

A New World of Solutions and Service Provision from Space



The 5G Journey... and the 6G Destination c21-virtual

The 5th Epoch Series - Hyperconverged TMT Networks: Space + Terrestrial - 24.v2

November 7th, 2024



Space Economy Scenario

The Space Sector in complementarity-alternative to the Terrestrial one, is in great expansion dual-use Civ/Mil thanks to the constant increase in reliability, capacity, performance, components-systems miniaturisation, global coverage of LEO MEO constellations, decreasing cost of technologies and services

From niche offer due to limited capacity/high costs (intercontinental communications, Digital Divide, Backhauling, VSATs, EO reserved for a few entities, etc.), to a new paradigm of abundance and competitive costs for nextgen LEO / MEO / GEO never experienced before

SatCom (GEO-LEO), SatEO (LEO), SatNav (GEO-MEO), benefit from the experience gained on Terrestrial for Software-Defined, Virtualisation, Cloudization, Edge, Hyperscaling, AI/ML, Digital Twin, As-a-Service, 5G Slicing

Global development trends currently focused on Multi-Orbit, Multi-Band, In-Flight Flexible Payloads, RF/IF over IP, RF MW to Laser for ISLs and UpDown Links, 5G NTN (Sat D2D)



Space Economy Market

Estimates and extrapolations from analysts' data differing from each other

World over **400 BUSD**



SatCom 85,66 BUSD 2023
GEO - LEO / CAGR 9,4 %,
forecast period 2022-2032
Includes **SatIoT 1 BUSD** / CAGR 20 %



SatEO 8,8 BUSD 2023
LEO / CAGR 6,92 %,
forecast period 2024-2032
Includes weather satellites MEO



SatNav 216,95 BUSD 2023
GEO - MEO / CAGR 9,5 %,
forecast period 2024-2030
*GNSS Core systems GPS (USA), GLONASS (RUS),
Beidou (CHN), Galileo (EU)*



Space Access **100 BUSD**
Launchers

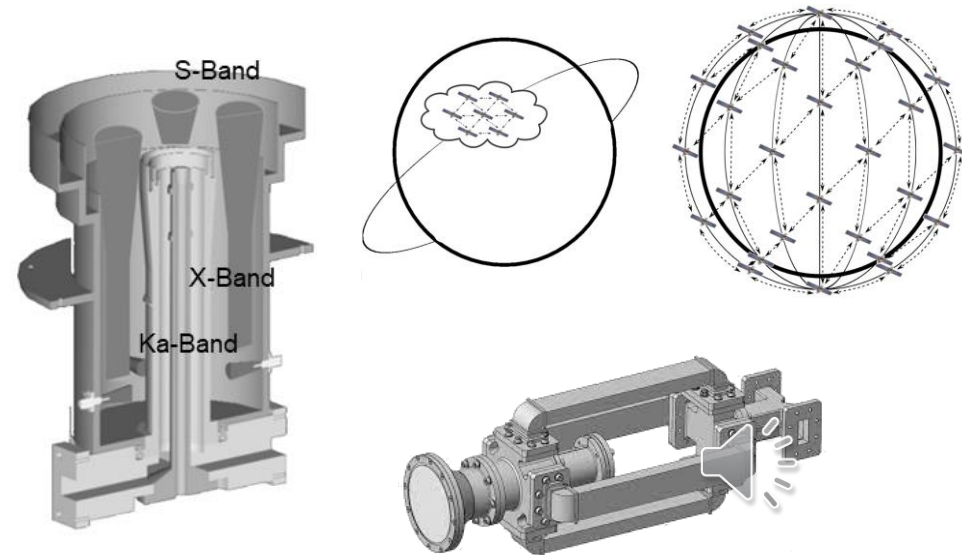
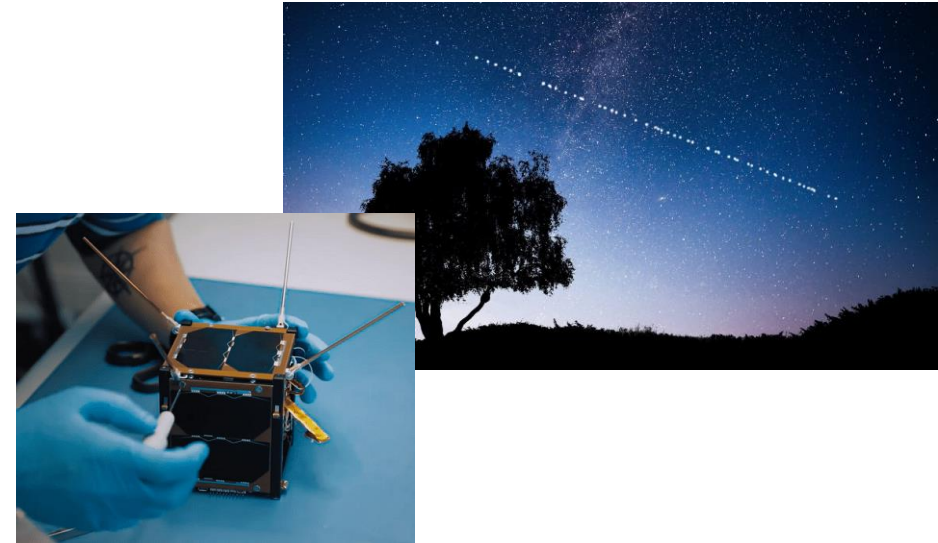
There are currently more than 10,019 active satellites, two-thirds of which belong to the SpaceX constellation.
Most of the active satellites are LEO (9,254)

