Present and future of Satellite services

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The Challenge of Relevance
in a Digital Connected World

“Satellite is what we use when we don’t have access to conventional terrestrial communications or when they fail…”

(P.S. This is not a bad thing…)

“Satellite doesn’t give us the same performance as terrestrial communications services but it is good enough or better than nothing…”

If the expectation gap is increasing, for how long will “good enough still be good enough?

Future satcom must maintain the relevance and utility in an increasingly connected world.

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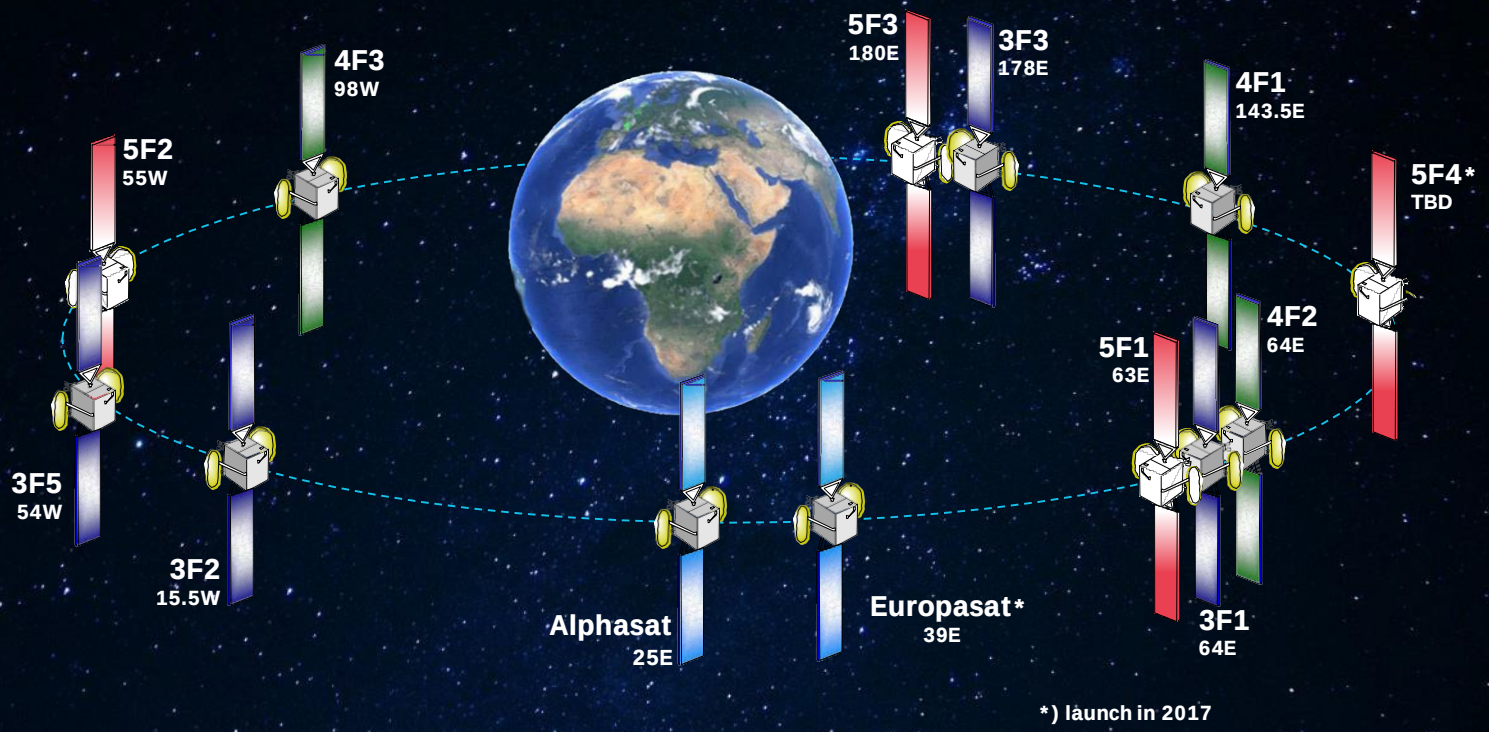
New satellite technologies
Large portfolio of services using different frequency bands

Inmarsat fleet

Real global access in L, extended L, S and Ka-bands



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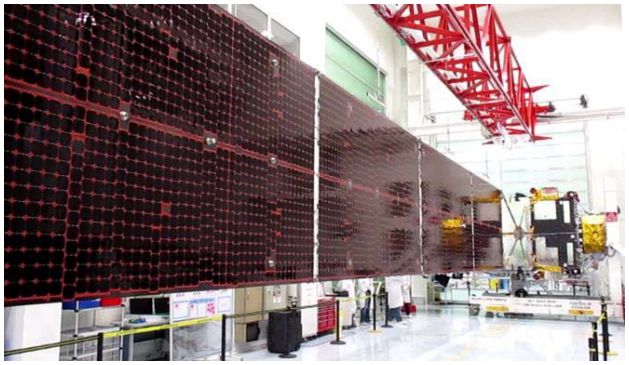
Inmarsat new satellites

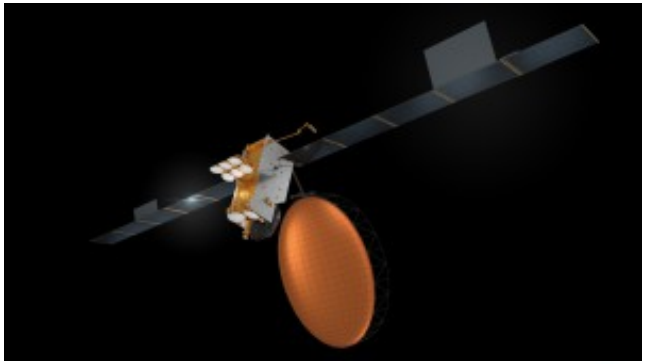
L, S and Ka-band systems



Europasat (S-band, launch in June 2017)

