5G – Satellite Infrastructure

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What we do

- We broadcast over 8,100 TV channels that reach over 1 billion people
- We connect over 300 customers in 130 countries and planes, ships, oil rigs
- We deliver HD & Ultra HD content to any platform, on any device
- We help restore connectivity after natural disasters
- We champion SpaceX reusable rocket technology
- We support telcos with their 4G roll-outs and connecting remote areas
Channels

>8,100 channels

SD >5,300 SD channels
HD >2,700 HD channels
UHD 50 UHD channels

33% of all SES channels are HD
TV channels via satellite, fibre, and IP: >3600
Managed playout channels: >525
Complete suite of services that deliver video to VOD and OTT platforms through the MX1 360 platform: Complete suite of services that deliver video to VOD and OTT platforms through the MX1 360 platform:
Hours of streaming video per day: >8400
Hours of premium sports & live events per day: >620
SES Networks at a Glance

GEO-MEO-Terrestrial network architecture

>30Gbps managed worldwide

99.99% measured service availability*

99% global coverage with customers >130 countries

>500 expert staff across >25 countries

Up to 2Gbps per MEO beam with low latency (<150ms)

*benchmark: 99.97%
SES IS WELL-POSITIONED TO ADD VALUE TO THE 5G OPPORTUNITY BY COLLABORATING CLOSELY WITH KEY PUBLIC AND INDUSTRIAL STAKEHOLDERS

70+ satellites (incl. 20 MEO) covering 99% of the globe and world population

Unique GEO-MEO constellation complemented by a ground segment, together forming a flexible network architecture that is globally scalable

Driver of INNOVATION in building a cloud-scale, automated, “virtual fibre” network of the future
TAKING A LEADERSHIP ROLE IN THE 5G ECOSYSTEM
Recognition that 5G represents a satellite services opportunity

Enable satellite integration within 5G

Commercialise satellite products and services for 5G

Develop and Demonstrate satellite integration within 5G
Satellite helps responding to strong demand for data communications from consumers and businesses, driven primarily by video, and overcoming geography and cost constrains.

Satellite's ubiquitous availability helps accelerate global 5G deployment on the ground, at sea and in the air.

Next-generation satellite equipment and networks are leveraging key 5G technologies, standards and capabilities in order to ensure seamless integration and enable significant cost reductions.

Satellite industry is investing massively in new satellite and ground infrastructure to support those new capabilities and needs.

5G enables new business models also for the satellite industry – to the benefit of affordable connectivity worldwide.
What is 5G?

Key Usage Scenarios

- Enhanced mobile broadband
  - Gigabytes in a second
  - 3D video, UHD screens
  - Work and play in the cloud
  - Augmented reality
  - Industry automation
  - Mission critical application
  - Self-driving car

- Voice
- Smart home/building
- Smart city

Future IMT

Massive machine type communications

Ultra-reliable and low latency communications

Not all of the identified 5G use cases have the extreme bandwidth and/or latency requirements that 5G technologies will enable.

Bandwidth and latency requirements of potential 5G use cases (Source: Nokia)

Source: ITU-R M.2083

Source: CEPT ECC Report 280
Key Satellite Features that Enhance the Networked Society

UBIQUITY
MOBILITY
BROADCAST/MULTICAST
SECURITY

Source: ESOA
Satellites Support the Key Usage Scenarios for 5G

▲ Enhanced mobile broadband (eMBB)

- Satellites already enable 2G/3G/4G networks to reach unserved areas in many parts of the world today
- Latest and next-generation high throughput satellites (HTS) will support the increased bandwidth requirements of future 5G mobile networks

▲ Ultra-reliable and low-latency (uRLL)

- International broadcasters, MNOs, governments depend on us every day to ensure ultra-reliable communications
- GEO latency is acceptable for many 5G applications, and new MEO and LEO networks will be able to support more latency-sensitive applications
- Satellites can even help 5G networks meet their sub-1ms latency requirements by multicasting common content to mobile base stations

▲ Machine-to-machine communications (mMTC)

- Satellites already support SCADA and other global asset tracking applications today, and can scale to support future machine-to-machine (Internet-of-Things) communications
- New ground technologies, such as smaller, lower cost, electronically steerable, and/or phased-array satellite transceivers are making ubiquitous deployment for IoT feasible

Satellite contributes to addressing data demand as well as geographical and costs constraints
Satellites Can Even Help Achieve Sub-1ms Latency

▲ Sub-1ms latency is very difficult to achieve, even for 5G mobile networks

▲ According to GSMA Intelligence, “Understanding 5G” (Dec. 2014):

- “Achieving the sub-1ms latency rate … will likely prove to be a significant undertaking in terms of technological development and investment in infrastructure.”
- “Services requiring a delay time of less than 1 millisecond must have all of their content served from a physical position very close to the user’s device. … possibly at the base of every cell, including the many small cells that are predicted to be fundamental to meeting densification requirements.”