The present greatest activity in space is not from putting satellites into orbit, orbital shifts, payload reconfigurations, etc., but from spy satellites spying on other spy satellites (!)



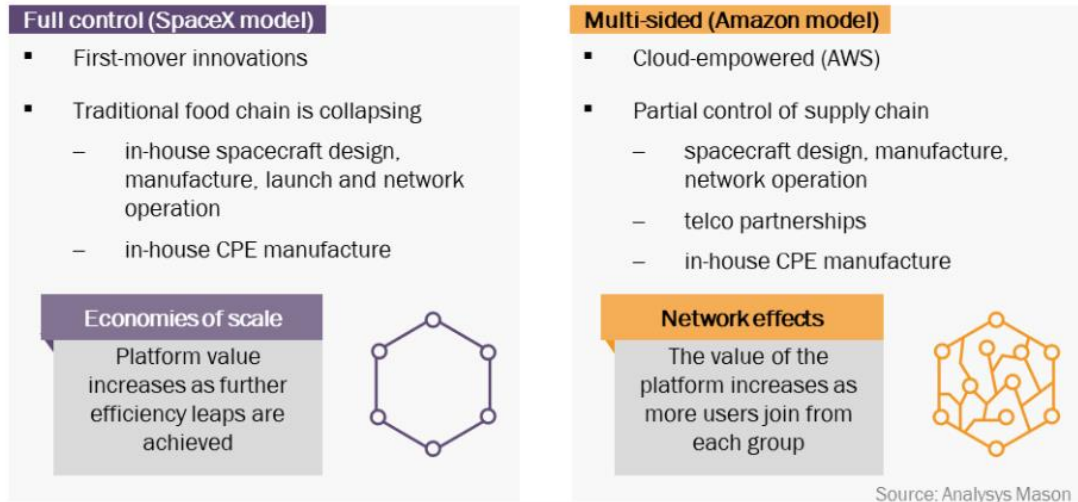
Examples of evolutionary impact in Space/Ground Segment

- **Micro/Nano/Pico Satellite Production**
- **GEO, MEO, LEO Multi-Orbit / Multi-Band**
- **Networks architectures evolutions of LEO Constellations**
Space-Time dynamic routing, Collaborative-Autonomous formation flying (Rendezvous & Docking, Swarms, Formation Flying such as Trailing, Cluster, Leader-follower,..)
- **In-Flight Flexible Payload for Missions reconfiguration-updating**
Electronically Splittable, Shapeable, Steerable
- **Capex Opex reduction and Services expansion thanks to technological evolution, miniaturization, performance, reliability, convergence, interoperability**
AI/ML, RF Digitization, SD Software-Defined (i.e. radio, modem), Cloudization, Virtualization, Edge, GSaaS,..
- **Multi-Band Multi-Orbit Ground Segment Antennas for SatEO and SatCom (i.e. S, X, K/Ka - Ka/Q/V Bands)**
Frequency / Band expansion for increased Com throughput (HTS / VHTS), or Earth Observation image data via complex MW circuit techniques for the antenna feeder and autotracking, with Gbps receivers/demodulators