Inmarsat-5 F4 (Ka-band, launch in May 2017)

Inmarsat-6 (L & Ka-bands, launch in 2020)



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Maritime and aero safety – future services

- **Global Maritime Distress and Safety System (GMDSS**)
  - compulsory on any ship above 300gt
- **Inmarsat-C:** Distress Alerting, Enhanced Group calls, Reporting and Polling services

FleetBroadband Safety	Maritime Safety Terminals with enhanced functionality

- **Inmarsat Classic Aero - Safety and Operational Services**
  - Flight Tracking
  - Cockpit operational and safety services
  - Installed on 95% of the current long haul fleet (> 10000 aircraft)
- **GADSS (Global Aeronautical Distress and Safety System)**
  1) Global Flight Tracking
  2) Autonomous Distress Tracking
  3) Flight Data Recovery

SwiftBroadband-Safety (SB-S)	Supports all GADSS requirements. Available for initial retrofit installation on existing aircraft today and is scheduled to become a standard option on new aircraft deliveries from 2018

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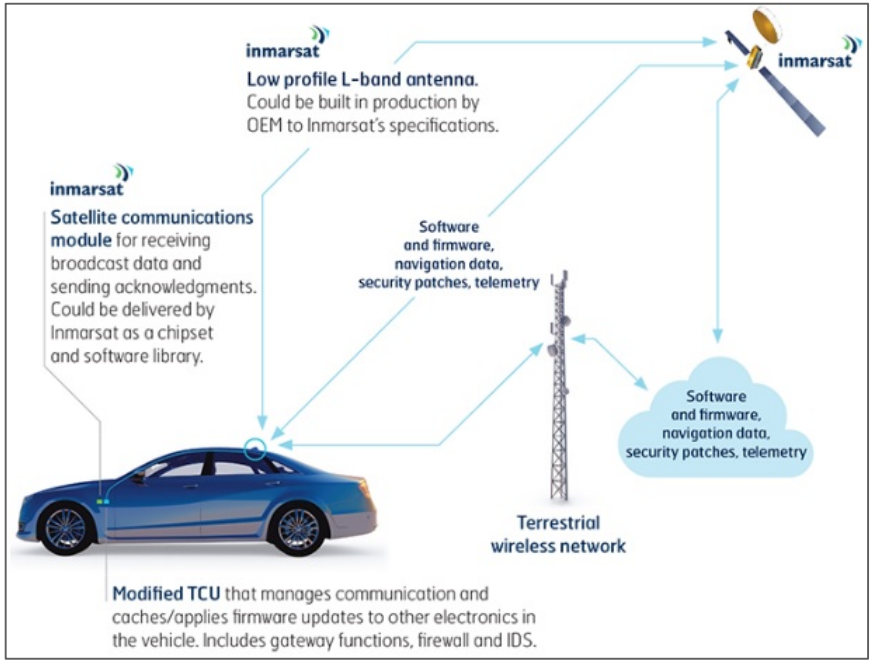
New service offerings

New business opportunities

M2M

European Aviation Network (EAN)



Connected car

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Inmarsat – well positioned for the future

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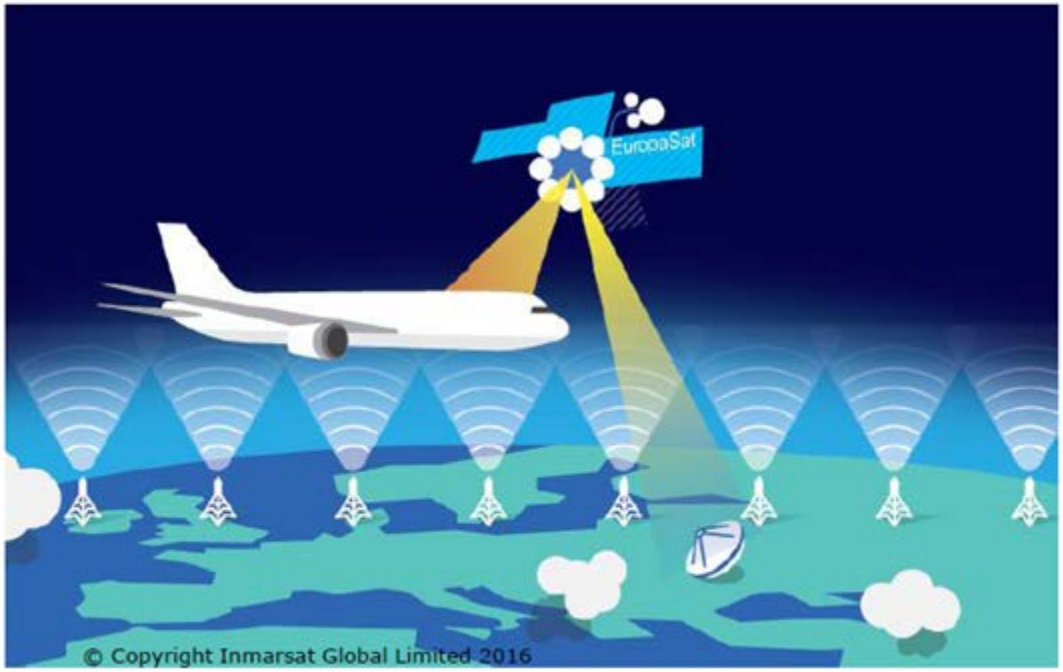
Rolling out a new aviation connectivity network in Europe (EAN)

