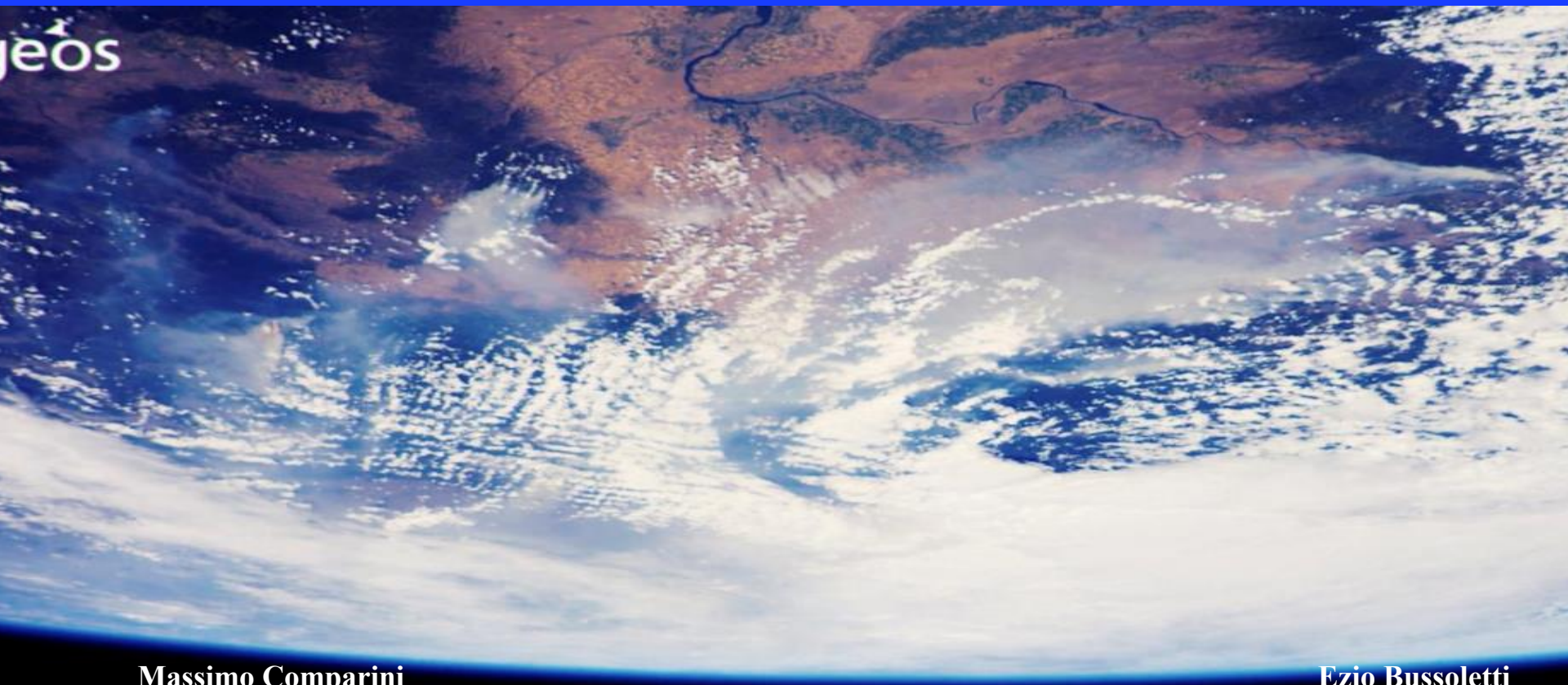
The Space Sector today and in the near future



Massimo Comparini

e-GEOS – Chief Executive Officer
Telespazio – Director Line of Business GeoInformation
Chairman - Space Innovation in Itaty