SatCom - LEO mega-Constellations and HTS/VHTS/EHTS

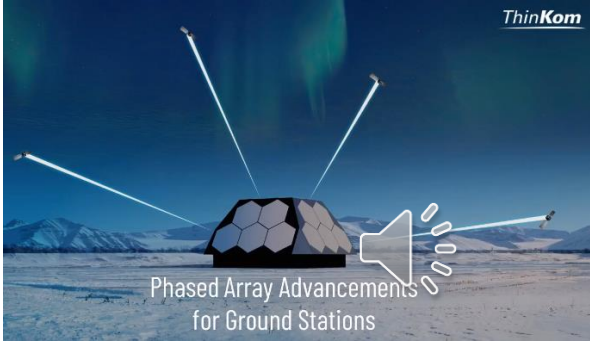
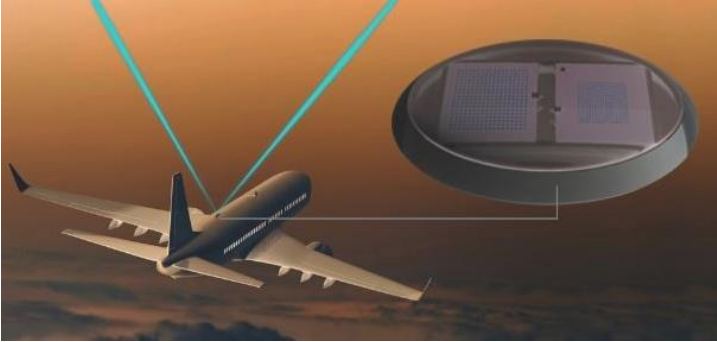
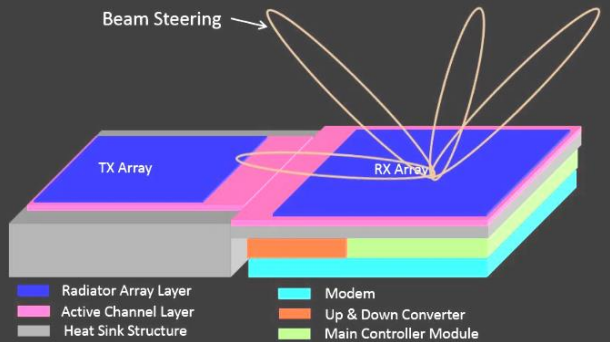
- LEO capabilities and mega-Constellations are redefining strategies and approaches on new services, applications, markets
- SpaceX Starlink, OneWeb, Amazon Kuiper (Ka-Band), etc. are the main reasons for the Satellite Sector transformation
- Starlink is currently dominant and disruptive
 - *Self-pointing terminal in Ku-Band over LEO in a system that also includes Ka- and V-Band*
 - *Speeds up to 220 Mbps* download / up to 25 Mbps* upload (*depending on service plan, precautionary specifications being a constantly growing Constellation which in some regions already reaches 300 Mbps down net of geo locations and congestion)*
 - *Latencies of 25-60 ms compatible with live streaming, videoconf, gaming*
 - *App control, Ikea-style installation documentation*
 - *Worldwide Direct 2 Cell for LTE Terminals (LTE NTN, satellites configured as eNodeB for Text services from 2024 and Voice/Data/IoT services from 2025)*



- With B2B/C subscription prices continuously falling, Starlink is currently comparable to FWA (over RadioLink or over 5G) and surpasses VDSL2 FTTC *Including cases of FTTH/B NOK delivery due to the impossibility of passing the fiber between ROE and Modem Router which requires investments in alternative channeling to be paid by the user*
- High/Very High/Extremely High Throughput Satellite are expected to play a key role as enablers of the upcoming 6G Networks *High data rate and wide coverage mainly GEO with several hundred Gbps, Multi-Band (Ka, Ku, Q, V), QoS, Beamforming, Beam Hopping, Spot Beams, Frequency Reuse, Advanced Modulation Techniques, Reconfigurable ESPAA Electronically Steered Phased Array Antennas, Digital Processing, AI/ML, Security, Standardization, Patents, Channel Multiple Access Techniques, Routing, Load Balancing, SDN*