The European Aviation Network

To deliver high-capacity connectivity across Europe, Inmarsat will **combine an S-band satellite infrastructure with a "ground component"** of the Inmarsat network (Aviation Complementary Ground Component, ACGC)



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EAN: the scalable answer to high density traffic

S-band satellite coverage deployed over Europe - MSS

Integrated 4G LTE network technology – CGC

> Complementary Ground Component (CGC) operating at S-band (2x 15MHz)

> High performance, high efficiency

Superior passenger experience thanks to high throughput, capacity and low latency

> Overall network capacity up to 50Gbps to aircraft across the EU

> Low latency (40ms)

> Densification and sectorisation will deliver capacity growth. 4G technology adoption ensures technology evolution

Lower total cost of ownership

> Lightweight, low cost equipment

> High reliability, low maintenance

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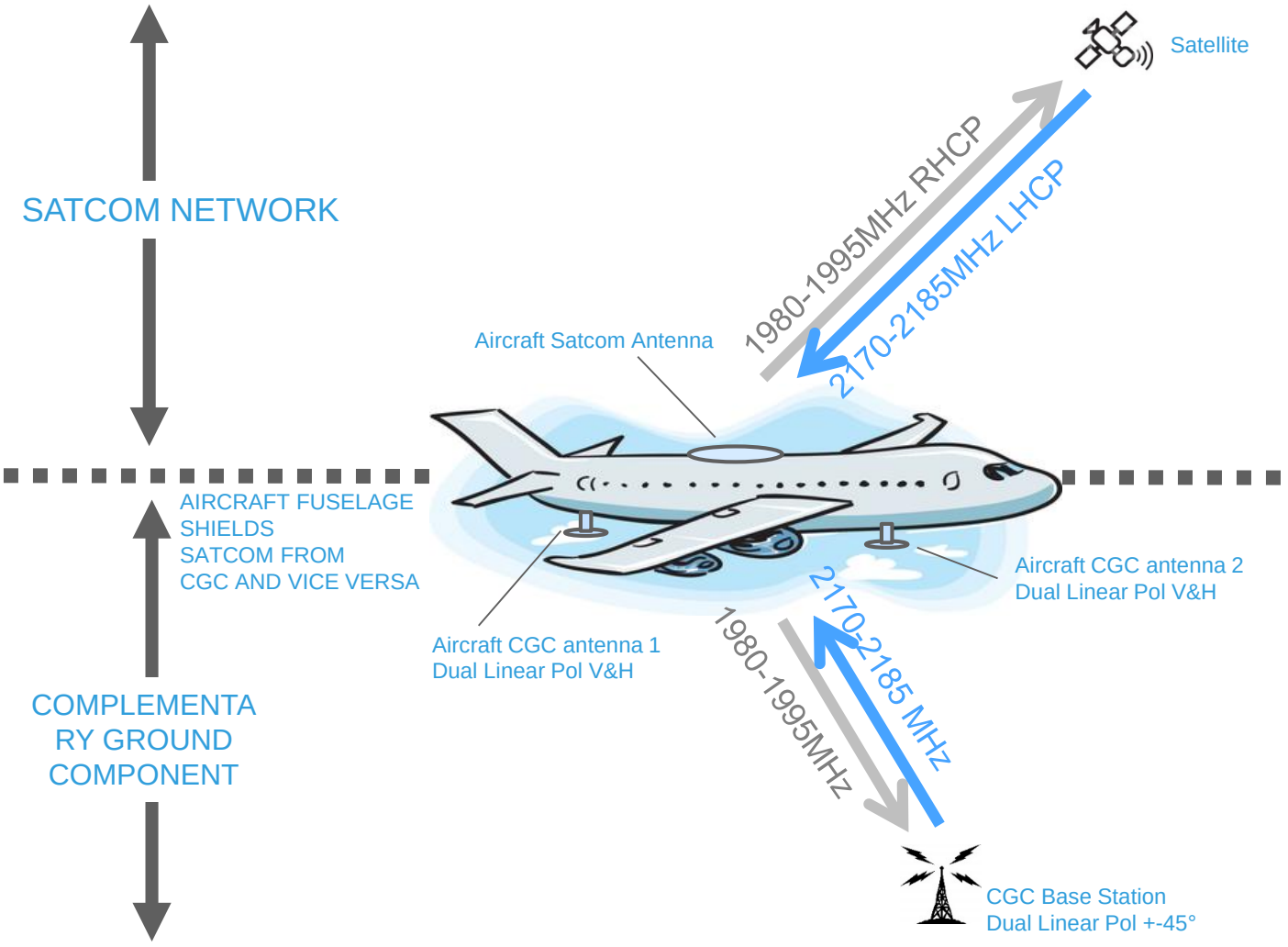
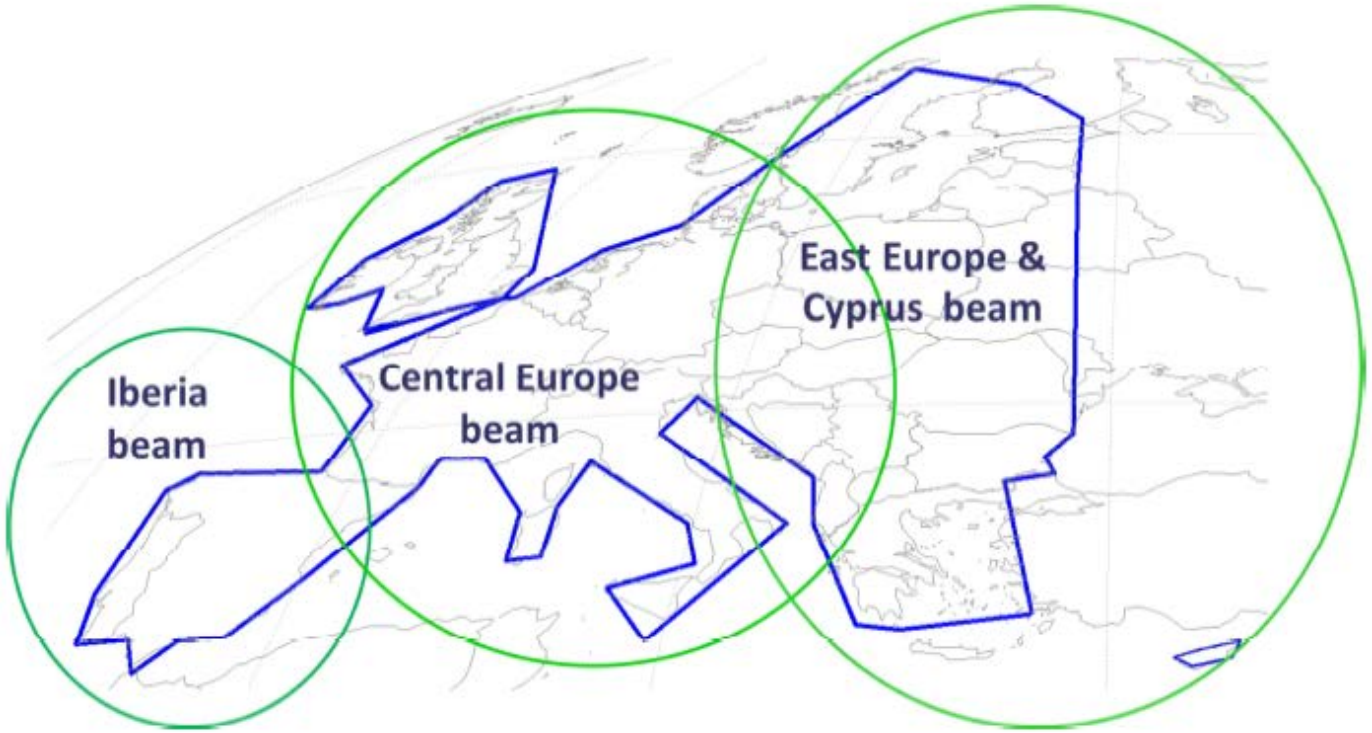

