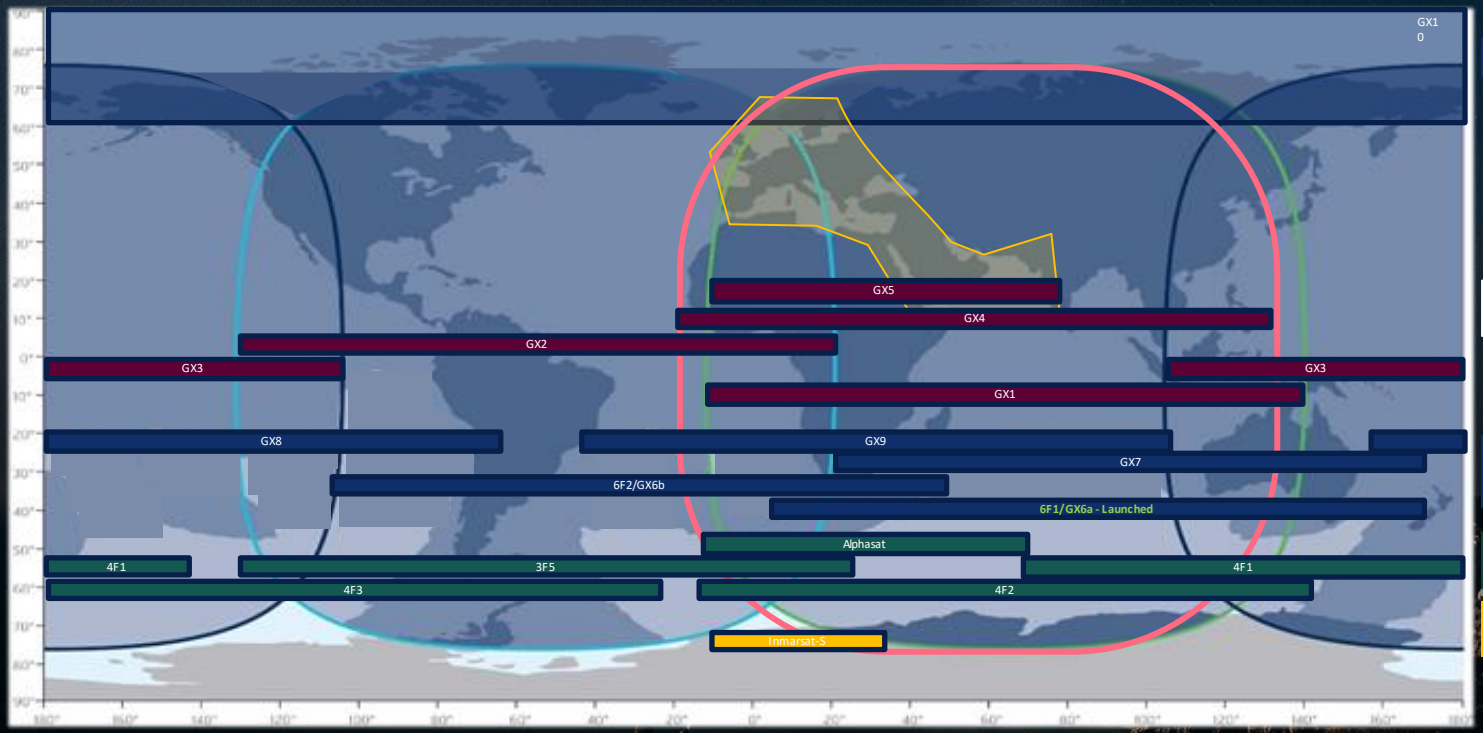
- ELERA SAS (L-band)
- Global Xpress SAS* (Ka band)
- EAN SAS (S-band)
- Independent national network

*Global Xpress also makes use of partner satellite networks in various regions



GLOBAL COVERAGE MOBILITY NETWORK

Reliable, global, high-performance



Future satellite locations notional, all satellite locations subject to change

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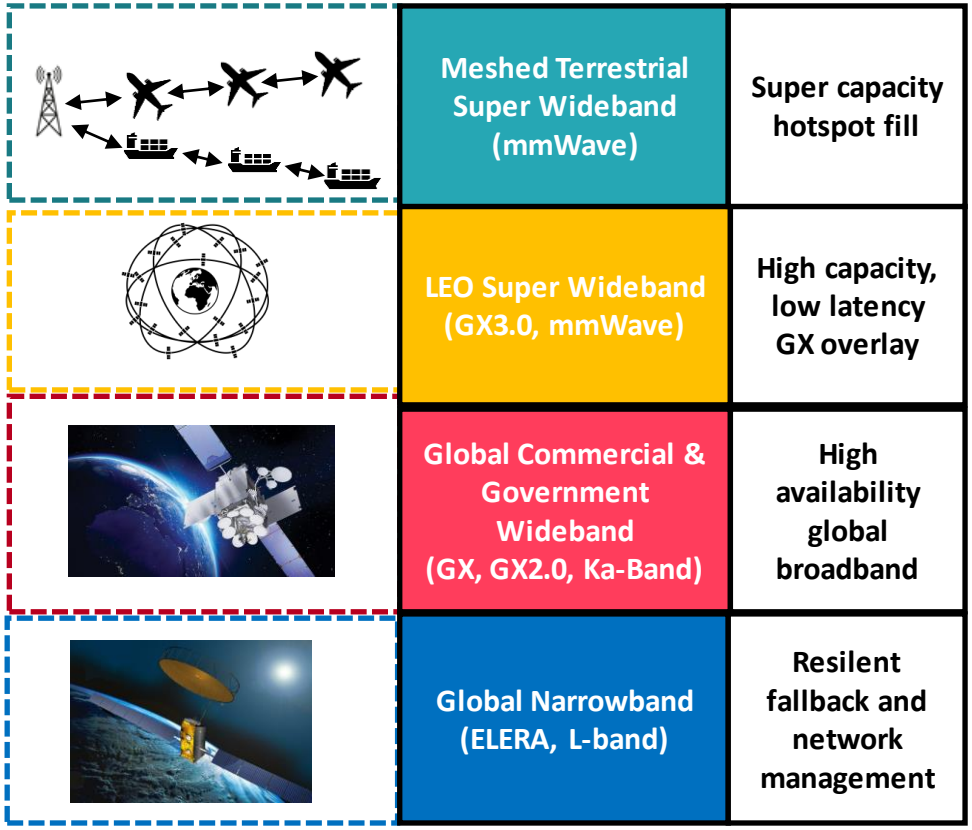
ORCHESTRA

THE ORCHESTRA VISION

A NETWORK OF NETWORKS

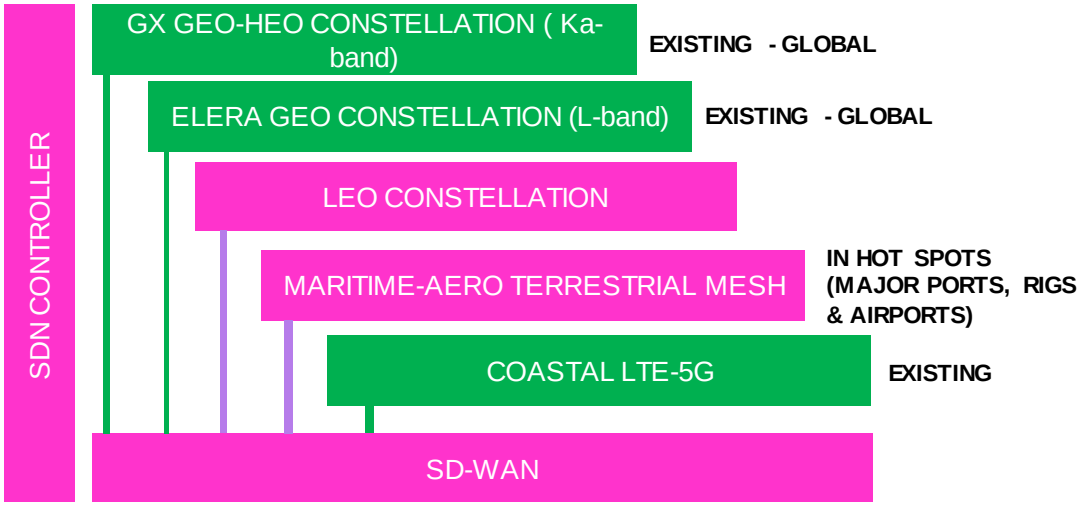
"COMPLEMENTARY UNDERLAY NETWORKS OFFERING THE BEST AVERAGE THROUGHPUT & LATENCY COMBINED IN A SEAMLESS WAY TO THE BENEFIT OF USERS AND APPLICATIONS"

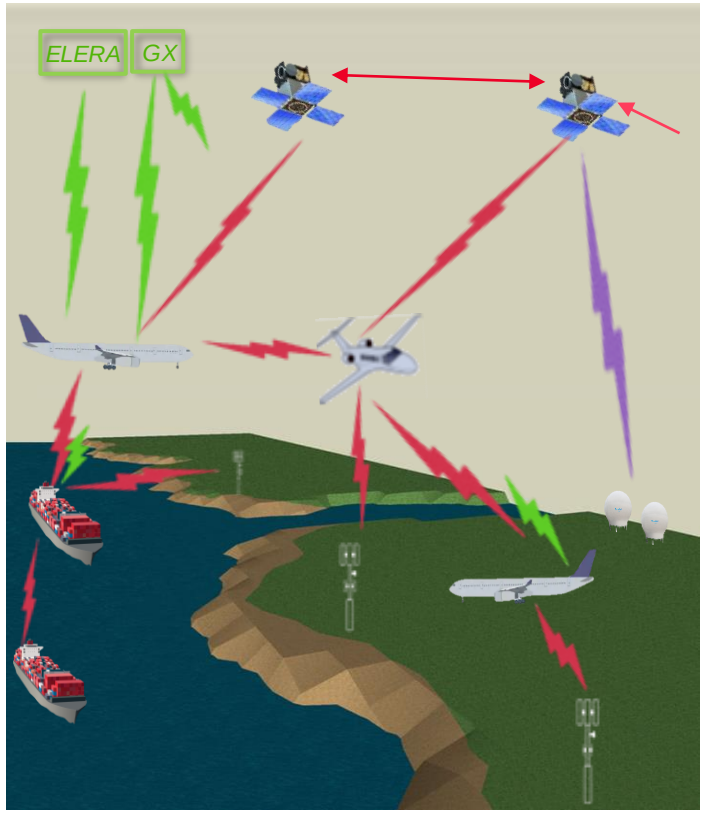
- Global Xpress and ELERA are Inmarsat's current flagship networks
- ORCHESTRA introduces maritime and aeronautical mesh networks and a LEO layer as additional high-speed underlays, complementing the global coverage and resiliency of the Global Xpress and ELERA networks



ORCHESTRA

A NETWORK OF NETWORKS

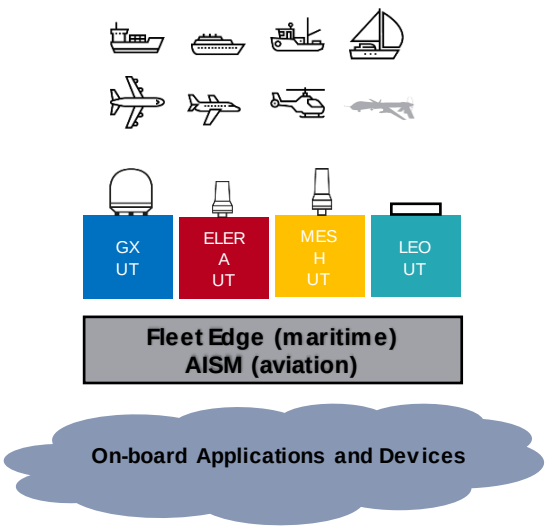




OFFERING THE BEST AVERAGE TPUT-LATENCY AND UNMATCHED ULTRA-RESILIENT EXPERIENCE TO APPLICATIONS COMBINING ALL AVAILABLE UNDERLAY NETWORKS AT ANY POINT IN TIME OR GEOGRAPHY