SatCom - The revolution of ESPAA

- Eutelsat Tooway over GEO Ka-Band 22/6 Mbps down/up, 15 years ago was revolutionary for Digital-Divide with FWA still non-existent and a compact non-VSAT terminal
Gordionet has implemented dozens of Tooway B2B/C systems also with VPN integration
- The revolution of ESPAA Electronically Steered Phased Array flat Antennas
Technology already used for COTM/P CommunicationOnTheMove/Pause (Fixed, Mobile Vehicles and Trains, Maritime, Avionics, UAVs, Military)
- In addition to Satellites (LEO, GEO HTS/VHTS) and Internet Sat Terminals, Single/Dual-Band ESPA Antennas for Legacy/GSaaS Teleports are already on the market
- Strategic assessments are multiplying for greater complementarity between Terrestrial and LEO Sat Internet/GEO HTS, also due to FTTH-5G slowdown of implementation plans in some countries

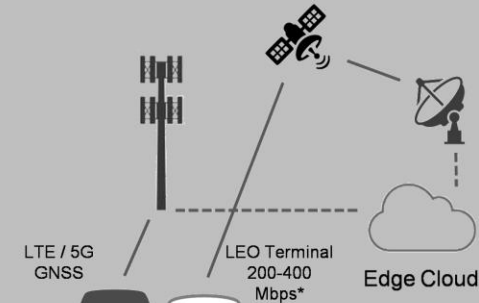


SatCom - COTM/P for Railways - 5G/LEO Hybrid model

Train-to-Ground Communication



- Train-to-Infrastructure, Mobile, Satellite
- Hybrid 5G - LEO SatCom with WiFi extension is currently considered the best model
- 5G vs/complementarity LEO SatCom (intended as stable coverage on the national - international urban/suburban/rural railway line)
- Current test results for download/upload speed-latency on-the-move, upload speed fundamental for Operations / Passengers real-time video Services
- Advanced Load Balancing Router
- For onboard systems Rail stds are needed (i.e. EN50121-3-2), more rigorous for Operations less for WiFi Passengers
- Traffic percentage estimate Operations vs Passengers, average monthly TB per Passenger
- Services percentage estimate 5G vs LEO SatCom
- Business models under discussion comparing Capex investments (carriages and Control Center adaptation) and Opex reduction / ROI - Services revenues



PIS Passengers Information System - IoT - Video Surveillance - Driver Information - Infotainment / Audio Video distribution - Ticketing - Payment System - Train Diagnostics - Emergency Comm



LEO Terminals Business/Enterprise versions



SatCom - COTM/P for Vehicles

Mobile Office - Hotspot - Internet - Video (SNG) - IoT - Telemedicine - Energy Plants, Wind Farms, Oil & Gas works along pipelines - Emergency



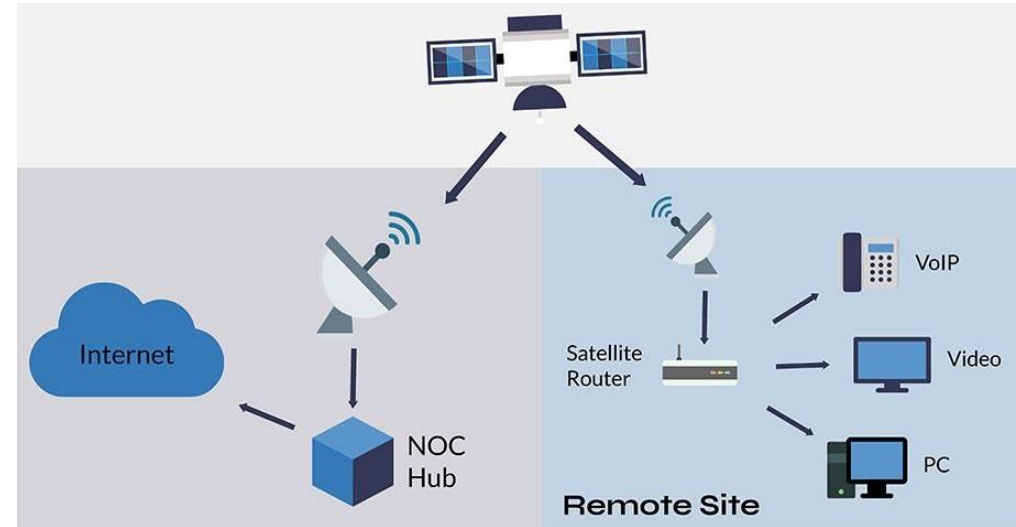
would you like to overcome a mountain?