SATCOM NETWORK
AIRCRAFT FUSELAGE SHIELDS SATCOM FROM CGC AND VICE VERSA
COMPLEMENTARY GROUND COMPONENT
Satellite
1980-1995MHz RHCP
2170-2185MHz LHCP
Aircraft Satcom Antenna
Aircraft CGC antenna 2
Dual Linear Pol V&H
Aircraft CGC antenna 1
Dual Linear Pol V&H
2170-2185 MHz
1980-1995MHz
CGC Base Station
Dual Linear Pol +-45°

Europe Satellite Coverage

S-band User Link



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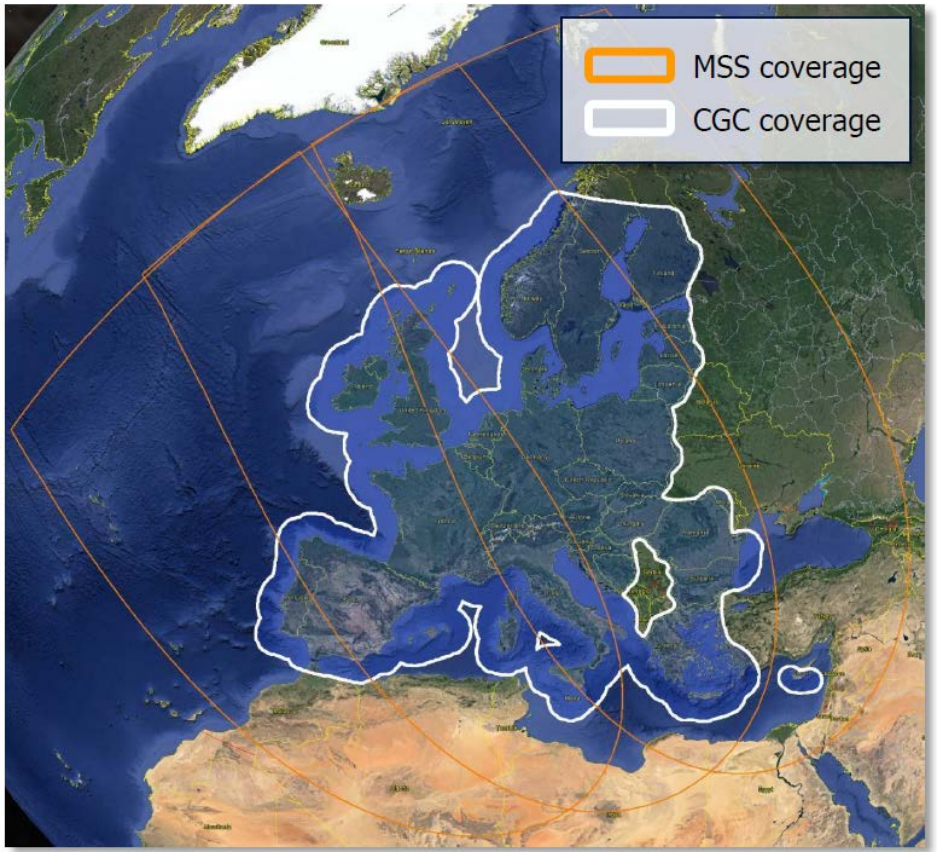
ACGC Towers EUROPE & Hybrid Coverage