Ezio Bussoletti

Coordinator
Space & Aeronautics Area
PNR MIUR

Space Phases Evolution

First Space wave

Space as Political Power Cold War

Moon landing 1969

JFK Speech 1962

2° Space wave

Science and Exploration Early Comms

inmarsat

1979

Navstar 1 1978

INTELSAT

3° Space wave

DAB DBS HTS Comms LEO/MEO Earth Observation Navigation Systems

2007-2010

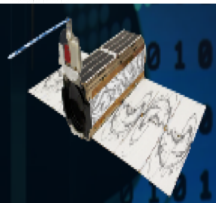
COSMO SkyMed

mid 90's

mid 2010's

OneWeb

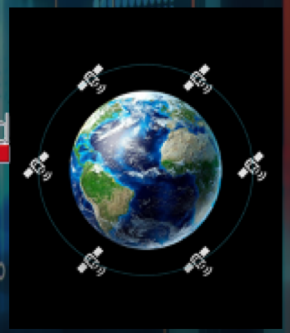
Globalstar



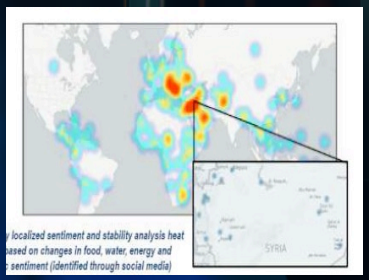
4° Space wave

Democratization Sharing Economy In Space

Earth Digital Twin

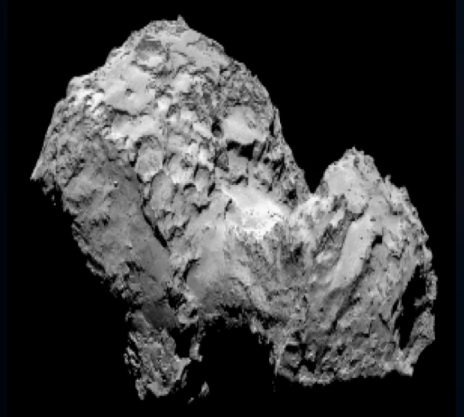


Pattern of life



THE SPACE SECTOR

- *Attractive strategic goal*,
- The number of countries and companies and their *downstream applications continues to grow*
- Space often is considered as expensive though national investments represent very small percentage relative to GDP in all G20 countries
- High-technology niche: it employs about One million *persons*: public administrations (space agencies, space departments in civil and defense-related organizations), the space manufacturing industry (launchers, satellites, ground systems); direct suppliers to this industry (components), and the wider space services sector (commercial satellite telecommunications, navigation and raising earth observation).



UNITED NATIONS
Office for Outer Space Affairs

Space for the 2030 Agenda

Adopted by all UN Member States in **2015** provides a shared blueprint for **peace and prosperity** for people and the planet, now and into the future.

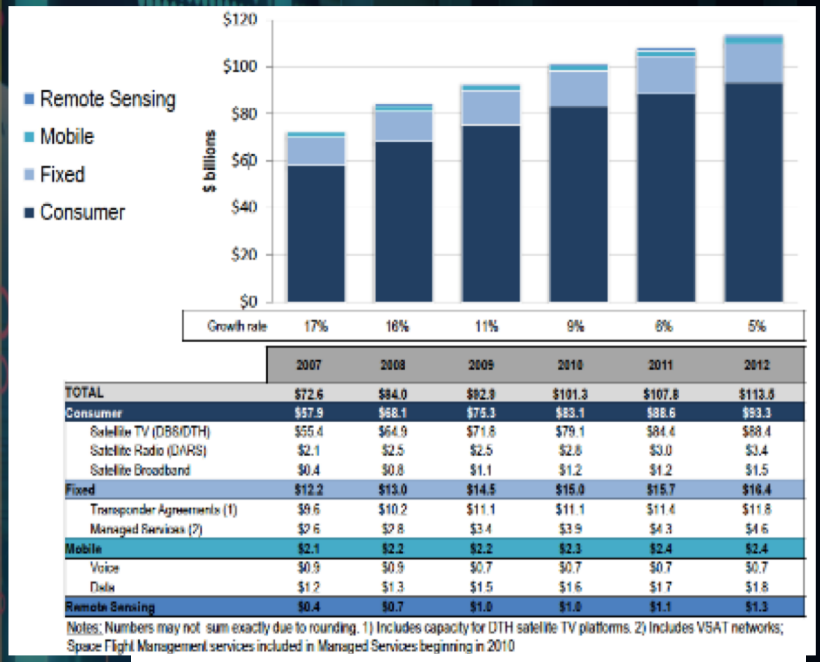
The 17 Sustainable Development Goals (SDGs) are an **urgent call for action** by all countries – in a global partnership