GORDIONET
 LEO COTM-P up to 220d/25u Mbps - GB/TB according monthly service subscription
 Mobile Office - Hotspot - Internet - Video - IoT - Telemedicine - Emergency
 Supply or adaptation of SUV/Minivan - Terrestrial WiFi Extender - Portable Power Station



EU under pressure and current ww domination of SpaceX

- Space Law Article 25 provides for Italy a “reserve of transmission capacity through satellite communications” in the event of a blackout of Terrestrial Internet Networks
- Pnrr project delays broadband coverage in white and grey areas
- Resistance to evaluating integrations and complementarities by Terrestrial Operators who have always been against Satellite

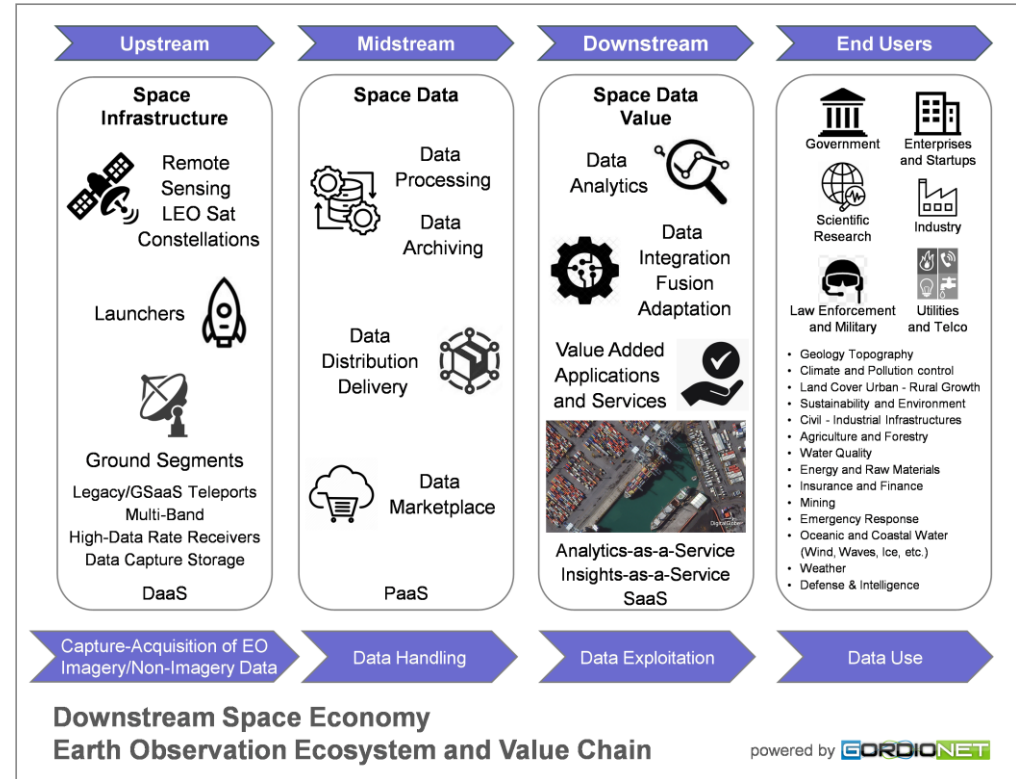
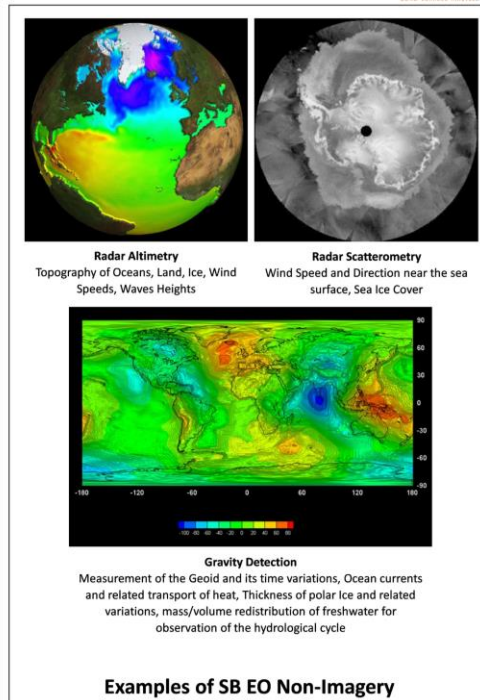
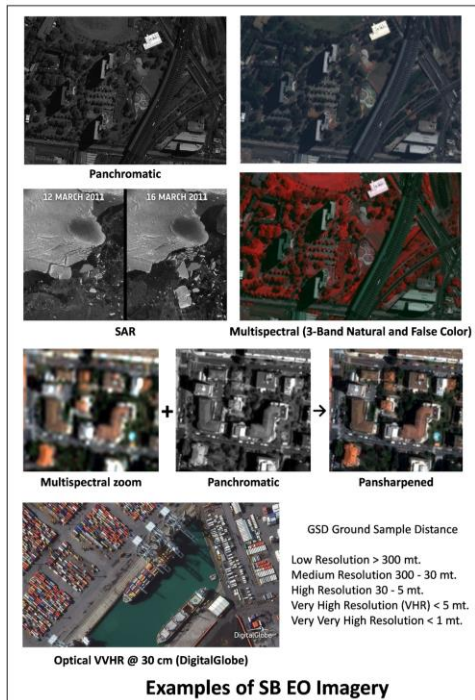