- “Paradoxically, the low latency requirement for 5G network is a big ally in this vertical for satcom as many new locations for content servers will be required. In the transition to 5G, content needs to be moved to the edge and many new locations will be required, densifying CDN networks and making satellite multicast a viable option.”
- “The emergency and growth of applications like virtual reality, augmented reality, tactile Internet or video streaming will only accelerate this requirement to move capacities to the edge.”

Thus, satellites can help 5G networks achieve sub-1ms latency by multi-casting content to caches located at individual cells, even in places without fiber.
Role of the Satellite in the 5G Ecosystem

Satellite's ubiquitous availability helps accelerate global 5G deployment on the ground, at sea and in the air.

**TRUNKING & HEAD-END FEED**
Satellites provide a very high speed direct connectivity option to remote / hard-to-reach locations.

**BACKHAULING & TOWER FEED**
Satellites provide a high speed connectivity (incl. multicast content) to wireless towers, access points and the cloud.

**COMMS ON THE MOVE**
Satellites provide a direct and/or complementary connection for users on the move (e.g. on planes, trains, automobiles and ships).

**HYBRID MULTIPLAY**
Satellites deliver content complementing terrestrial broadband (as well as direct broadband connectivity in some cases).
Building the Satellite Infrastructure to Support 5G Roll-out

70+ satellites (incl. 20 MEO) covering 99% of the globe and world population

Massive investments in satellite and ground infrastructure to support new capabilities and requirements

Coverage +Capabilities +Capacity

2019 2020 2021 2022+

#5GMediaRoad2019, Munich, 08 May 2019
Technology Development Approach for Satellite Integration into 5G
Short/Mid-Term Focus: Operational Integration of Satellite Backhauling into 5G

▲ Short/Mid-term: Fully-fledged implementation for operational integration of satellite backhauling into the heterogeneous 5G “network of networks” through plug & play approach with focus on higher layer enablers (SDN, NFV, Network Slicing, MEC, etc) under common network management and orchestration.

▲ Long-term: Possibility to use a 3GPP standardised version of 5G NR for the satellite waveform (nice-to-have feature).

Satellite into 5G is mainly about the higher layers, not about 5G waveforms, ultra-low latency, or cell towers in space.
Joint 5G Technology Innovation Projects Overview

▲ SaT5G: Satellite and Terrestrial Network for 5G
▲ Customer: European Commission (EC)
▲ Funding Programme: EC H2020 5G PPP Phase 2
▲ Total Budget: 8.3 MEUR (100% funded)
▲ T0 Date: June 2017
▲ Duration: 30 months
▲ Main Objective:
  • To research, develop, validate and demonstrate key technology enablers for “plug-and-play” integration of SatCom into 5G networks, with focus on 5G use cases for eMBB use cases.

▲ SATis5: Demonstrator for Satellite-Terrestrial Integration in 5G Context
▲ Customer: European Space Agency (ESA)
▲ Funding Programme: ESA ARTES Advanced Technology
▲ Total Budget: 1.4 MEUR (100% funded)
▲ Kick-Off Date: October 2017
▲ Duration: 24 months
▲ Main Objective:
  • To build a large-scale real-time live end-to-end 5G integrated network PoC testbed that enables the satellite terrestrial convergence into 5G context. Focus on both eMBB and mMTC use cases.

▲ EdgeSAT: Edge Network Computing Capabilities For Satellite Remote Terminals
▲ Customer: European Space Agency (ESA)
▲ Funding Programme: ESA ARTES Future Preparations
▲ Total Budget: 300 KEUR (100% funded)
▲ Kick-Off Date: April 2019
▲ Duration: 12 months
▲ Main Objective:
  • To explore the applicability and implementation of edge networking concepts in satellite networks
  • To specify and validate a SatCom MEC-enabled edge node through GEO demos
SaT5G Project at a Glance
SaT5G: Satellite and Terrestrial Network for 5G

▲ European Commission H2020 5G PPP Phase 2 - Grant Agreement No. 761413
▲ Kick-Off: 01 June 2017 (Duration: 30 months)
▲ Aim: To research, develop, validate and demonstrate key technology enablers for “plug-and-play” integration of SatCom into 5G networks, with focus on eMBB use cases