MARITIME & AERO PLATFORMS

ULTRA-RESILIENCY AND IMPROVED USER EXPERIENCE



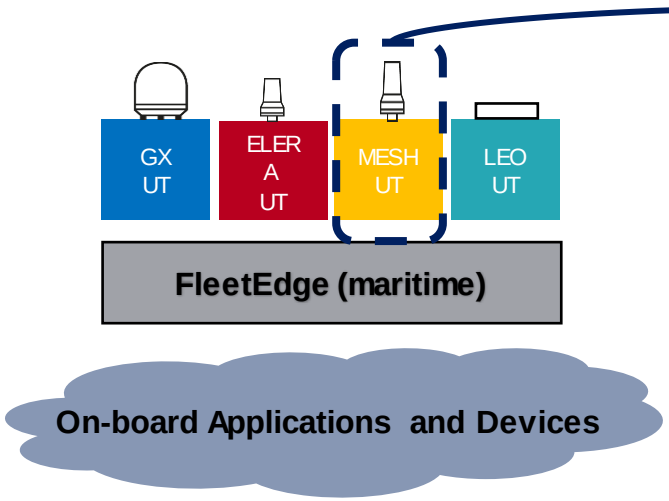
- Discrete Optimized Compact Terminals initially
- Over time, more integration targeted
- Number of underlays depends on platform, use cases

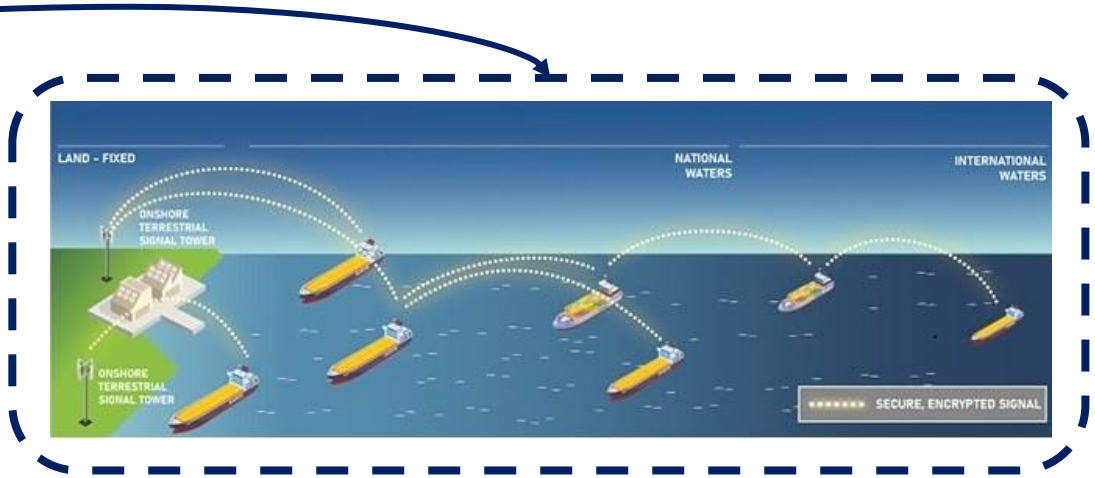
Maritime: Fleet Xpress (FX)
- Commercial shipping focused
- GX, ELERA terminals
- Inmarsat compute platform hosting software and services

Aviation: Advanced Integrated Services Manager (AISM)
- Crew and Passenger communication
- EAN (S-Band LTE and Satellite) and GX-only
- Inmarsat compute platform hosting software and services OR virtualised software running as tenant on third-party compute

Aviation: UAV
- Low SWaP requirements
- LTE and/or ELERA
- Combined User Terminal and Compute SoM

ORCHESTRA MARITIME MESH



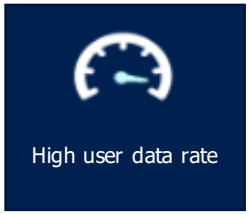


MULTI-ACCESS NETWORK FOR IMPROVED USER EXPERIENCE

- Traffic Switchover between multiple networks
- Existing and future networks combined
- Centralised Management for real-time optimisation
- Deployment envisaged in hotspots and high-demand areas

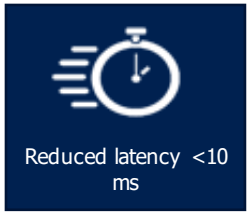
ORCHESTRA 5G MESH

ULTRA-RESILIENCY AND IMPROVED USER EXPERIENCE



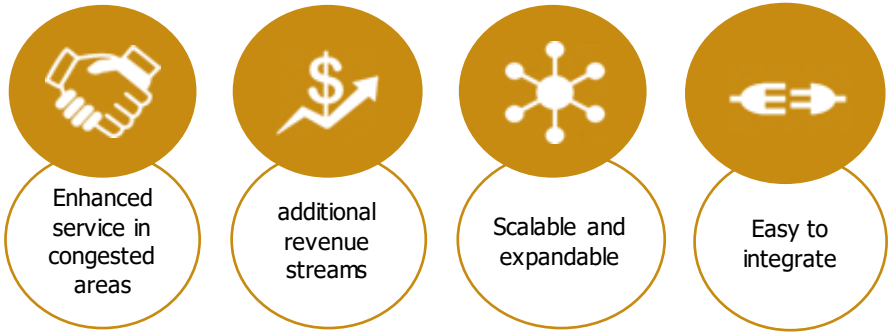
Base stations delivering up to 3 Gbps per ship

Smart selection between different available networks via SD-WAN



Enables very low latency use cases and local breakout

SDN assisted mobility and centralized topology control



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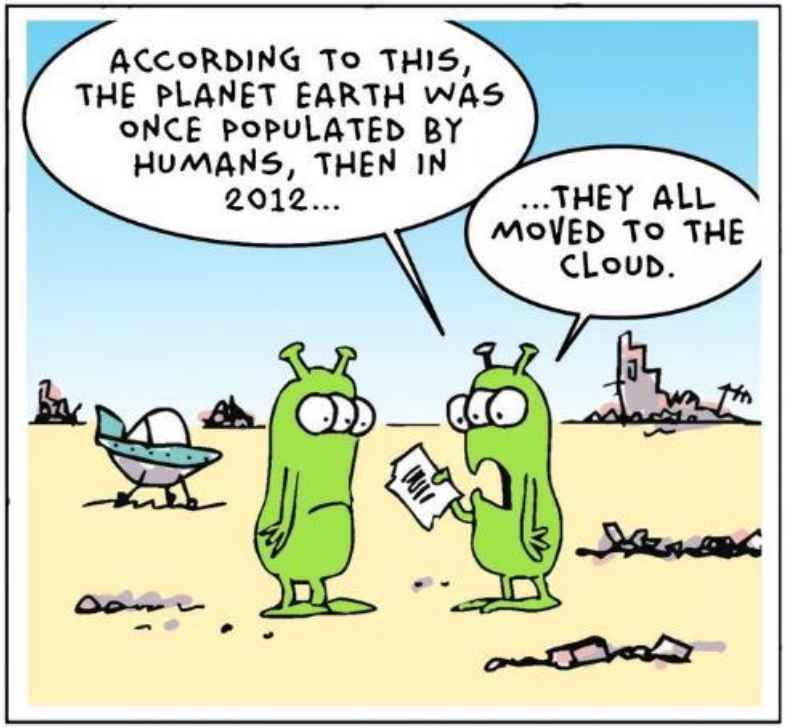
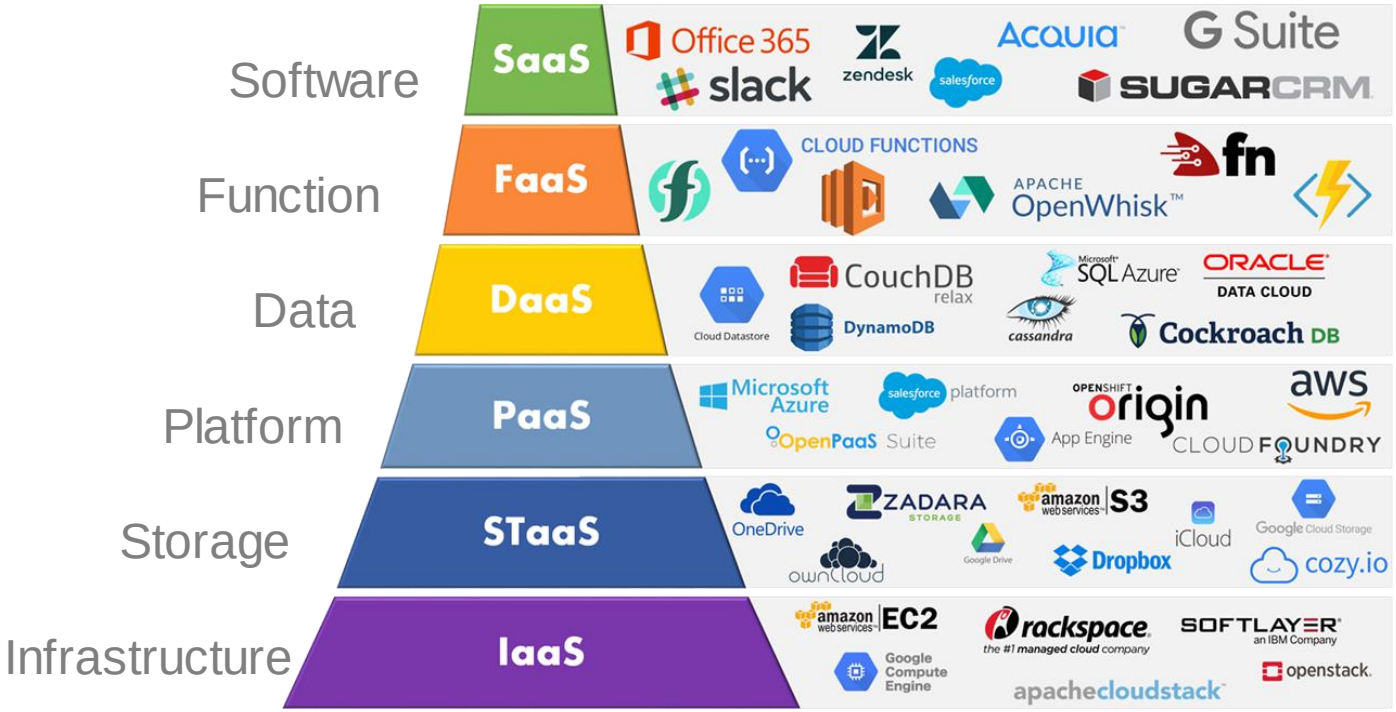
CLOUD AND SOFTWARE DEFINED NETWORKS IN SATCOM

BEFORE WE BEGIN… HOW WE GOT HERE

WWDC June 2011 – iTunes on the Cloud, when we used to pay for music by the song?!?