65 of the 169 SDG targets are reliant on the use of Space

SPACE4SDGS

THE SPACE SECTOR ECONOMY

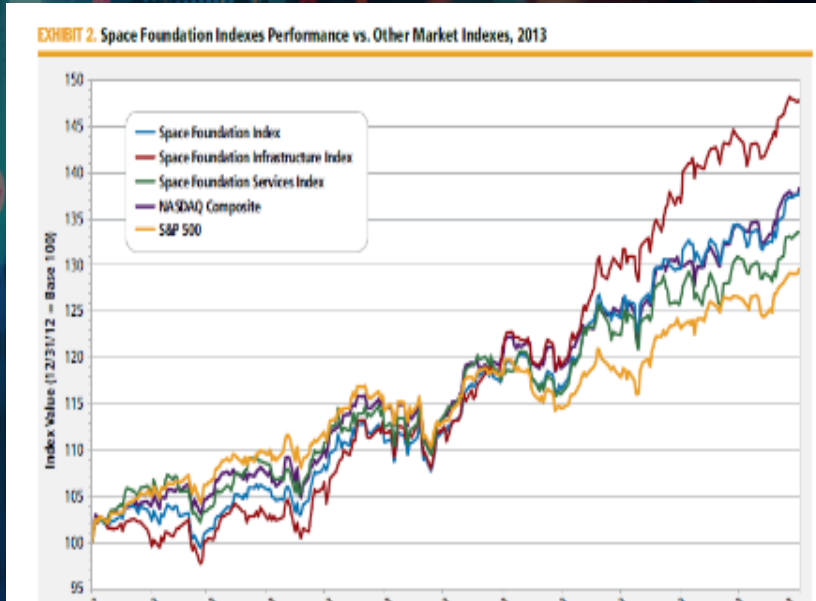
- Traditionally strongly dependent from public budgets, it has today achieved commercial maturity (in Telecom/Broadcasting and, recently, global navigation and Earth Observation)
- Public funding still represents a significant source for large space programs
- in the last few years pushing technology development across the whole industrial chain has injected an impressive amount of resources by private global industrialist and billionaires (Musk, Branson, Bezos, Zucken, ….)
- Today private funding (industry / market) accepts to support initiatives due to adequate financial return
- Investors confidence in the outlook for Space companies (robust performance of the Space Foundation Indexes)



	2007	2008	2009	2010	2011	2012
TOTAL	$72.6	$84.0	$92.9	$101.3	$107.8	$113.6
Consumer	$57.9	$68.1	$75.3	$83.1	$88.6	$93.3
Satellite TV (DBS/DTH)	$55.4	$64.9	$71.8	$79.1	$84.4	$88.4
Satellite Radio (DARS)	$2.1	$2.5	$2.5	$2.8	$3.0	$3.4
Satellite Broadband	$0.4	$0.8	$1.1	$1.2	$1.2	$1.5
Fixed	$12.2	$13.0	$14.5	$15.0	$15.7	$16.4
Transponder Agreements (1)	$9.6	$10.2	$11.1	$11.1	$11.4	$11.8
Managed Services (2)	$2.6	$2.8	$3.4	$3.9	$4.3	$4.6
Mobile	$2.1	$2.2	$2.2	$2.3	$2.4	$2.4
Voice	$0.9	$0.9	$0.7	$0.7	$0.7	$0.7
Data	$1.2	$1.3	$1.5	$1.6	$1.7	$1.8
Remote Sensing	$0.4	$0.7	$1.0	$1.0	$1.1	$1.3