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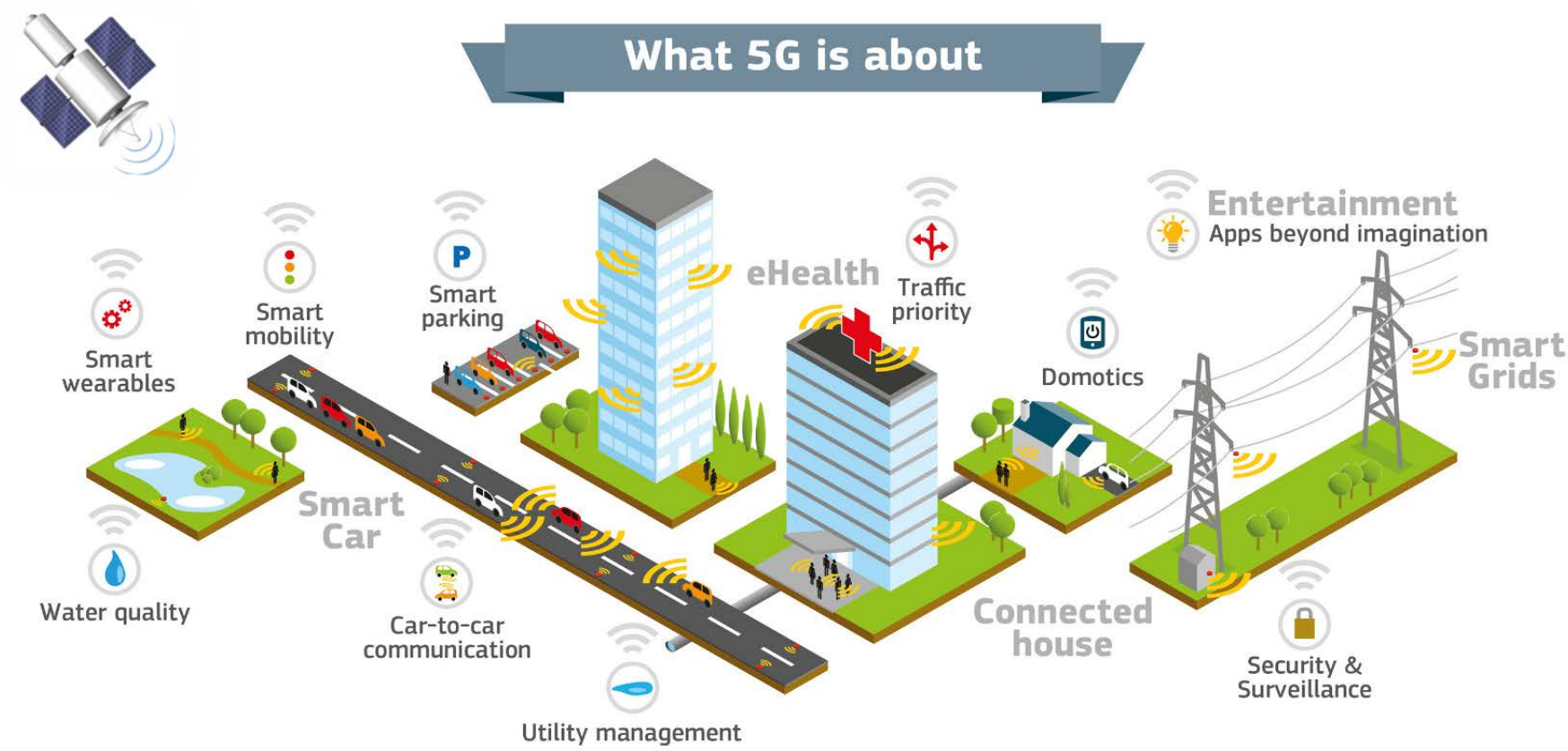
Satellites and 5G

5G Ecosystem –

Inclusive of Terrestrial & Satellite Technologies



European Commission

The “expectation gap” is narrowing for satellite communications through integration by bringing together ……

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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
- 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 (~30 kW),
  - Use of higher frequencies (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
- Many services are effectively provided by satellites also in urban areas, e.g. broadcast, multicast, backhaul
- Resilience: Including satellites as an integral part of the 5G ecosystem adds resilience
- Reliability: Lower frequency bands (e.g. L-band) ideal for high reliability applications, such as safety services
- Latency: Satellites naturally have longer latency than terrestrial systems
  - Constellations of small LEO satellites for lower latency requirements
  - **5G air interfaces should support satellite latencies**

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5G use cases supported by satellite