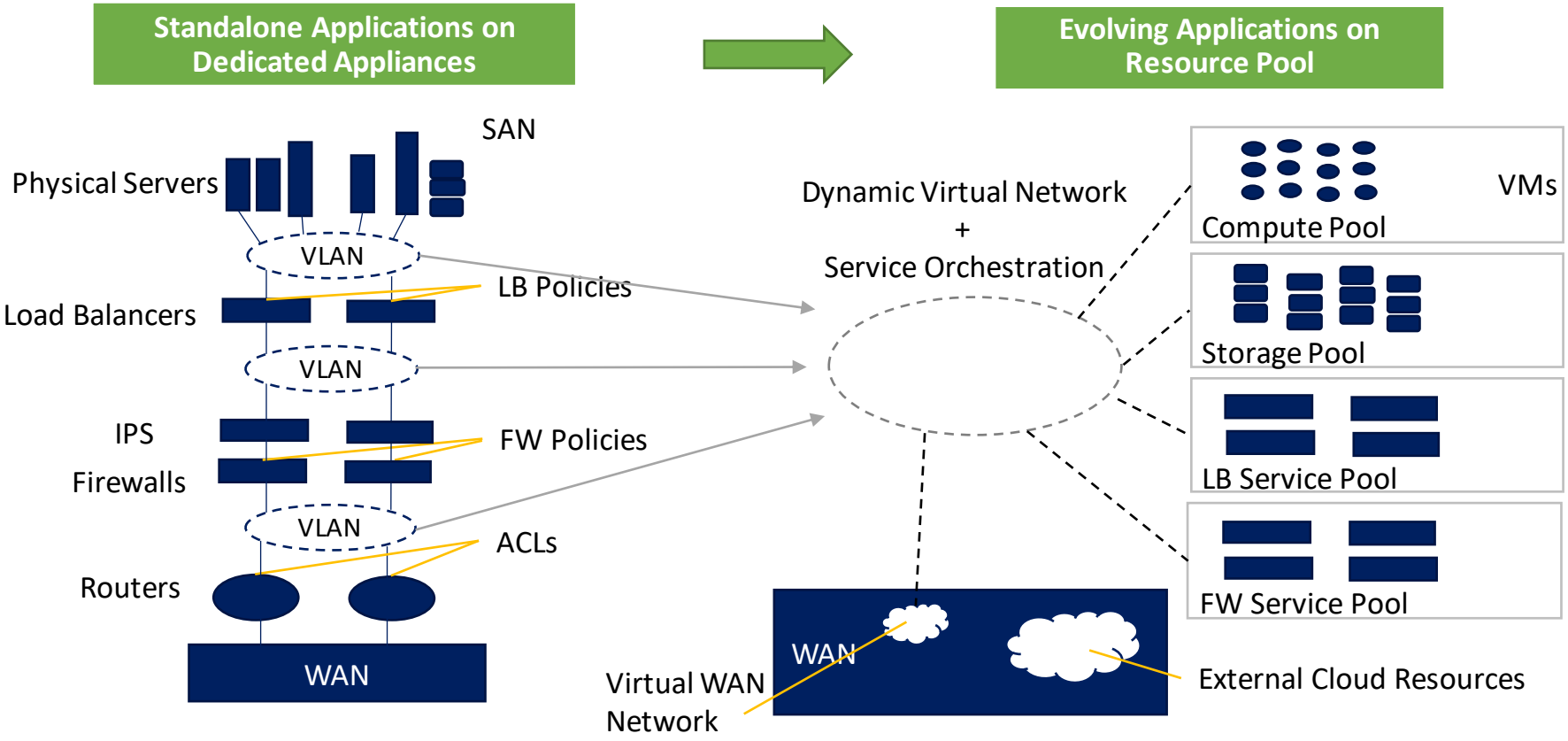


FAST FORWARD TO NOV 2022…



Evolution of Computing and Networking

The trend of shifting towards Software Defined Everything



ABC's of Software Defined Everything

Let's define the terms we are using today…

Application Programmable Interface (API)
Set of rules and specifications that software programs can follow to communicate with each other.

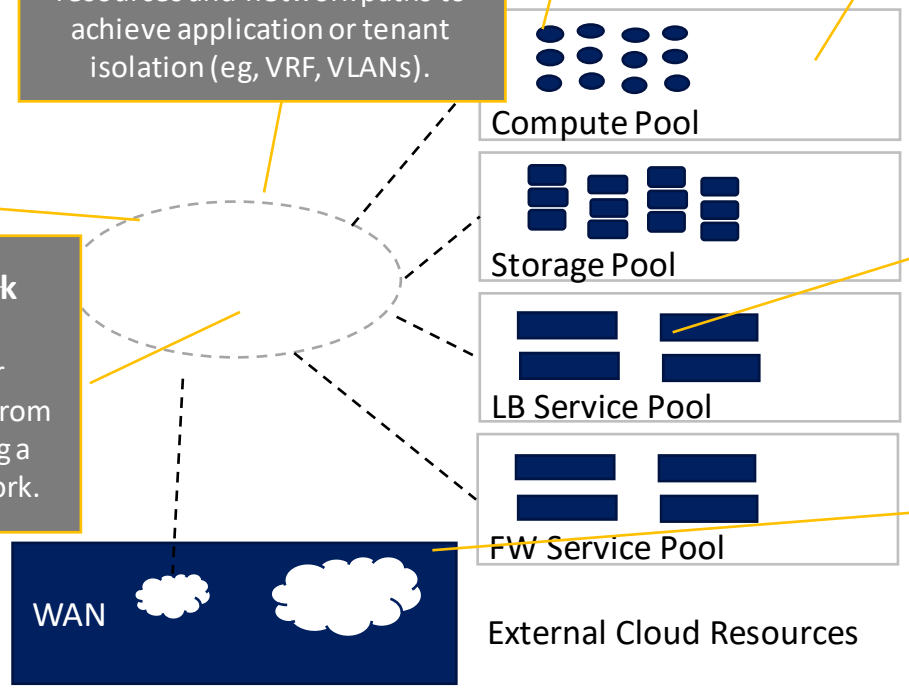
Network Virtualization (NV)
The virtualization of network resources and network paths to achieve application or tenant isolation (eg, VRF, VLANs).

Containers
Shares the Linux kernel by using the OS on the host machine

Virtual Machine (VM)
A software computer, which runs and OS and applications. Every VM has virtual devices that have the same functionality as their physical hardware counterparts.

A hypervisor acts as an agent between the VM environment and the underlying hardware.

Software Defined Network (SDN)
An architecture approach for separation of the control plane from the forwarding plane, achieving a centralized control of the network.



Network Functions Virtualization (NFV)
The act of virtualizing Layer 4-7 functions such as firewall or IDPS, or even load balancing (application delivery controllers).

Cloud Computing
The delivery of on-demand computing over the Internet, on a pay-for-use basis. Various models: IaaS, PaaS, SaaS.

INMARSAT CLOUD LANDSCAPE

	On-Premises Telco Clouds	On-Premises Enterprise Clouds	Hybrid	Public Clouds (AWS, Azure & GCP)
Differentiator	Catered to ultra-fast networking telco applications workloads, with SDN & MANO	Catered to end user web-based transactional workloads (eg, IT applications)		Quick to provision; Catered to be very scalable, cost effective pay per use
Where	• Within our Centralized Data Centers • Smaller footprints may be deployed at National Gateways and some SAS sites	• Within our Centralized Data Centers		• Amazon Web Services • Google Cloud Platform • Microsoft Azure
Anticipated Workloads	• Routers • Firewalls • Deep Packet Inspection	• Network Monitoring • Regulatory Logging		• Service Assurance Data Lakes • Corporate IT Applications

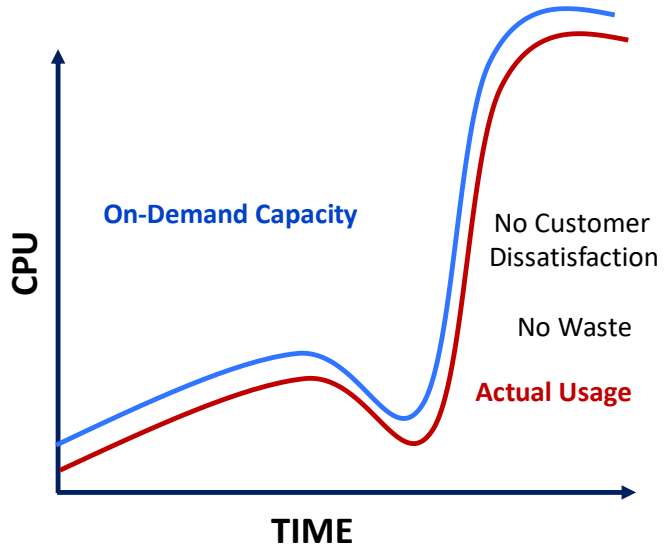
There is no one-cloud-fits-all solution, as many metrics (workload performance, cost) dictate the appropriate cloud type; however, “Cloud-First” mentality has been fully embraced across the organization, both in our core and retail networks

THE BENEFITS OF VIRTUALIZATION

If you need a router or firewall, for example, you stand one up – likewise, if you no longer need it, you tear it down

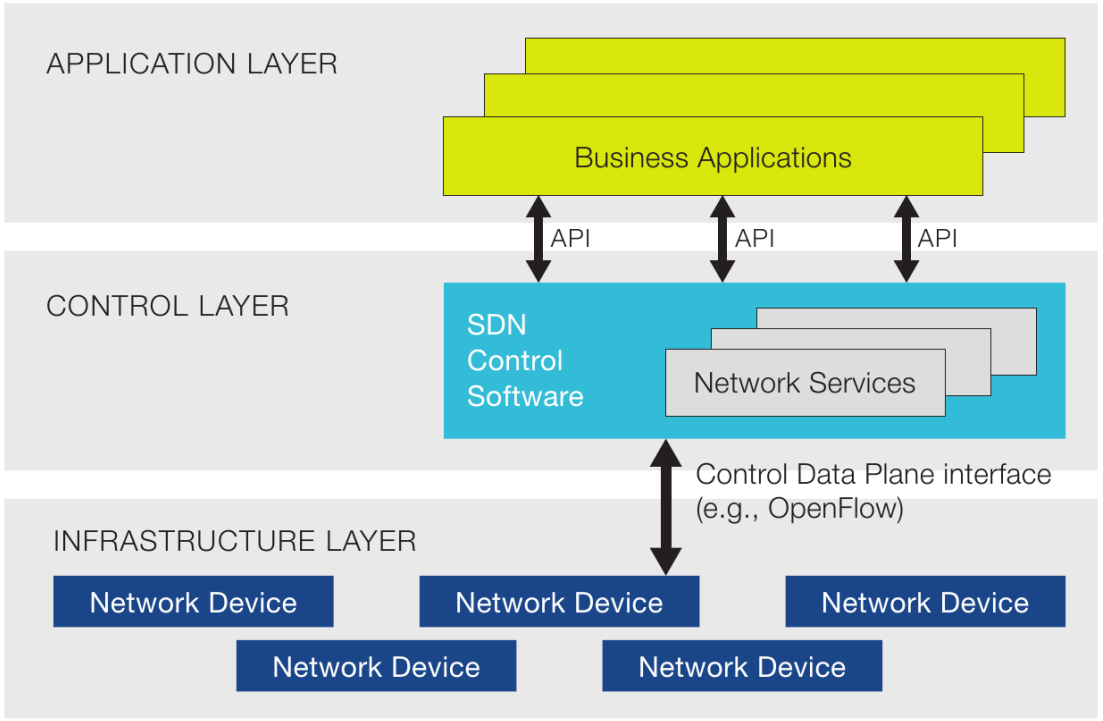
1. We can scale virtual network functions (VNF) on the cloud elastically based on real-time demand
2. Over time, we can upgrade the underlying compute to tomorrow's performance without impacting the VNFs
3. Deployments should be 'greener' with less hardware and fewer racks to fill
4. Virtualized appliances are *generally* less expensive than their appliance counterparts – at times, the vendors allow you to stamp out as many instances as you need, and you just pay for the support

In fact, we are seeing in some cases vendors who only provide virtualized forms of their applications

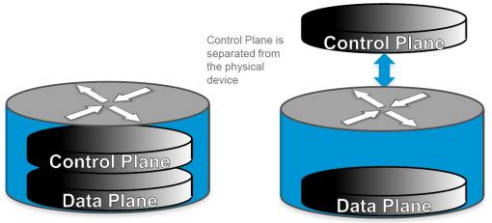


WHAT IS SOFTWARE DEFINED NETWORKING?