Notes: Numbers may not sum exactly due to rounding. 1) Includes capacity for DTH satellite TV platforms. 2) Includes VSAT networks; Space Flight Management services included in Managed Services beginning in 2010

Source: SIA State of the Satellite Industry Report October 2013



EXAMPLES OF PRIVATE ENGAGEMENTS

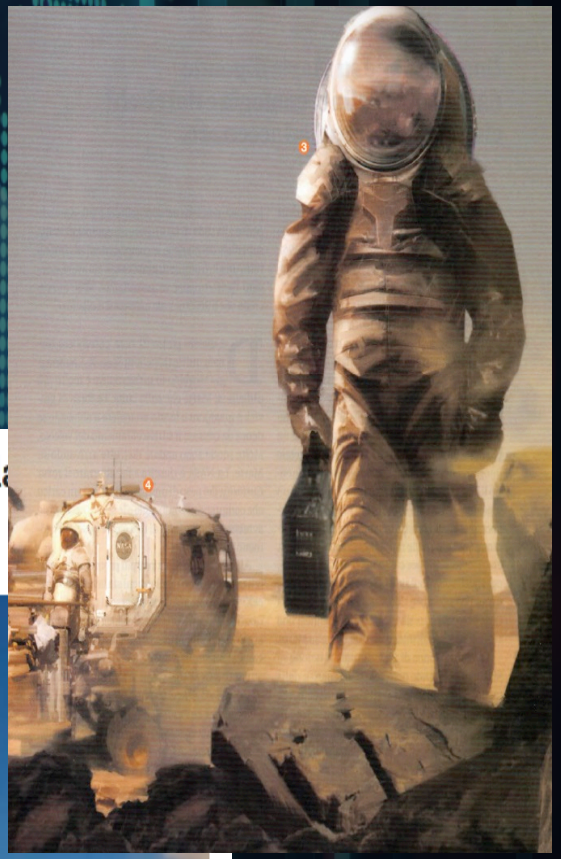
FARNBOROUGH INTERNATIONAL AIRSHOW

Virgin Galactic spinoff Orbit to launch rockets from the UK with space deal

- Virgin Orbit sealed a deal with the U.K. Space Agency to launch its LauncherOne rocket via Cosmic Girl, a modified Boeing 747-400 plane.
- Virgin said Monday the agreement meant Orbit would be the first firm to operate flights to space from British soil.

Ryan Browne | @Ryan_Browne_
Published 7:35 AM ET Tue, 17 July 2018

CNBC



Blue Origin successfully tests escape system in l… Shepard launch

by **Jeff Foust** — July 18, 2018

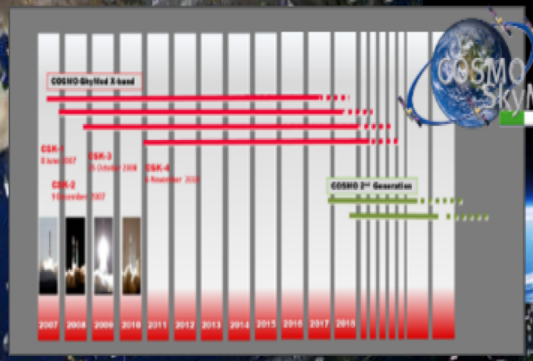
THE SPACE SECTOR ECONOMY

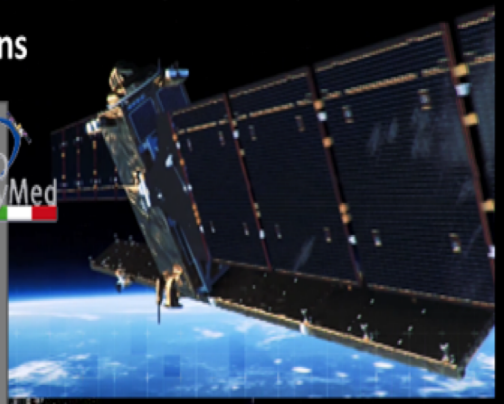
Constellations will account for 70% of the future demand