Service Category	Deployment Scenario/Services	3GPP SA Use Case (TR 22.891-200)
Multimedia delivery	Mobile Broadcast	5.53 Vehicular Internet & Infotainment 5.56 Broadcasting Support 5.64 User Multi-Connectivity across operators
	Content Caching	5.36 In-network and device caching
	Broadcast to home	5.56 Broadcasting Support
Broadband	Mobile Broadband to users and Vehicles	5.28 Multiple RAT connectivity and RAT selection 5.29 Higher User Mobility 5.53 Vehicular Internet & Infotainment
	Fixed Broadband to homes and enterprises	5.41 Domestic Home Monitoring
	Ubiquitous coverage- Remote areas services	5.30 Connectivity Everywhere 5.10 Mobile broadband services with seamless wide-area coverage
	Backhaul Connectivity	5.30 Connectivity Everywhere 5.10 Mobile broadband services with seamless wide-area coverage
	Broadband to moving platforms- flights, ships etc.	5.30 Connectivity Everywhere 5.12 Connectivity for drones 5.29 Higher User Mobility
Machine Type Communication	Fleet Tracking	5.43 Materials and inventory management and location tracking
	Asset Management	5.43 Materials and inventory management and location tracking
	Wide area sensor management	5.42 Low mobility devices 5.73 Delivery Assurance for High Latency Tolerant Services
Critical Communication	Disaster Management	5.3 Lifeline communications / natural disaster 5.31 Temporary Service for Users of Other Operators in Emergency Case
	Air Traffic Management	
	Reliable Communication	5.73 Delivery Assurance for High Latency Tolerant Services
Vehicular Communication	Traffic Updates and Software Upgrades	5.33 Connected Vehicles
	eCalls and Emergency Notifications	5.3 Lifeline communications / natural disaster 5.31 Temporary Service for Users of Other Operators in Emergency Case

3GPP
A GLOBAL INITIATIVE

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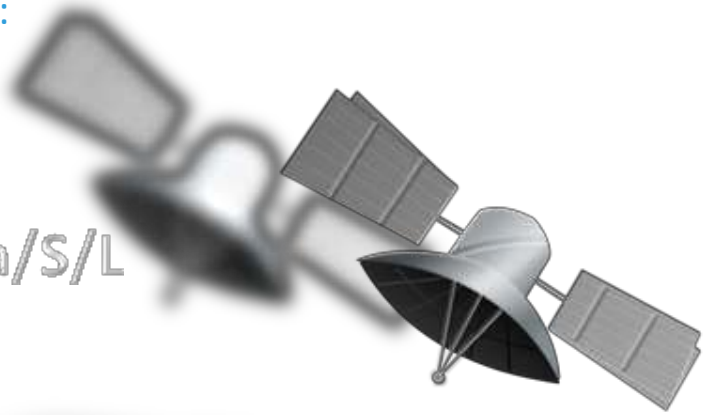
Four key elements that can work together

"Organise to Innovate" model:



Radio Access Network
(remote modem & SAS modems/controllers)

Core Network
(remote communications stack &
core terrestrial network infrastructure)

Service Platform
(remote service apps &
core terrestrial service platform infrastructure)

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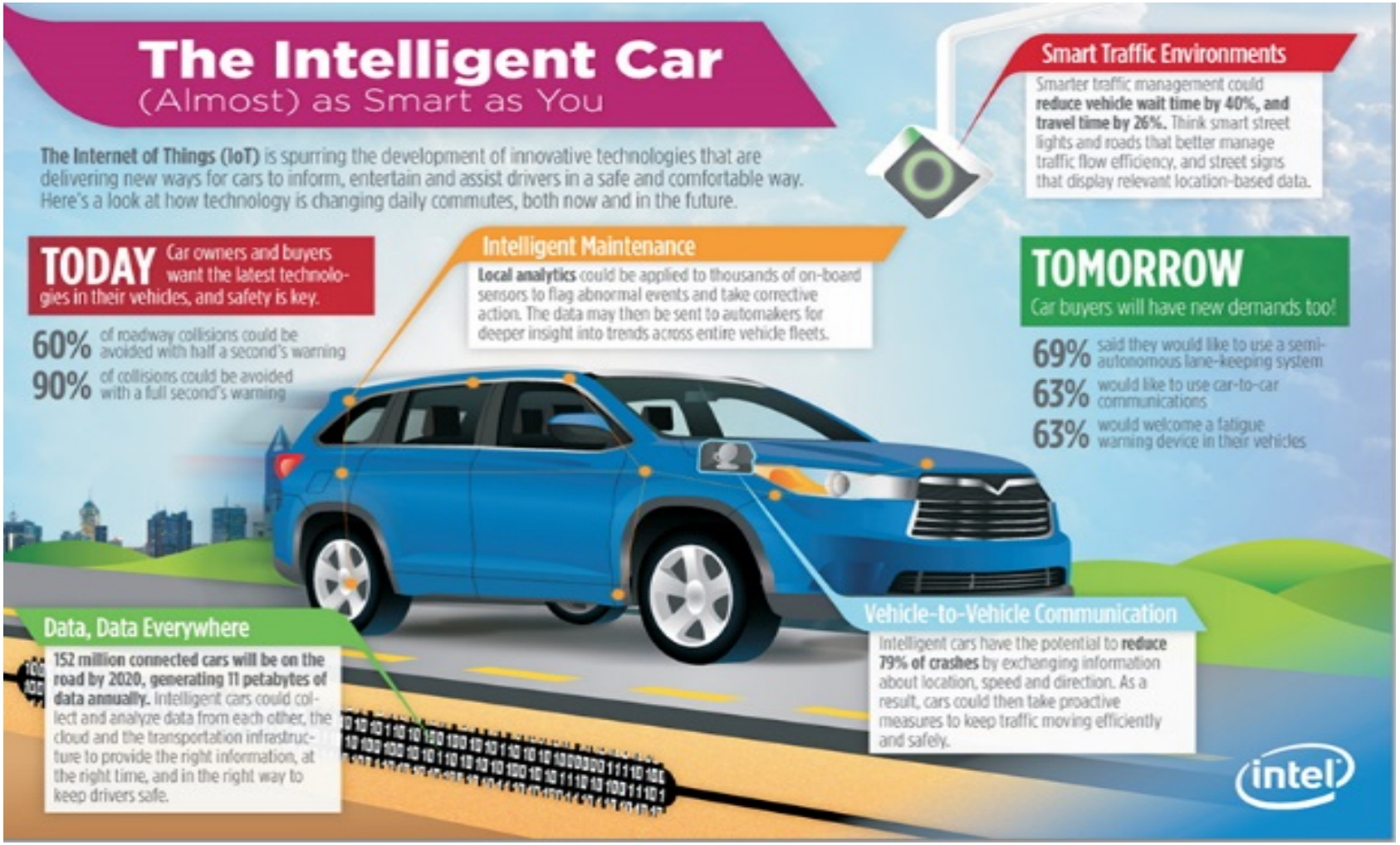
Example : Connected Car - 1