The decoupling of traffic forwarding and processing from control



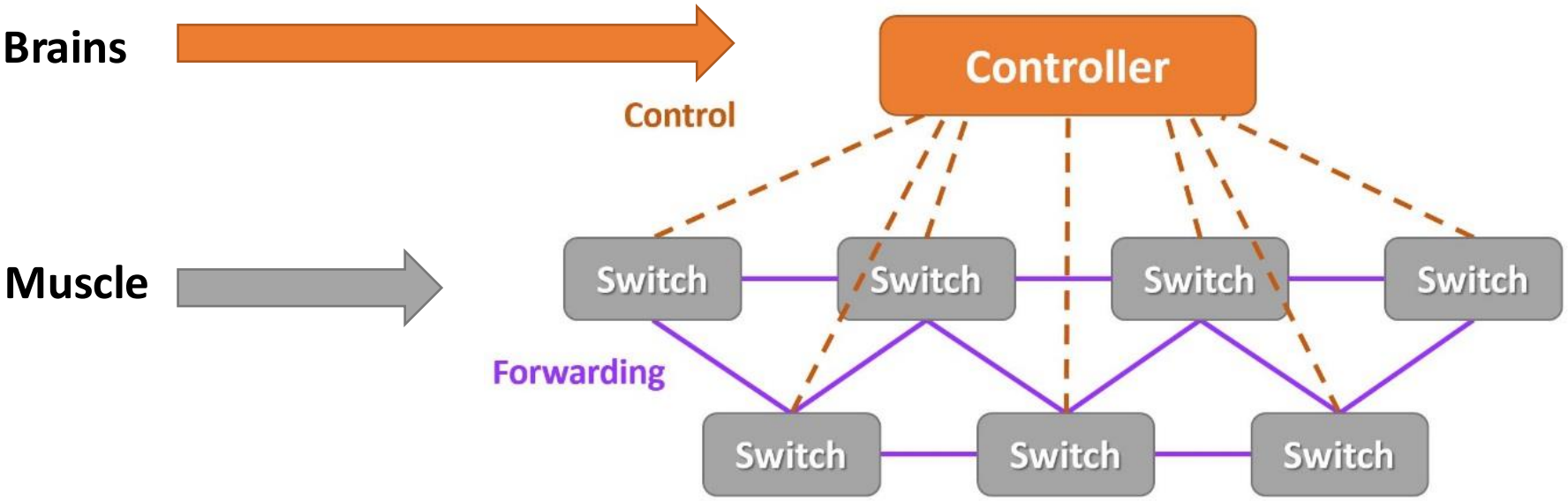
Source https://www.opennetworking.org



- Enables the network control to become directly programmable
- Enables the underlying infrastructure to be abstracted for applications and network services

WHAT DO YOU ACHIEVE VIA SDN?

- Logically centralized control, using OpenFlow
- Enterprise Management
- Better Quality of Service (QoS)



SDN AND NFV OPPORTUNITIES WITH SATCOM

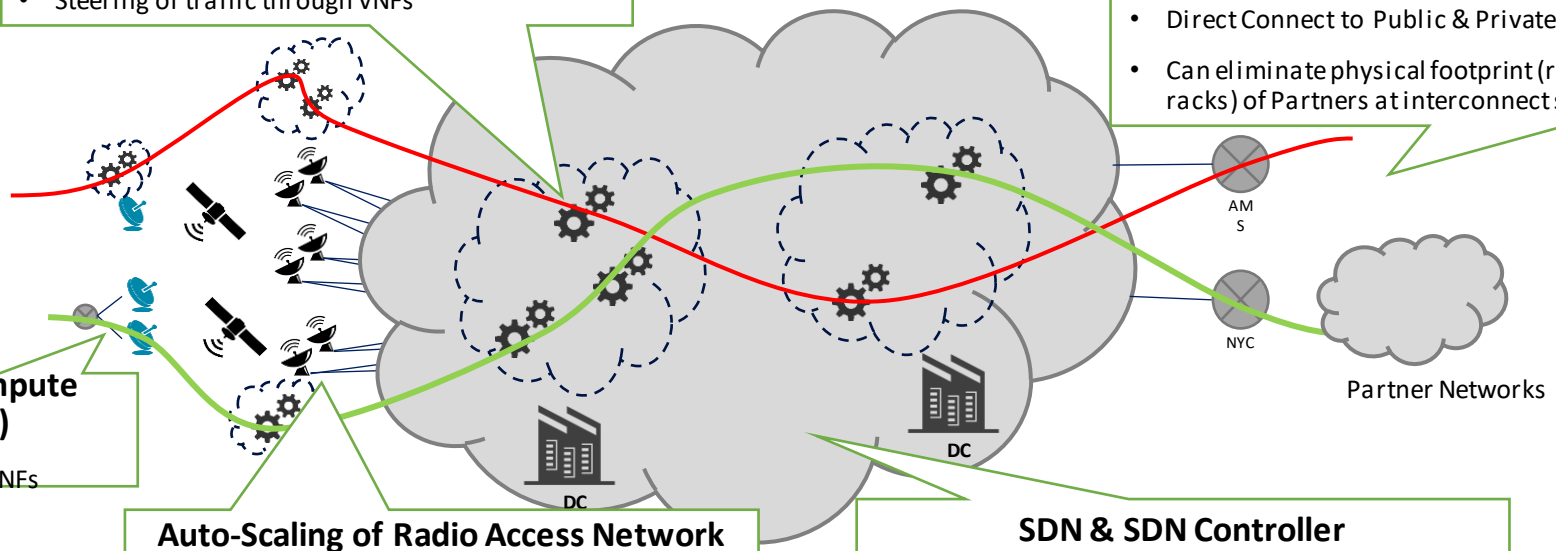
Use cases prevalent throughout end to end path – Edge, RAN, Data Centres, Interconnect

Service Function Chaining

- Hosting of Partner & CAP applications
- Steering of traffic through VNFs

Flexibility in Interconnect Options

- Layer 2 and/or Layer 3 options
- Direct Connect to Public & Private Clouds
- Can eliminate physical footprint (routers, racks) of Partners at interconnect sites



Edge Compute (CPE)

- Hosting of VNFs

Auto-Scaling of Radio Access Network

- Fully virtualized platforms
- Deployment of PP processors can be centralized
- Scales up and down as required to meet demand

SDN & SDN Controller

- Full control & automation of network assets
- Significant reduction of service provisioning times
- API driven

Benefits of SDN:

Efficiency:
Optimize existing applications, services and infrastructure

Scale:
Rapidly grow existing applications and services

Innovation:
Create and deliver new types of applications and services and business models

Simplified operations:
Agile networks, greater flexibility

Cost effective:
Reduce hardware cost

Benefits of NFV:

Accelerate Time-to-Market:
Reducing the time to deploy new networking services to support changing business requirements

Reduce CAPEX:
Reducing the need to purchase purpose-built hardware

Reduce OPEX:
Simplifying the roll out and management of network services.

Deliver Agility and Flexibility:
Quickly scale up or down services to address changing demands

Inmarsat is committed to fielding SDN/NFV technologies through various major initiatives to improve efficiency and customer experience

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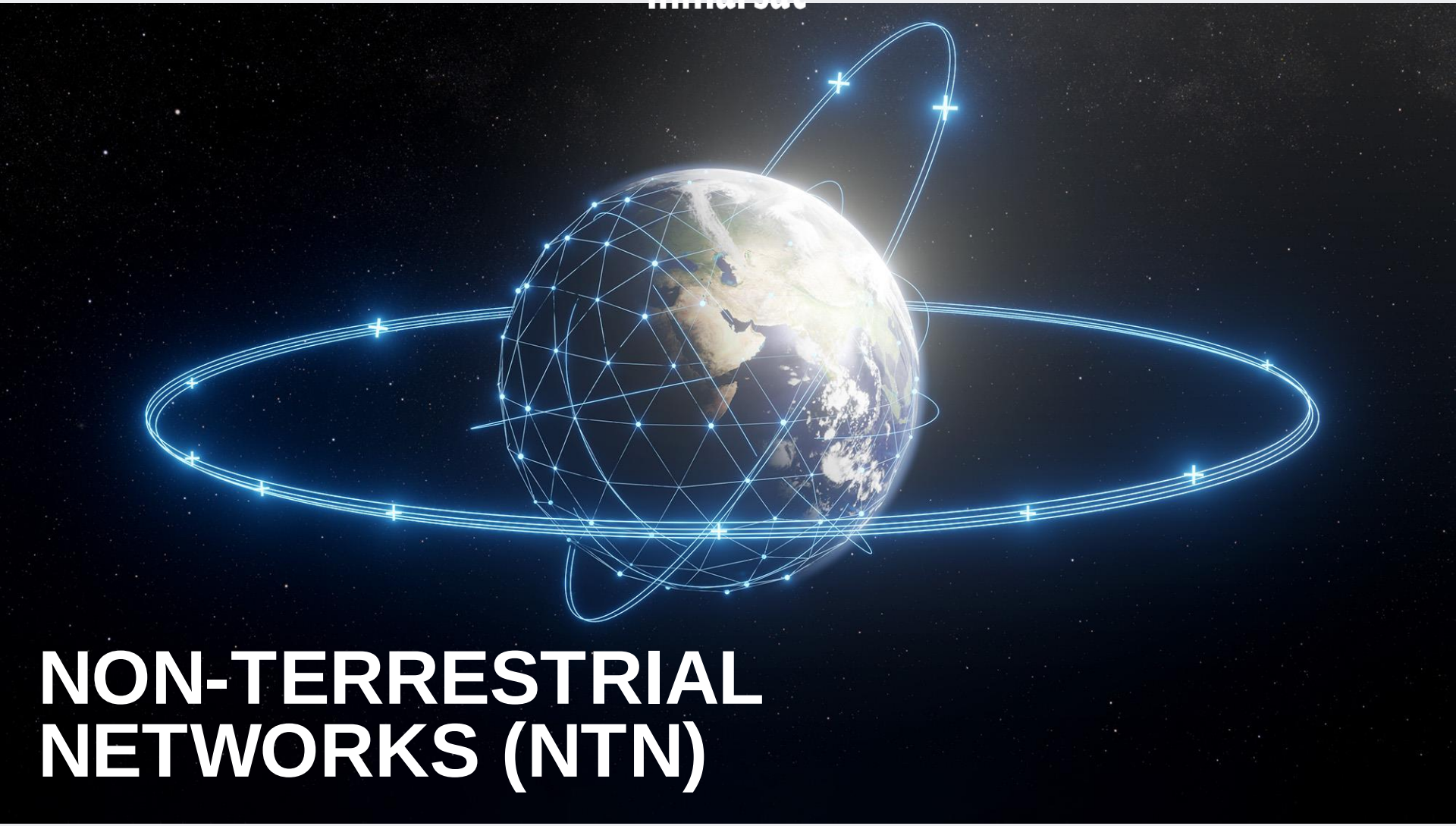