Smallsat demand is experiencing a increase **x7**

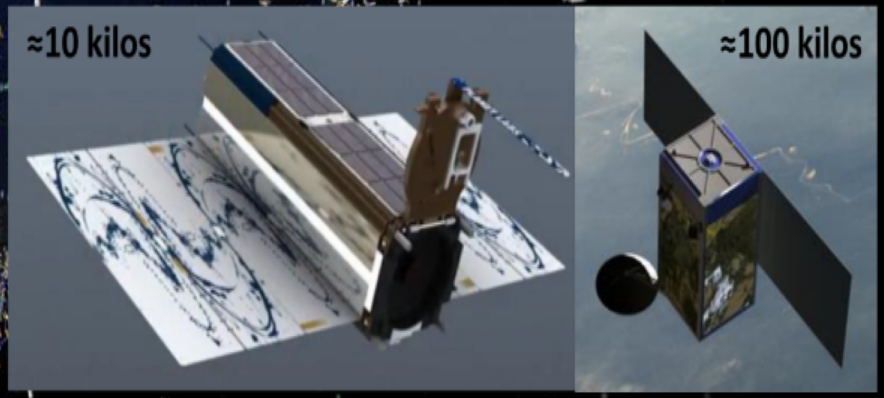
evolution of large infrastructure (high end sensors few sats)

≈2 tons





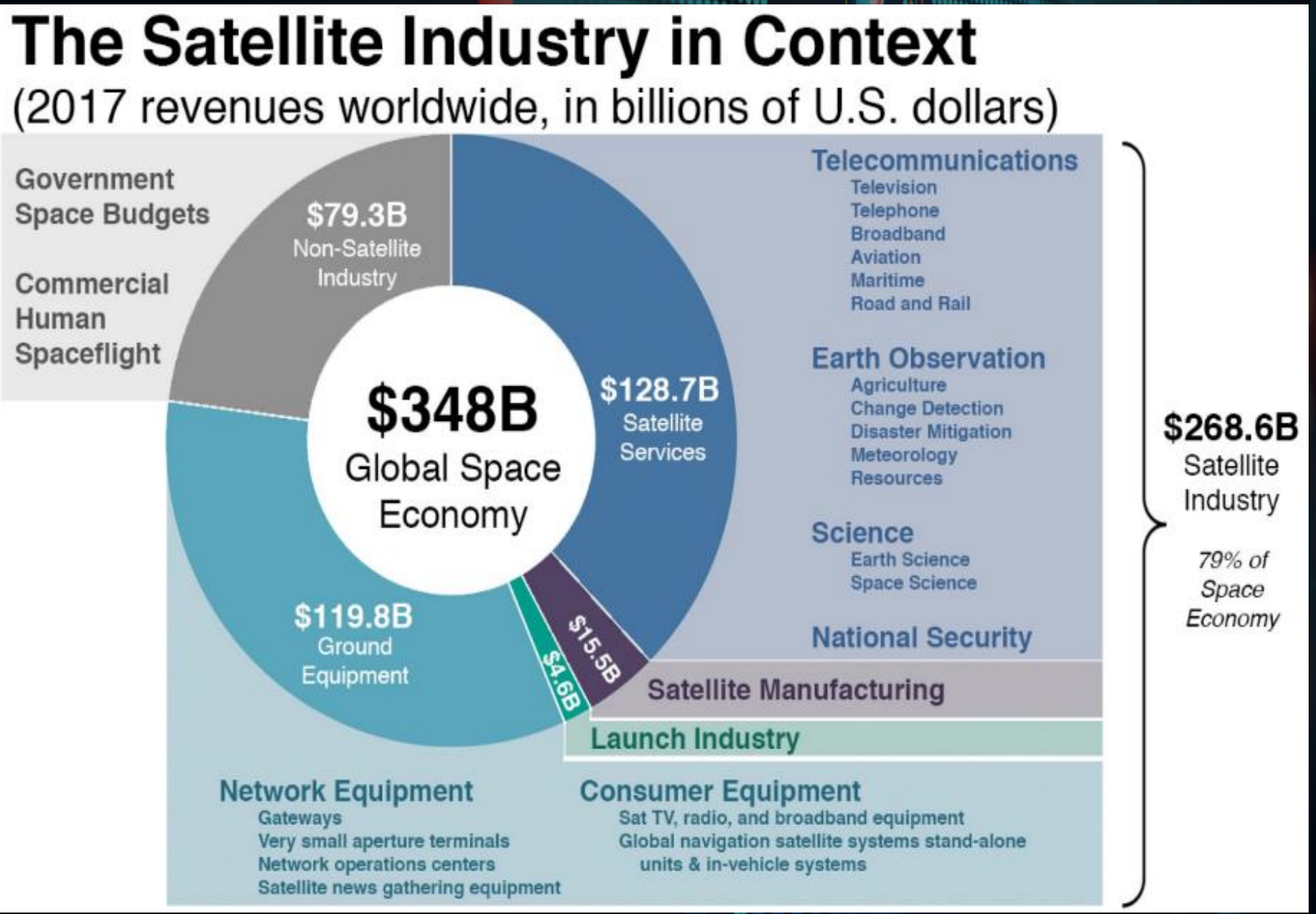
emerging constellations (low end sensors/many sats)