- Current SpaceX Starlink Internet via Satellite (constellation > 6,000 LEO satellites) with competitive performance and prices compared to French Eutelsat OneWeb (constellation of around 650 LEO satellites, ESPAA terminal much more expensive)
- Delays European IRIS² constellation deployment programme by the consortium with French-German Airbus and French Thales, whose space divisions are struggling with merger prospects
- Current SpaceX dominance over launchers long used by NASA but also by the EU due to delays in new launcher programmes by the French Ariane and the Italian Avio



SatEO

- Quality, accessibility, affordability of satellite data
- Continuous evolution of Passive/Active Payload Remote Sensing, with spectral-spatial-temporal-radiometric resolutions increasingly higher

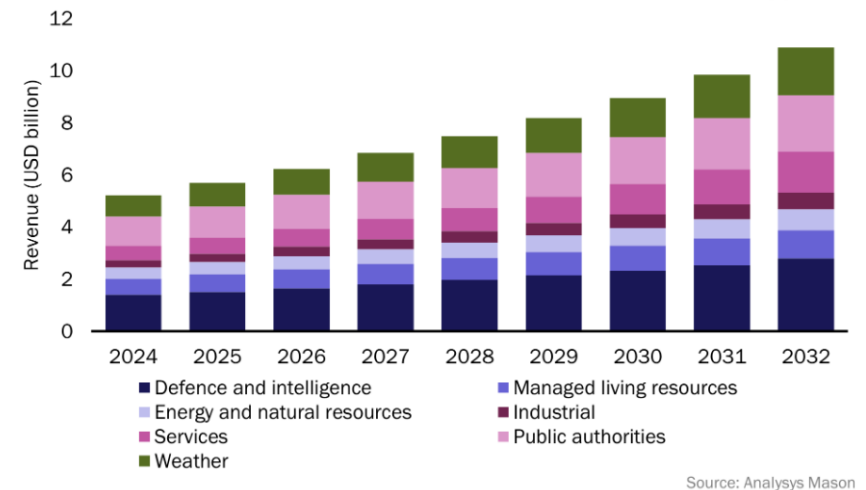
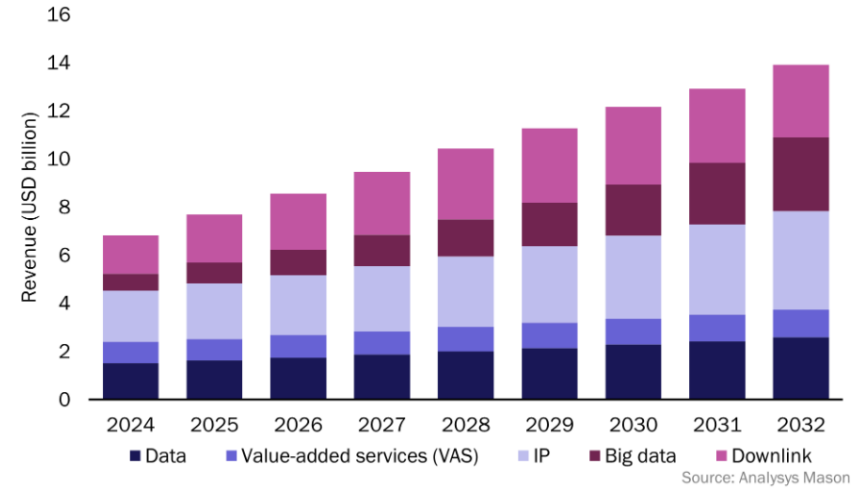
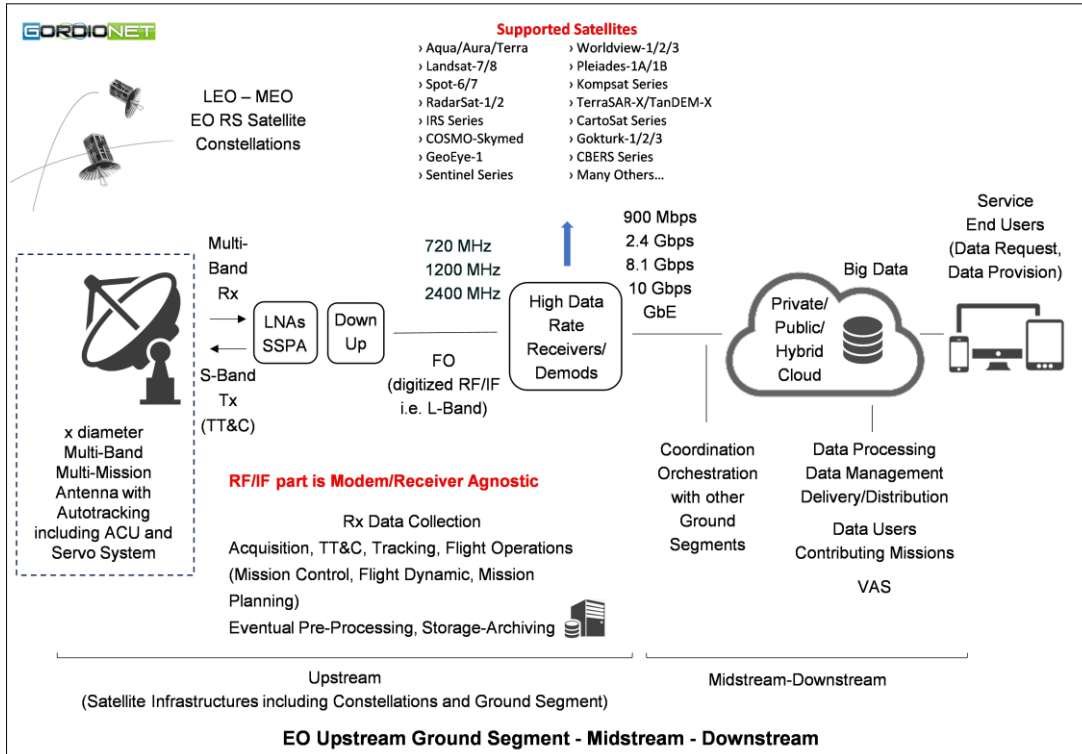


- Impressive growth of the downstream SatEO market not only for Defence and Intelligence (D&I), which remains the dominant vertical due to increasing geopolitical conflicts, but also for public and private companies in several sectors



SatEO - The Market

The SatEO market includes the infrastructure evolution of both LEO RS Satellites and Ground Segment including Tri-Band Antennas, high-capacity receivers/demodulators, and the whole Midstream Downstream value chain