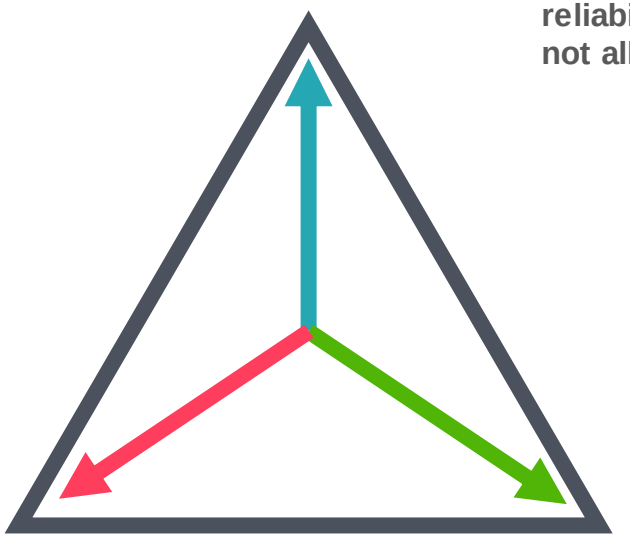
NON-TERRESTRIAL NETWORKS (NTN)

5G: USE CASES

5G enables new families of use cases and further adoption by industry verticals

Enhanced Mobile Broadband (eMBB)

High bandwidth, data rates, and traffic volumes. High reliability in some but not all cases.



IoT

Massive Machine-Type Communication (mMTC)

Millions of devices, low data rates, low cost, low energy consumption

Ultra-Reliable, Low-Latency Communication (URLLC)

Very low latency, very high demand reliability and availability. Not necessarily high bandwidth.

5G NON-TERRESTRIAL NETWORKS (NTN) IN A NUTSHELL

3GPP RELEASE 17 INTRODUCES SUPPORT FOR ACCESS NETWORKS BASED ON AERIAL OR SATELLITE PLATFORMS

Extension of 3GPP standards for 5G System and air interface to support access and backhaul via air- and space-borne platforms.

Use cases:

- eMBB → NTN-NR (sub-7 GHz and 10+ GHz inc. Ka band and above)
- mMTC → NTN-IoT via NB-IoT + LTE-M (sub-7 GHz)

User Devices:

- Handheld, IoT
- VSAT (fixed, mobile)
- low speed (pedestrian), medium speed (vehicle, train), high-speed (aircraft, UAV)

Access Nodes:

- GEO/GSO
- NGSO (LEO, MEO, HEO*)
- HAPS (High Altitude Platform Stations)
- ATG/A2G (Air To Ground)

SUCCESSFUL NB-IOT TRIAL IN 2020

VALIDATED NB-IOT RELEASE 17 NTN FEATURES IN REAL WORLD TRIAL

Set-up

UE: Unmodified MediaTek NB-IoT chipset

Satellite: Inmarsat Alphasat L-band, GEO orbit

eNB: Institute for Information Industry (III)

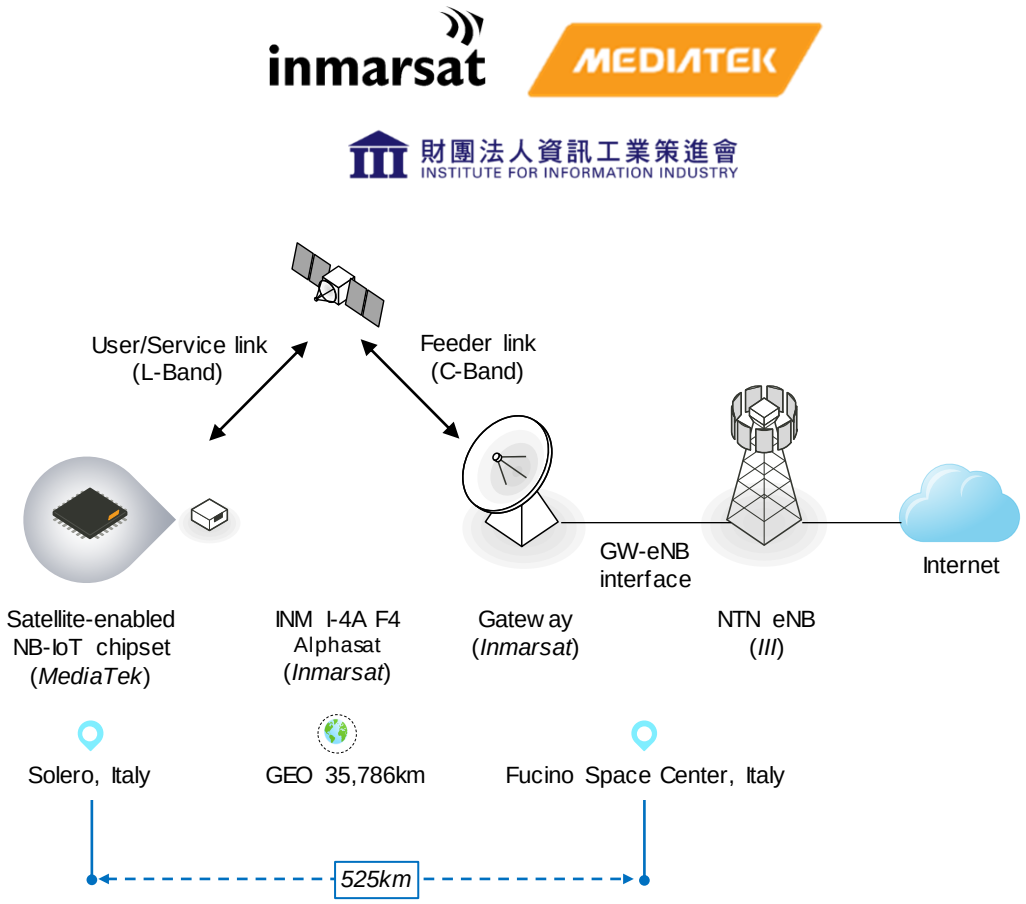
UE and eNB 525km apart

Result

Bi-directional link successfully established

Aug 19, 2020

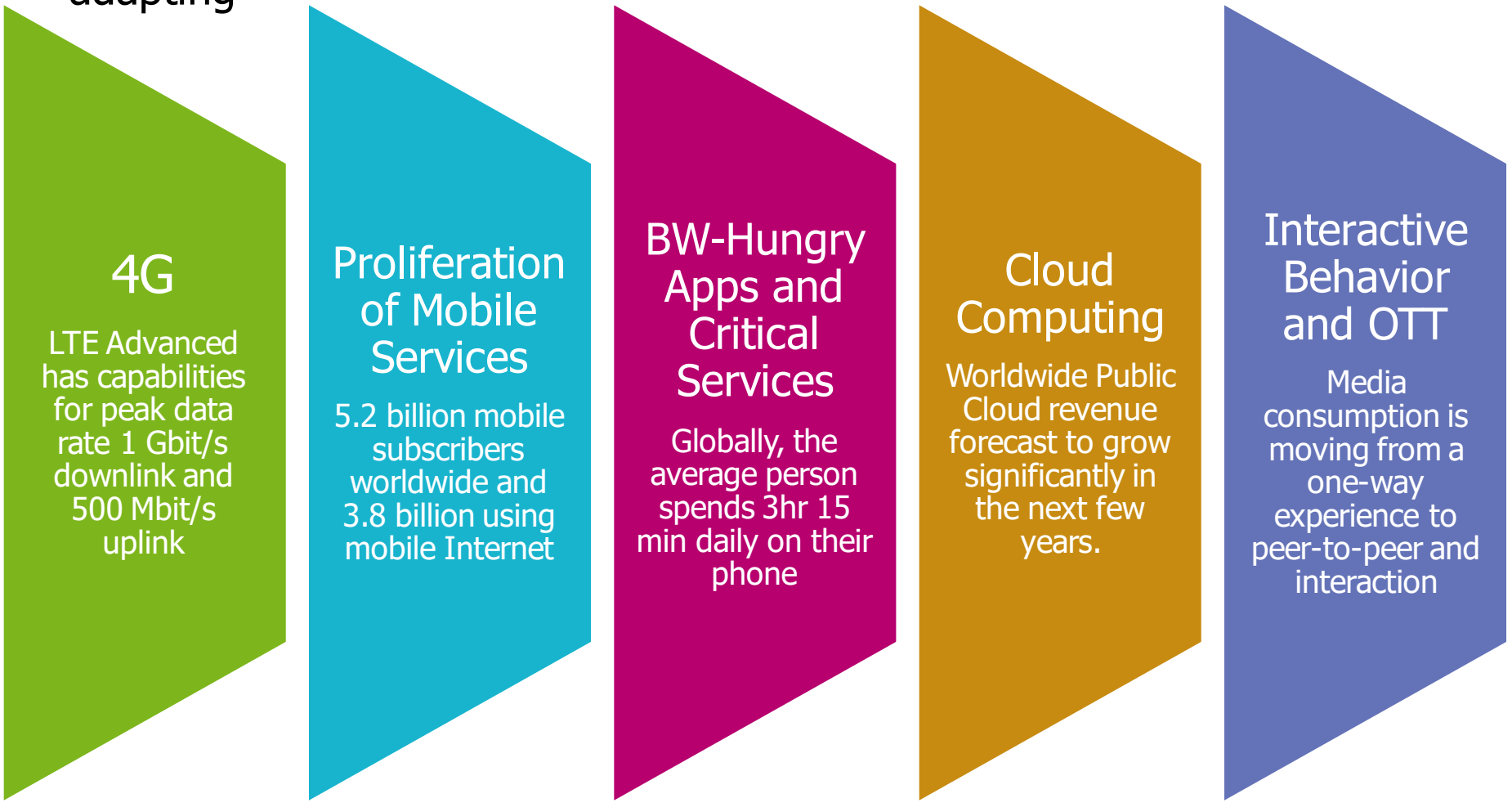
https://www.inmarsat.com/news/successful-trial-advances-global-5g-iot-communications/
https://www.mediatek.com/news-events/press-releases/mediatek-conduct-worlds-first-public-test-of-5g-satellite-iot-data-connection-with-inmarsat



Forward Looking – Enabling the Connected World

The Connected World

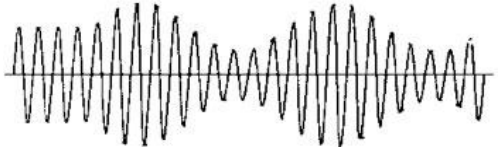
End user expectations are evolving, and satellite strategies are adapting

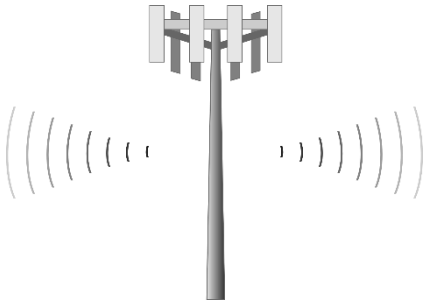


High speed access to anything, from any device, anywhere, anytime

What is 5G?