THE SPACE SECTOR ECONOMY

- Industry shareholding shifted from public to private over the years, some still under "public surveillance" (through governance or ad hoc regulation) but a number of new companies raised up in the last few years
- Mostly employing dual technologies, predominantly "user driven" as opposite from original "technology push" approach,
- More emphasis to applications and service development
- A new *Space Economy* is emerging much wider than the space sector itself and can be defined using different perspectives.
- It can be defined by its products (e.g. satellites, launchers…), its services (e.g. broadcasting, imagery/data delivery), its programmatic objectives (e.g. military, robotic space exploration, human spaceflight, Earth observation, telecom…), its actors/value chains (from R&D actors to users), and its impacts (e.g. direct and indirect benefits…).

THE SPACE SECTOR ECONOMY



Space Democratization

- Decreased costs, increased capabilities and path breaking innovations are making satellites and space applications and services more relevant to businesses and public good
- Satellites transform businesses and quality of life today much more than ever, associated technologies have expanded at an exponential speed
- This dynamic known as "Democratization of Space", implies that more people and new organizations are part of the industry
- IT'S NOT AT ALL ONLY A TECHNOLOGY EVOLUTION
  IT'S A CULTURAL PARADIGN SHIFTS

New space race where the players, technology, and services are as diverse as innovative

Global connectivity

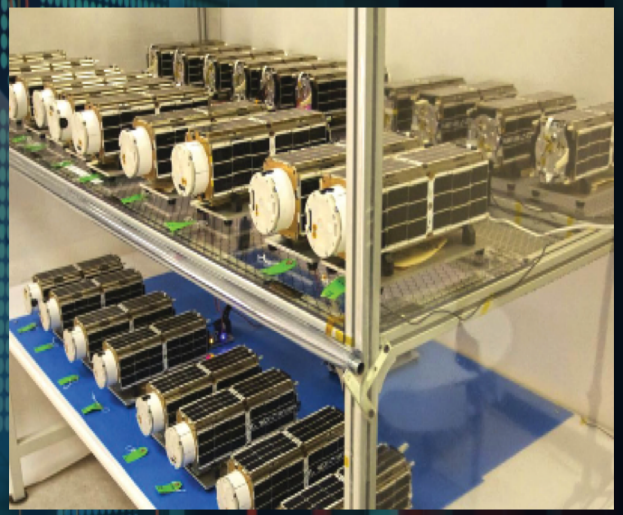
Global geospatial

Space Democratization

- **The rapid evolution of technology** (Improvements in launch systems, sensors, other input technologies and innovations such as the smallsat architecture) **drives down costs.**