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Example: Connected Cars - 2

Major Players

- Car Manufacturers – BMW, Hyundai, Kia, Toyota, Nissan
- Solution/Apps – Intel, Microsoft, Apple, Google
- Connectivity Providers – Vodafone, Orange ,

Market Forecast

› Global connected car market worth $39bn by 2018 (GSM, SBD)
› Rapid take up of M2M technologies and Apps
› By 2020 – 152m connected cars (Intel)
› ME covers around 12% of the market for High Value Vehicles (SUVs) (Nissan)

Services – 79% of Road accidents can be avoided (Intel)

› For enhanced safety
› Vehicle monitoring – performance / health
› Schedule maintenance – remote access
› In-car infotainment – internet on move
› Built -in satellite navigation GPS, GLONASS, IRNSS ?
› Embedded SIM for Satellite 5G networked – Broadband Connectivity

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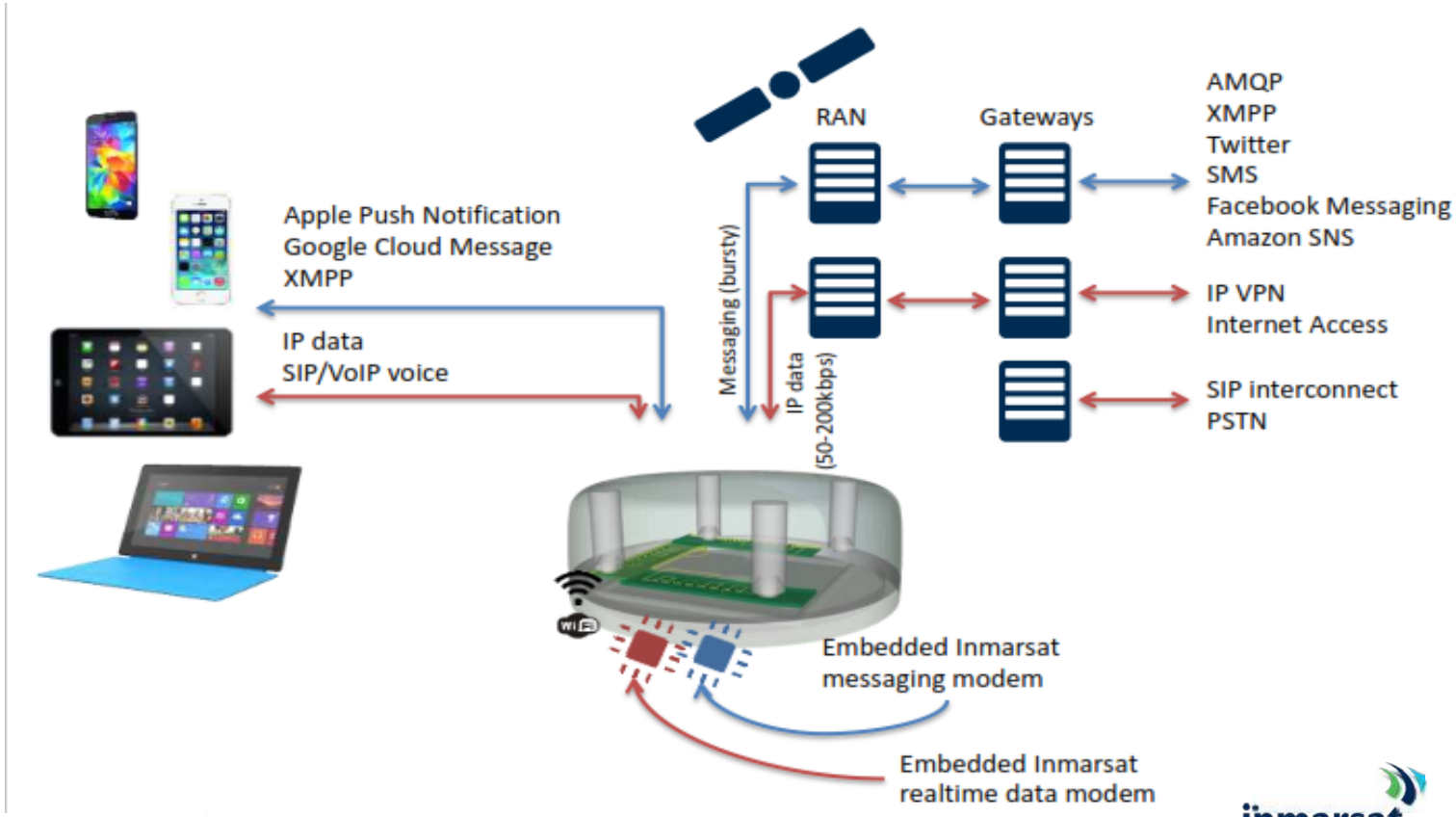
Example: Connected Car – 3