- A technical specification?
- A frequency band?
- A business model?





Like all the previous "G"s, 5G describes a new paradigm of connectivity.

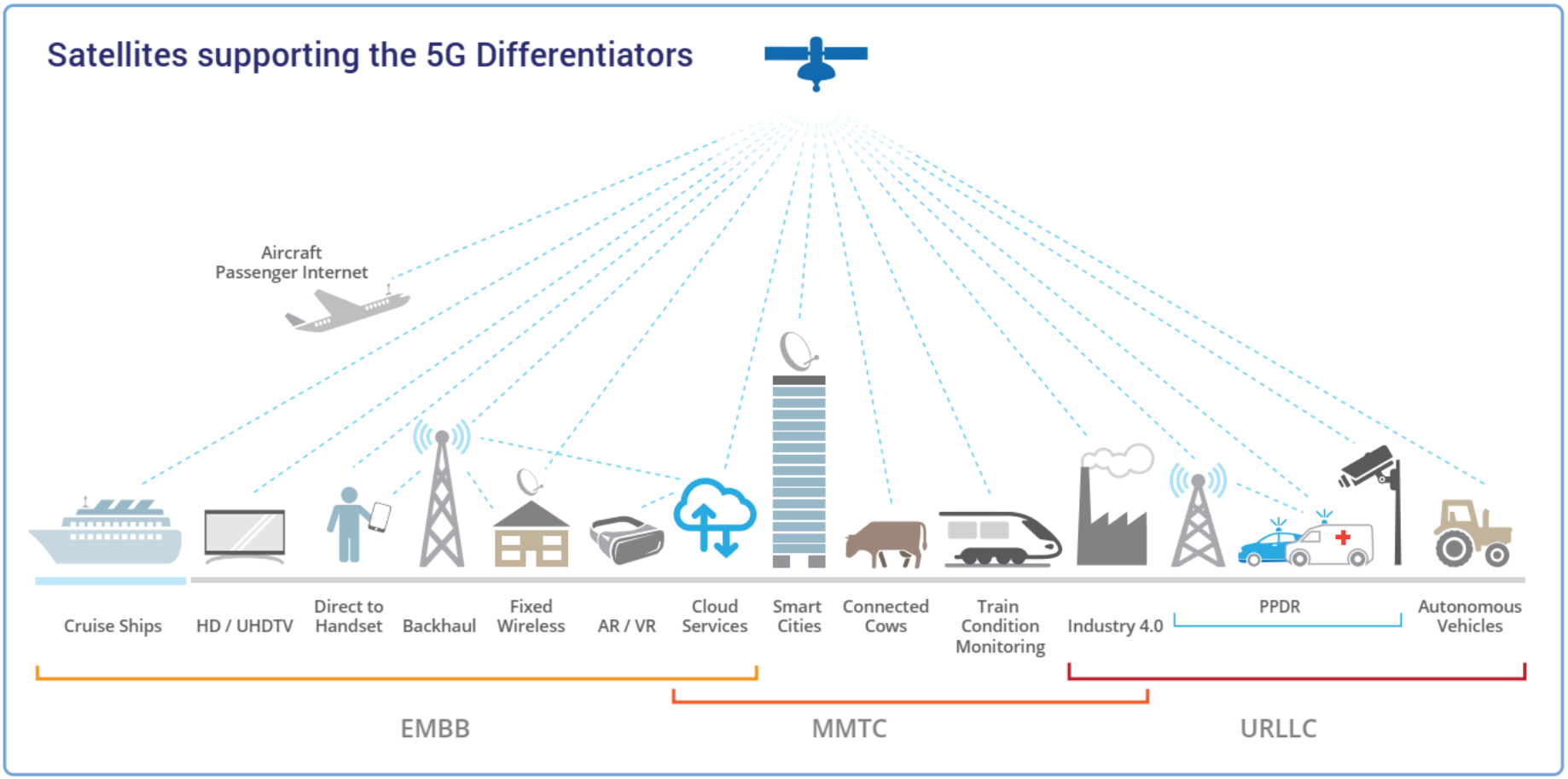
5G Ecosystem

European Commission

Value of satellites in the 5G ecosystem

- **Coverage**: Satellites continue to be the most effective means for reaching areas beyond terrestrial coverage as well as to passengers in trains, aircrafts & vessels
  - Many services more effectively provided by satellites also in urban areas, e.g. broadcast, multicast, backhaul
- **Capacity**: user expectations for higher mobile broadband data rates
  - Satellite networks continue to evolve to keep up with expectations and demand, e.g., increased throughput (in Tbps), more powerful spacecraft
  - Use of higher frequencies with greater bandwidth (e.g. Q/V-bands) for feeder links to free up lower spectrum bands for service links
  - Reducing the Cost per bit of data communications
- **Resilience**: Largely immune to natural and manmade disasters. Connectivity when all other networks are down.
- **Reliability**: Lower frequency bands (e.g. L-band) ideal for high reliability applications, such as safety services
- **Latency**: Some satellites naturally have longer latency than terrestrial systems
  - Constellations of small LEO satellites for lower latency requirements
  - Many applications are not latency-sensitive; and not all terrestrial networks are low-latency
- **Diverse Capabilities**: Satellites bring functionality like one-to-many broadcast and location-based services that will be essential to achieving the promise of 5G

Satellite as the Enabler of 5G Use Cases



Source: ESOA "5G Ecosystems Executive Summary"

Avoiding a 5G Digital Divide

- 5G offers benefits for people everywhere
- COVID-19 has highlighted that connectivity is a basic need to ensure socio-economic inclusion and the functioning of economies and governments
- Existing mobile networks have not achieved ubiquitous coverage and there is no reason to expect 5G will change this.
- Terrestrial 5G in the C-Band or mmW bands will rely on denser network topographies of small cells. Infrastructure that may be too expensive to be profitable in some communities.

- 5G must not be reserved for the urban elite.
- Only a heterogeneous 5G network with multiple technologies will connect the excluded and allow them to participate in a world that is racing ahead with technological developments.

Source: ESOA "5G Ecosystems Executive Summary"

5G and Satellite

Why Satellite & 5G?

Ubiquitous Telecommunication Requires Hybrid Networks

- 5G aims to provide reliable, fast & **ubiquitous** telecommunication networks
  - Ubiquitous 5G can drive and enhance economic development for the whole population
- Regional, mostly urban, terrestrial only investments will not deliver ubiquity
  - Urban use case are common e.g. smart cities, drone tracking
- Satellite delivers truly ubiquitous global coverage with great efficiency
  - Partnership between satellite & terrestrial networks to deliver the 5G vision – regional or global

SATELLITE FOR 5G: CONNECTING THE UNCONNECTED

- L- Band Satellite capacity will also be key for **extending 5G backhauling into more remote areas**
- Satellite provides high bandwidth, ubiquitous service beyond cities and unreachable areas, **supporting data delivery at the edge and enabling network availability for communications on moving platforms**
- Beyond 5G backhauling, **Hybrid L-band solutions will support a wide range of new 5G applications** such as connected vehicles and autonomous driving, Inmarsat's unique solutions could efficiently support the firmware or software over-the-air ("FOTA/SOTA") updates, map updates and real-time traffic conditions and parking availability

3GPP 5G project – Adding Non-terrestrial Networks

NTN = GEO, LEO & MEO SATELLITES AND HAPS

IoT

- Industrial verticals (mining, tracking, agriculture etc.), safety applications and personal communications

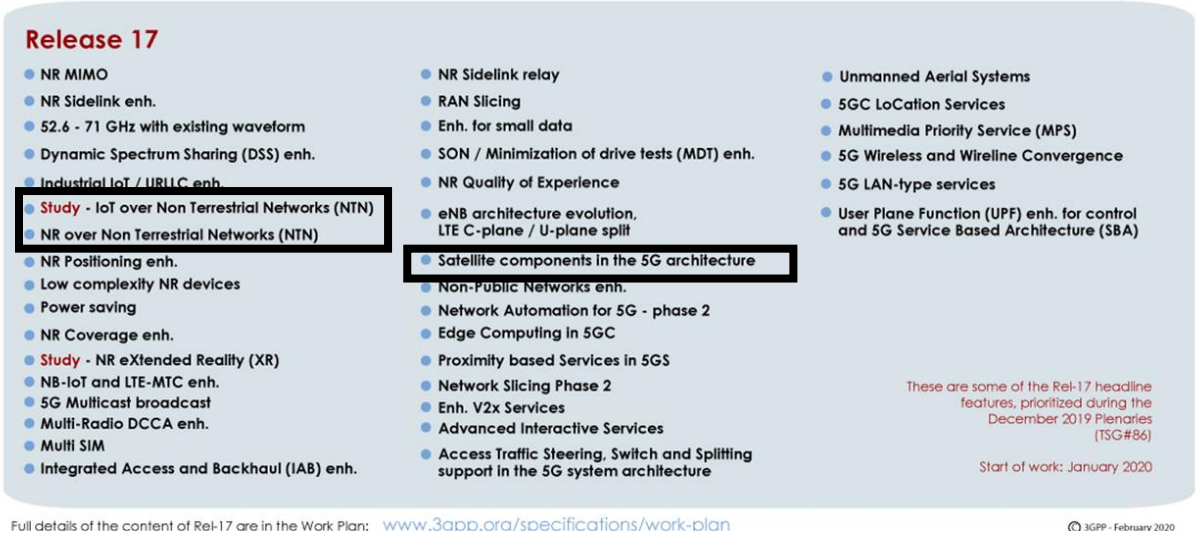
Broadband / NR

- Universal coverage and terminals

5G Network architecture

- Options to deliver core & backhaul using either satellite or fiber. Use common SDN & NFV architectures.

Satellite plays an important role providing ubiquitous coverage working with terrestrial MNO networks.



Satellite Operators Already Use Mobile Phone Technologies

E.G., Inmarsat: Three generations of mobile technology

4G – EAN, European Aviation Network

- In Flight Connectivity using a hybrid satellite / terrestrial network in partnership with Deutsche Telekom

3G – Inmarsat BGAN

- Broadband global area network providing 3G based voice and data globally

2G – Inmarsat GSPS

- Global satellite phone system providing 2G based voice & messaging globally

The Satellite Component of IMT 2020

ITU-R WP 4B

WP4B Report - Vision, requirements and evaluation guidelines for satellite radio interface(s) of IMT-2020 **was approved by the ITU**