Further info: http://sat5g-project.eu/
SATis5 Project at a Glance

SATis5: Demonstrator for Satellite-Terrestrial Integration in 5G Context

▲ European Space Agency (ESA) ARTES Advanced Technology - Contract No. 4000120663/17/NL/CLP
▲ Kick-Off: 01 October 2017 (Duration: 24+12 months)
▲ Aim: To build a large-scale real-time live end-to-end 5G integrated satellite terrestrial network Proof-of-Concept testbed, with focus on eMBB and mMTC use cases

Further info:
https://artes.esa.int/projects/satis5
5G-VINNI Project at a Glance

5G-VINNI: 5G Verticals Innovation Infrastructure

▲ Customer: European Commission (EC)
▲ Funding Programme: EC H2020 5G PPP Phase 3
▲ Total Budget: 20 MEUR (100% funded)
▲ Kick-Off: 01 July 2018; Duration: 36 months
▲ Main Objective:
  • Build an open large scale 5G End-to-end facility that can:
    - demonstrate that key 5G network KPIs can be met
    - be validated, accessed and used by vertical industries (H2020 ICT-19 projects) to test use cases and validate 5G KPIs
▲ Consortium:
  • Project Coordinator: Telenor (NO)
  • Large industrial EU consortium comprising 23 partners, incl. Major MNOs and Mobile Industry Vendors
  • SES: Consortium Partner, Experimentation Facility Site Owner & Operator

Further info: https://www.5g-vinni.eu/
5G-VINNI Key Objectives

▲ Design an advanced and accessible 5G end to end facility for vertical industries
▲ Build several interworking sites of the 5G-VINNI end to end facility
▲ Provide user friendly zero-touch orchestration, operations and management systems for the 5G-VINNI facility

▲ Validate the 5G KPIs and support the execution of E2E trial of vertical use cases to prove the 5G-VINNI capabilities
▲ Develop a viable business and ecosystem model to support the life of the 5G-VINNI facility during and beyond the span of the project
▲ Demonstrate the value of 5G solutions to the 5G community particularly to relevant standards and open source communities with a view to securing widespread adoption of these solutions

Main Facility Sites
- Norway (Oslo, Kongsberg)
- UK (Martlesham)
- Spain (Madrid)
- Greece (Patras)

Experimentation Sites
- Portugal (Aveiro)
- Germany (Berlin)
- Germany (Munich)

Moving Experimentation Facility site: Satellite Connected Vehicle (SES)
Successful Live Over-The-Air Demos Conducted in 2018-2019
Validating Key Technologies for Satellite Integration into 5G

Demonstrated key benefits of satellite backhaul integration into standard 3GPP core network architecture using SDN/NFV/MEC-enabled 5G testbed as proof-of-concept for satellite integration into 5G

SDN  NFV  MEC  eMBB  mMTC  Network Slicing  5G Core Network Integration
MWC 2019 Demo Overview
OSMOSIS edge computing on SATis5 satellite 5G testbed

Demonstrated integration of GEO satellite backhauling into standard 3GPP 5G Core Network and versatility of SATis5 testbed to support various “customer” use cases

Objectives

▲ Satellite backhaul integration into latest 3GPP Rel’15 compliant 5G Core Network
▲ SDN, NFV and MEC technologies integration into satellite communications
▲ OSMOSIS Edge Computing Use Case:
  • eMBB and URLLC network slicing use cases over satellite
  • Efficient multi-access content delivery and edge caching over satellite
  • ABR streaming and CDN integration
5G Aero Backhaul Demo Testbed Architecture
Over-the-air demo expected in Q4 2019

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SaT5G Use Case 4: 5G Moving platform backhaul

- **Use Case Description**: Broadband connectivity to airplanes for Next Gen IFEC
- **Addressed 5G Functionalities**: Satellite access for backhaul Support of SDN/NFV, Edge caching, Network Management and orchestration. Traffic steering between unicast and multicast resources. Mobility management in realistic aircraft scenarios.
- **Demo Testbed Platform & Partners**: 5G Aero Testbed (Munich DE) Zodiac In-flight Innovation, SES, Gilat, BT, Quortus, i2CAT, Broadpeak

#5GMediaRoad2019, Munich, 08 May 2019
Ubiquitous data communications capabilities are driving the digitisation of everyday life and business. 5G will enable a step change in those capabilities further fueling bandwidth demand.

Media is a major driver of demand for bandwidth.

Satellites will play an important role in proliferating 4G, 5G and legacy data networks worldwide, including also to hard-to-serve, under-served and un-served areas.

SES is making significant investments in new satellite, network and service capabilities to support those opportunities.

SES is working with all stakeholders to ensure integration of satellite into the overall 5G ecosystem, enabling a range of vertical applications, especially media.

SES already demonstrated how satellite can be seamlessly integrated into 5G.

Media – a major driver for satellite integration into 5G