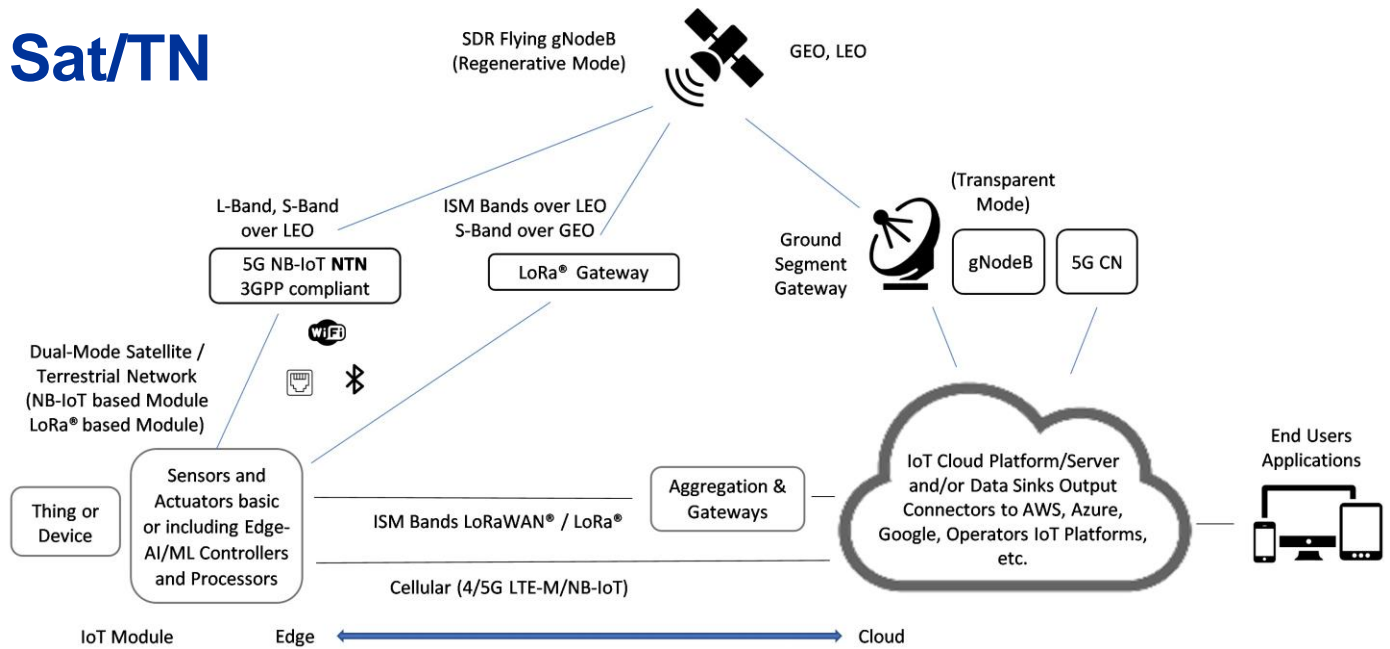


Where and how to purchase SatEO data/imagery depends on the type of data, such as resolution and/or AOI Area of Interest (e.g. payment per tile or square kilometer). Once the supplier or reseller has been identified with a quotation and contract, a data delivery via FTP is obtained. Most of ESA's EO datasets are freely available on the Internet with access after user registration

SatIoT - Dual-Mode Sat/TN



**Agriculture | Maritime | Logistic |
Transportations | Oil & Gas | Mining |
Energy and Utilities | Environment |
Constructions | Military and Defense**



The most suitable connectivity depends on local/international coverage, amounts of data bursts at infrequent/frequent intervals, bandwidth, latency, mobility, battery life, modules costs



Satellite 5G NB-IoT NTN

- Single eSIM for multiple cellular and satellite networks (i.e. Dual Mode LTE Cat-M1/NB2 Release 14 and 5G NB-IoT over NTN Release 17)
- Licensed frequency bands
- Suitable for stationary and slower-moving mobile applications
- Data rate up to 160/105 Kbps up/down (according a vendor/provider)
- Battery life up to 15 years (depending on data rates and frequency of transmission)
- Great reliability as the network is more exclusive
- Strong support for user identity, confidentiality, authentication and integrity
- Doesn't require a Gateway

| | | |
|---|---|---|
| 10MB cellular data per SIM per month | 10MB cellular data per SIM per month | 10MB cellular data per SIM per month |
| 10 satellite messages per SIM per month | 30 satellite messages per SIM per month | 60 satellite messages per SIM per month |
| Data and message pooling across SIMs | Data and message pooling across SIMs | Data and message pooling across SIMs |

Satellite LPWAN (LoRaWAN® / LoRa®)

- Over GEO widespread, over LEO can be intermittent
- Unlicensed spectrum
- Suitable for mobile and stationary applications, any location in clear view of the sky
- Requires a Gateway
- Data rates up to 460 Kbps (according a vendor/provider)
- Battery life up to 10 years (depending on data rates and frequency of transmission)
- Secure by design
- No dependency on terrestrial infrastructure



Thank you!

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All contents are extrapolated from Market-Business Analysis/Intelligence performed by Gordionet and/or from Gordionet's direct involvement in Space Sector/Economy projects. The contents are not confidential and are not under NDAs.

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