FIGURE 1

Satellite component of IMT-2020 Use Case

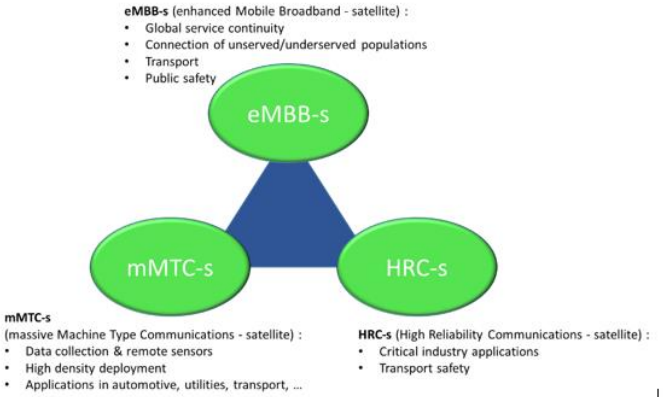
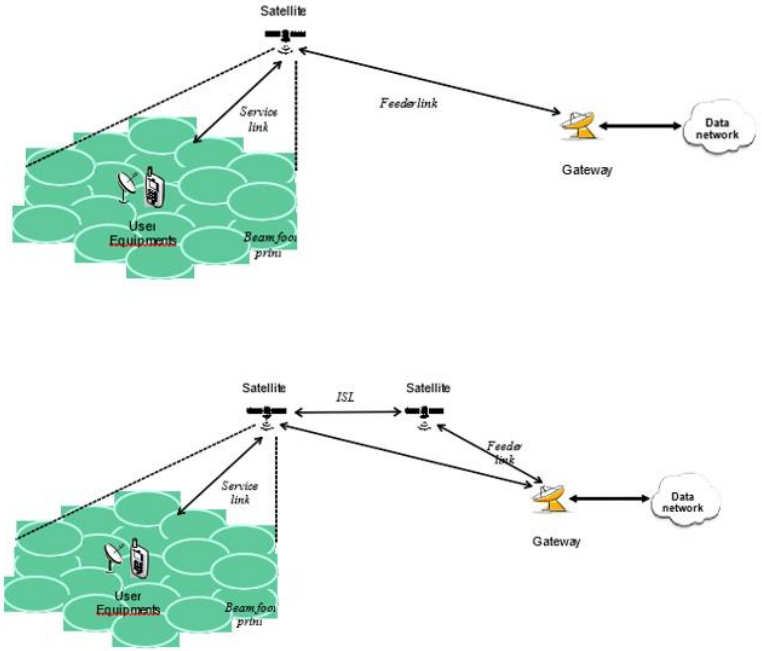
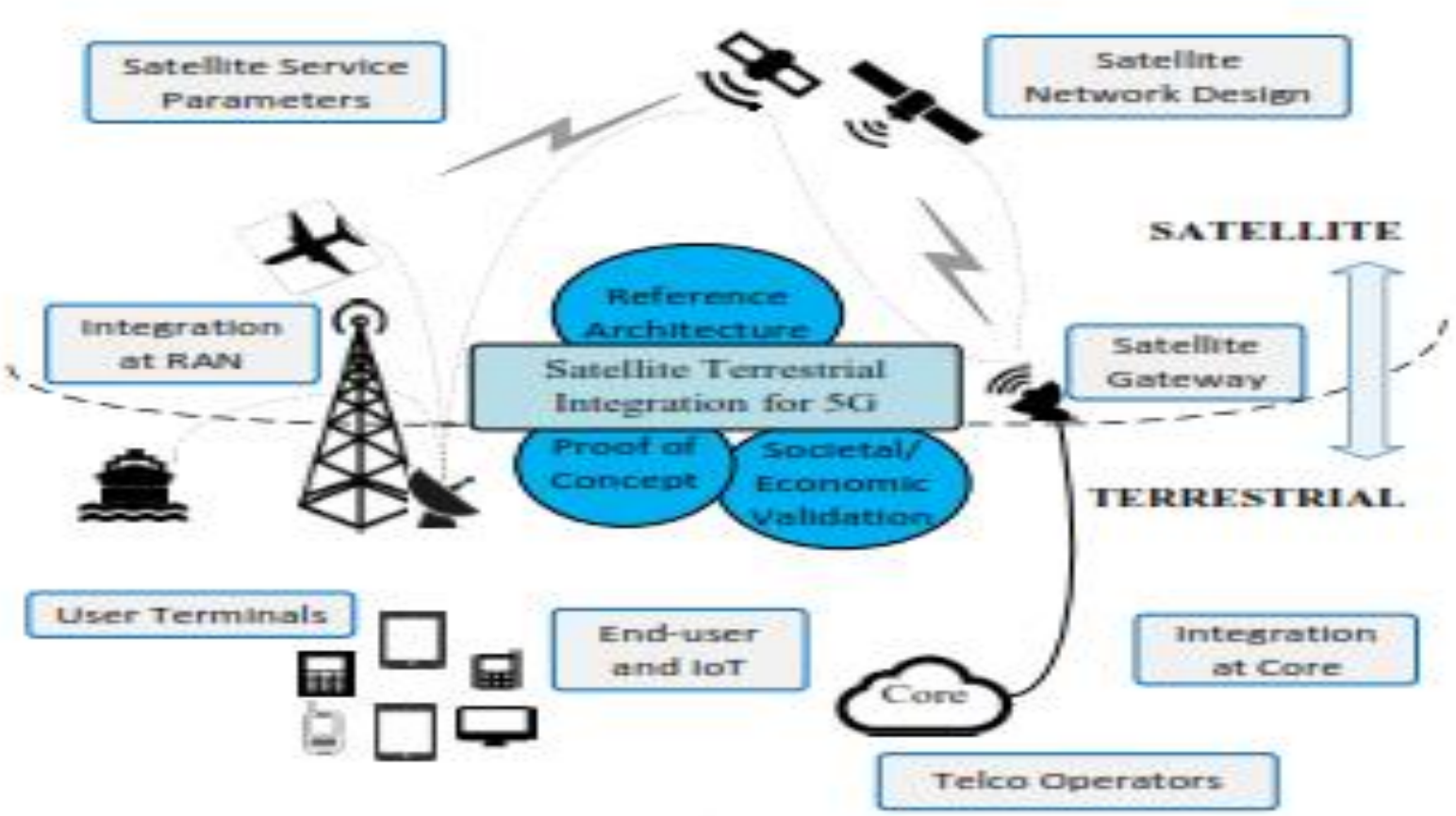


FIGURE 2

Example of typical system scenarios whereby the satellite implements respectively a transparent and a regenerative payload



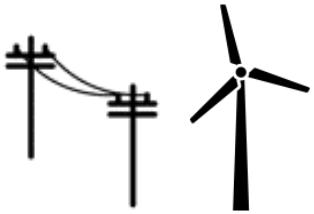
Integrated 5G Network Architecture



Agriculture and Rail Use Cases

Presenter: Steven Tompkins, Director Market Development

ENABLING THE SAFETY, SUSTAINABILITY AND EFFICIENCY ON LAND



Delivering the Smart Grid in Rural Areas and Enabling the Transition to a Low Carbon Economy

CEMIG

ERGON ENERGY

UK Power Networks

enel

Helping Move People and Goods Efficiently, Safely and Sustainably

rumo

HITACHI
Inspire the Next

ORBCOMM

Connecting Food Production from Seed to Fork Globally

HEXAGON AGRICULTURE

NEVONEX

SENSOTERRA

FARMBOT®
MONITORING SOLUTIONS

L BAND IS ENABLING THE WORLD TO PRODUCE MORE FOOD, SUSTAINABLY

- World population growing to 10 billion by 2050 (7 billion in 2011)
- We have no more land to produce food – must intensify (sustainably)
- IoT enables better decision making and increased efficiency
- Telematics and autonomy in agricultural machinery is enabling operational efficiencies and greater productivity
- Ubiquitous connectivity is required for most applications and many rural areas in suffer from a lack of reliable connectivity

CASE STUDIES
WATER & IRRIGATION MONITORING

FARMBOT MONITORING SOLUTIONS

- **2,100** water monitoring devices across Australia
- Inmarsat connectivity enabling Farmbot to move from water tank monitoring to **pump control**, **remote cameras** and **monitoring**
- Use of **OEM variant** of IDP module

SENSOTERRA

- Enabling **remote irrigation management** in fields with no connectivity or power
- Collaboration with Sensoterra and their **wireless soil moisture technology**
- LoRaWAN, backhauled by IDP with **integrated power** for a standalone installation

PONCE

- **Remote monitoring** of irrigation systems, regardless of system age or location
- **Retrofit device** enabled by Inmarsat satellite as the default communication method
- Use of **OEM variant** of IDP module

CASE STUDIES
PRECISION AGRICULTURE & PREDICTIVE MAINTENANCE

Tractor to satellite solution

Tractor direct to satellite enables transfer of **telemetry** and **precision farming** data in real-time

The simplest solution for **vehicular connectivity** – removes the need for **complex installations** and **maintenance**

Can be used on tractors and other vehicles – e.g. land cruiser

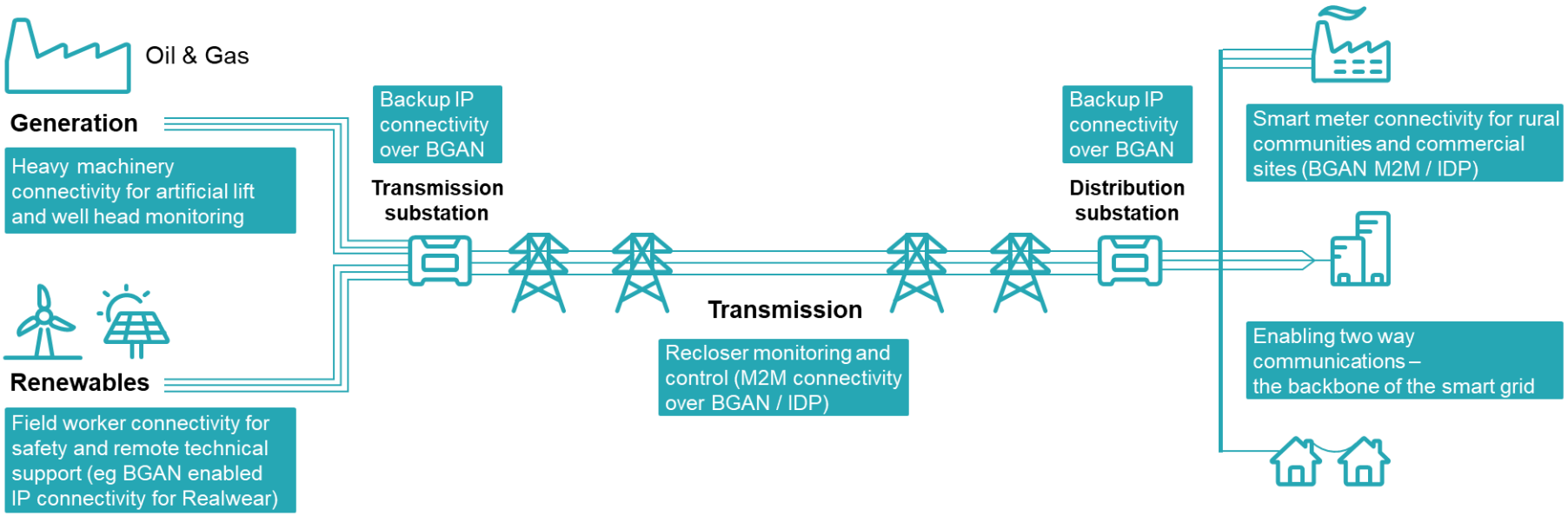
Autosteer and GNSS Augmentation

L Band is fundamental to the use of SBAS correction services globally

Enables precise positioning down to 2.5cm

Enables autosteer, precision agriculture and controlled traffic farming

L BAND IS ENABLING THE TRANSITION



ENABLING THE ENERGY TRANSITION

Transition & Transmission

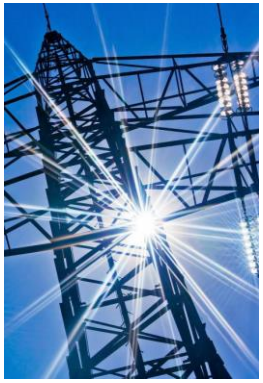
The energy transition from hydrocarbons to renewables is accelerating and brings **significant growth potential for monitoring and control of grid assets**

Use of **Solar is increasing rapidly** with companies focusing in on this technology. e.g. 70% of enel road-mapped projects are solar