Satellite 5G Integration



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The mobile satellite company

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Sustainable & Viable Spectrum access for all components of the 5G ecosystem

5G will require large blocks of contiguous spectrum,	Billions of dollars have been invested in satellite systems operating in C-band, Ku-band, and Ka-band (17.7-20.2 GHz/27.5-30 GHz)	Satellite spectrum is essential to allow the development of innovative satellite broadband and media services and to support the vision of 5G
5G will require > 1GHz per carrier on a globally harmonised basis	Advanced satellite networks will be required to support ubiquitous availability of 5G services.	Multiple GHz of contiguous spectrum are potentially available in the bands identified for ITU-R studies: 24.25-27.5, 37-40.5, 40.5-42.5, 47.2-50.2, 50.4-52.6 GHz
From the perspective of 5G system design, there is no clear preferred frequency range	Fixed satellite services (FSS) are also developing into other bands, especially Q/V band (37.5-51.5 GHz),	Bands that are well harmonised internationally are essential for both satellite applications and for terrestrial 5G

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Satellite uses in ICT ecosystem

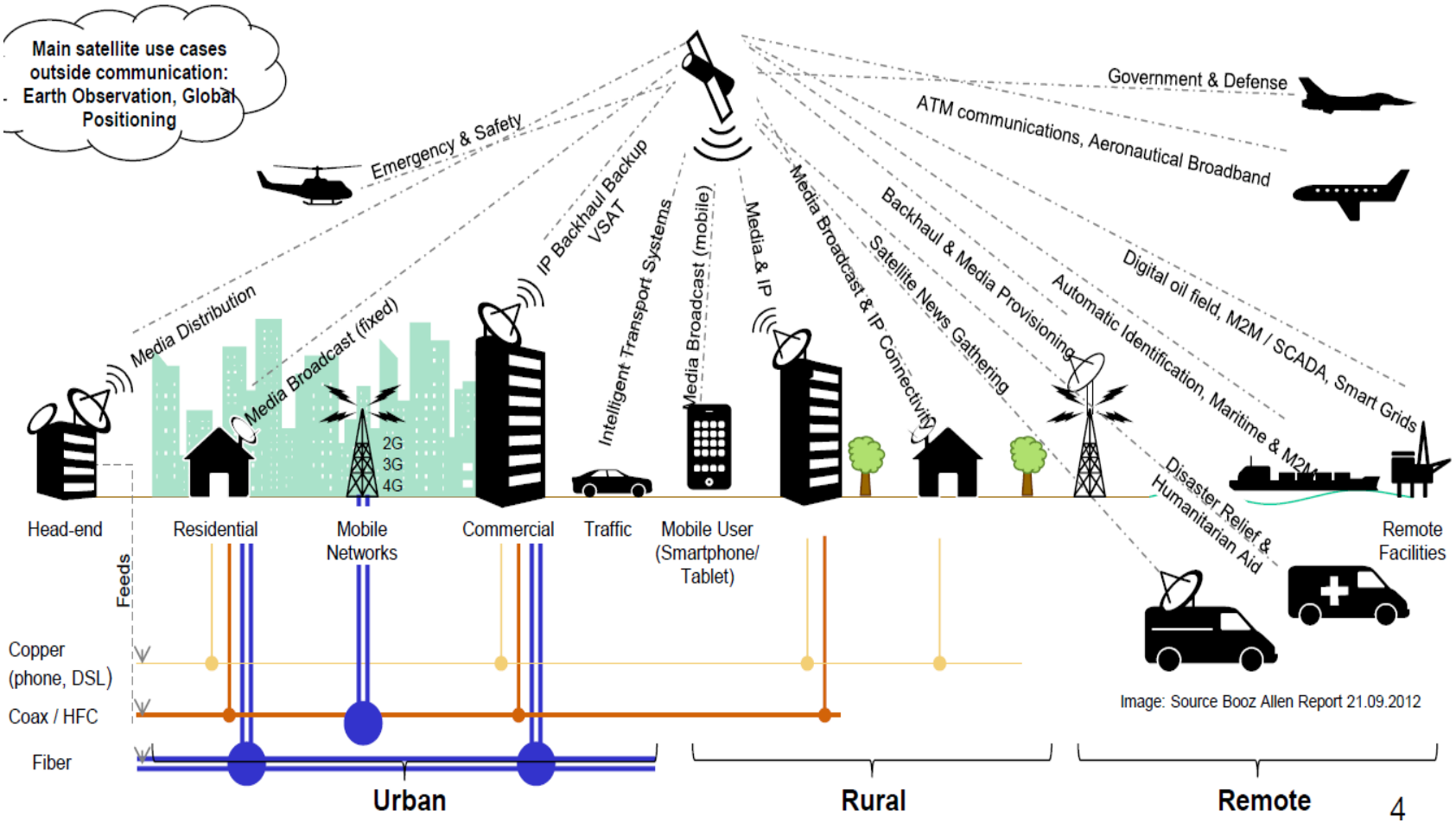

Image: Source Booz Allen Report 21.09.2012

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