The number of sites of power generation increases significant in renewable rich environments and **providers are regulated to provide key metrics** to deliver energy to the grid

The distance between energy generation and use also increases, prompting **large scale transmission projects**, offering growth potential in overhead transmission line monitoring

Opportunities



RECLOSER MONITORING & CONTROL – A KEY USE CASE

Use Case / requirement

Energy providers are under **increasing pressure to consistently improve service quality and reliability**

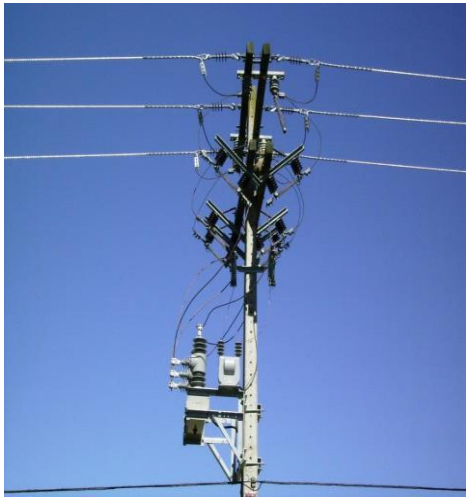
Circuit Reclosers are considered an essential device to maintain maximum **continuity of service**

Centralised reclosers are connected to a central control room and allow much greater visibility and control over a grid

The challenge with centralised reclosers is getting connectivity that is reliable enough to support always on control, as **in many remote areas cellular connectivity is intermittent**

L band is used on tens of thousands of reclosers around the world and has been trusted as the industry standard by electricity providers for over ten years

Solution



CASE STUDIES – DISTRIBUTION AUTOMATION

Recloser monitoring and control in Brazil

- Unreliable **cellular** connectivity, left Cemig having to operate reclosers manually
- Effective availability of remote reclosers now averages **98%** where **satcomm** is installed
- Plans to install further **760** further terminals in distribution network and substations

Smart meters

- To ensure fare rates for all, BCES installed automated metering – readings every **15 min**
- Network has ensured success of its **prepay** services and improved **customer** service
- Plans to **add more BGAN** terminals as it develops its integrates intelligent grid

Grid monitoring and control

- Integrated its recloser network into **existing control system** with Inmarsat's network
- Ergon installed **hundreds** of reclosers throughout its network
- Reclosures send **5 - 15 MB** of data a month

ENABLING MORE EFFICIENT RAIL TRANSPORT

- Telematics and advanced signalling technologies enable rail operators to increase capacity on existing lines, improve operational efficiency and safety
- Monitoring the natural environment give early warnings of natural disasters, such as floods and landslides saving lives
- All this requires highly reliable connectivity, but…
- **$59,000 – $170,000/km** the estimated cost of deploying private radio networks on the rail line
- Wireless communications, with satellite as a primary or back-up connectivity method is a cost-effective means of providing ubiquitous connectivity

RUMO S.A.

- Rumo S.A. is the largest heavy haul operator in Brazil, with 12,900 kilometres of railways
- Much of the network in rural locations – expensive or not possible to provide terrestrial coverage
- Expands coverage for hundreds of locomotives
- Voice communications between driver and operations centre
- Enabling telemetry data

TAILINGS MANAGEMENT

A GLOBAL PROBLEM

3,500+
Tailing dams in the world

13
Very serious failures between 2007 and 2020

200,000,000+ m³
of waste released in last ten years

CASE STUDY: AMERICAS TAILINGS DAM PROJECT

INMARSAT PROVIDES REMOTE TAILINGS DAM MONITORING SOLUTION TO MAJOR MINING COMPANY IN THE AMERICAS

In **2017** Inmarsat engaged with a **leading global mining company** and auditor Knight Piésold to **create a remote tailings dam monitoring solution.**

Installed in **December 2018**, the solution consists of **10 piezometers**, an **ultrasonic height sensor and weather station**, connected by Inmarsat's satellite to a **cloud dashboard.**

CASE STUDY: AMERICAS TAILINGS DAM PROJECT

INMARSAT PROVIDES REMOTE TAILINGS DAM MONITORING SOLUTION TO MAJOR MINING COMPANY IN THE AMERICAS

With over **100,000 data points** created each month, the mining company has a precise picture of conditions at the dam. This enables them to make **fast, accurate decisions** leading to high standards in safety and regulatory compliance.

The trial was deemed a success in February 2019 and the company is in discussions to deploy the solution across their tailings dam estate.

Why Insight Terra?

- **Climate Change** threatens lives, property and the planet
- **Insight Terra** ensures resilient and reliable data is made available for decision makers
- **Trusted data** with confidentiality and availability, offered through secure networking and reliable cloud computing
- **Ubiquitous data** availability anywhere and in real-time, through global space sensors and ground systems

Space Enabled Data Platform

IoT Sensor Data

Data Fusion & Analytics

Earth Observation Data

Smart & Secure Interconnectivity

inmarsat

Mining & Metals | Energy | Utilities | Transportation | Geohazards, Floods, Fire

L BAND IS CRUCIAL FOR ENABLING SAFETY AND SUSTAINABILITY GLOBALLY

- Satcom is vital for connecting assets in locations where it is not practical or cost-effective to use terrestrial infrastructure
- L Band is enabling always on, mission critical services and plays a leading role in agriculture, energy and transport
- The only frequency to provide all weather, highly reliable connectivity for critical applications

Conclusion and Policy Recommendations

Satellite Industry is Committed to Driving 5G Development

Satellite industry will continue to participate in various committees, including in 3GPP, EC, and ITU to ensure that satellite systems are integrated as an intrinsic part of the 5G ecosystem, for example:

- to support high availability and reliable connectivity using satellites for cases such as ubiquitous coverage, disaster relief, public safety requirements, emergency response, remote sensor connectivity, broadcast service, etc.

- to support an air-interface with one way latency of up to 275ms when satellite connection is involved

- to support seamless mobility between terrestrial and satellite based networks with widely varying latencies

The 5G Vision will not be realized without satellite as a key component

Promoting Realization of the 5G Vision Through Technology Neutrality

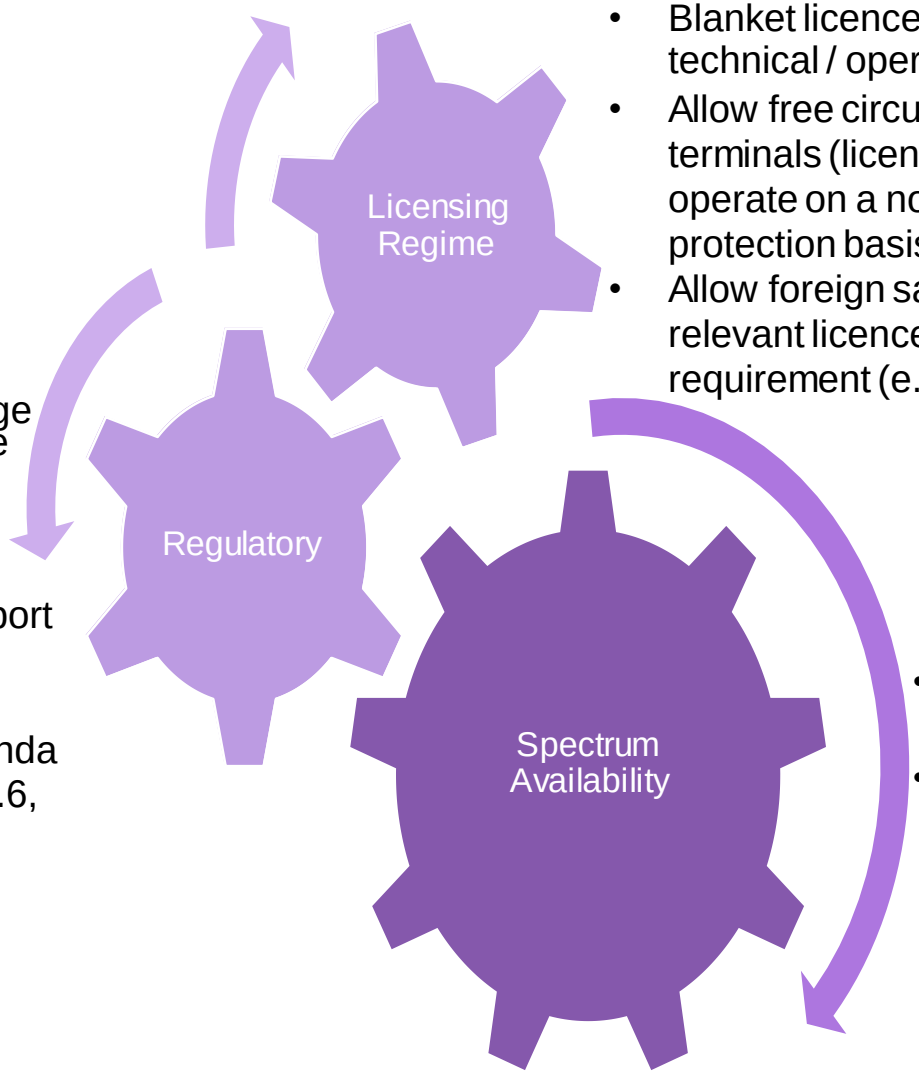
- Policies related to 5G and IoT should be technology neutral to the greatest extent possible, so as not to predetermine outcomes
  - Avoid prescribing artificial speed and latency requirements that will serve few use cases and meet the needs of fewer people
- Technologies and solutions should be industry-driven, and where standards are required they should be developed through open participatory processes
- Working groups, initiatives, multistakeholder processes and other government-sponsored technology development programs should be broadly inclusive of various technologies and networks
- Technology neutrality should extend pilot programs, grants, or research initiatives

Cost-Efficiency and Regulatory Considerations

- Lack of access often due to cost
- Ubiquitous satellite connectivity may be the most cost-effective solution in many areas; better than huge investments into new technologies
- Regulatory and licensing conditions should promote use of all 5G technologies, including satellite
- Blanket licensing/general authorization of satellite terminals reduces cost compared to individual licensing
- Reduce regulatory barriers/streamline licensing for innovative services (e.g., ESIMs)

REGULATORY REQUIREMENTS

- Light licensing for Satellite IoT
- Blanket licence for user terminals with similar technical / operational characteristics
- Allow free circulation for foreign satellite terminals (licensed at relevant countries) to operate on a non-interference and non-protection basis without licence
- Allow foreign satellite operators to apply for relevant licences without unnecessary requirement (e.g. local entity)



- Reduce regulatory hurdles or to encourage deployment of satellite services (e.g. landing rights requirement, reasonable spectrum pricing)
- Recognition of test report from accredited international test lab
- Support WRC-23 agenda items (e.g. AI 1.2, AI 1.6, AI 1.17)

- Access to sufficient spectrum for current and future needs
- Protection of existing spectrum allocation

Only A Mix of Technologies Will Deliver 5G
… and they are already starting to

Wi-Fi Eco-System is Evolving: Gigabit WiFi chips + devices becoming available: 200m radios shipped in 2017, 2020: >1bn ***"WiGig"***

Satellite Eco-System is Evolving: HTS, VHTS, GSOs + NGSOs using L,S,C,Ku,Ka bands & in future Q,V bands as well

Mobile Eco-System is Evolving:

Germany, Italy, Australia: **carrier aggregation** delivering up to 900 Mbps

Field Tests in UK & US: >20 Gbps delivered in 70GHz bands

- **On commercially viable basis**
- **No interference with other services**
- **Using Existing Spectrum**

Thank You

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