- **More sensors** and a **greater diversity** of their types mean **greater performances** (spatial resolution, higher temporal cadence & richer spectral coverage)

- **The combination of decreased cost and increased capabilities opens up new use cases, new industrial births and applications for businesses**



Space Democratization

- **Transformation** of the space industry largely **driven by new services and applications** (innovations in launch and satellite manufacturing technology & new applications)
- **"NewSpace":** rapid inventions and developments, lower costs, commercially available parts and incremental development
- **Shift from large players** (governments and big corporations) who operate satellites, distribute data and supply services, **to the market which includes many startups** that deploy new technologies to support traditional applications and develop new applications
- **The sharing economy in Space** (a double-digit B$ industry), **is one of the key running transformations**.

Cadillac 60s

Saturn late 60s

Tesla mid 10s

SpaceX reusable rocket

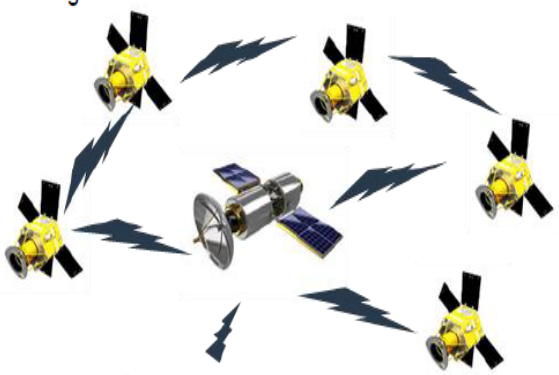
Space Democratisation

4 Small-Satellite Clusters Replacing Large Satellites

With low manufacturing cost and not mandating dedicated launch vehicles, small satellite clusters are beginning to set the trend of realizing improved space capabilities also enabling penetration into densely populated orbital space.

Formation flying and fractionated satellite architecture: navigation and formation control, modularity and open-architecture for expansion of existing clusters

Micropropulsion systems: MEMS-based miniaturized propulsion systems, precise attitude control for formation



Inter-satellite connectivity: distributed processing, advanced data routing protocols, faster relay, high data rate

Reconfigurable on-board electronics: post-launch system upgrade capability (software)

Small-satellite launch capability: dedicated launch vehicles, secondary payload adapters

2030 Small-Satellite clusters delivering complex-higher capability multi-missions at low cost

Future Apps

- **Multi-point imagery = Advanced ISR / Cartographic Imagery / Digital Maps**
- **Stand-Alone / Integrated Communication**
- **Timed multi-point data gathering = Advanced EO / Remote sensing**

Benefits

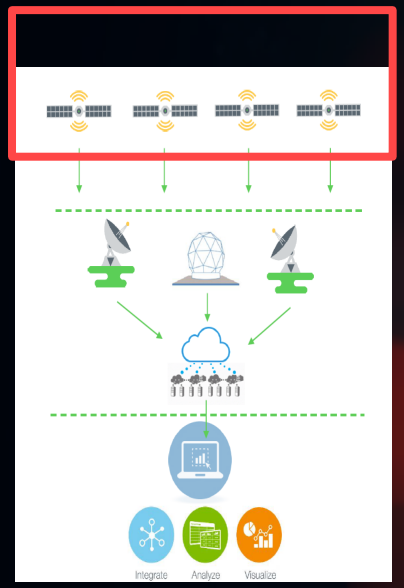
Reduced financial risk: Low cost satellite missions delivering enhanced mission capabilities across extendable mission life .

Improved capabilities: Reduced time-Improved quality data gathering (multi-point imaging), low-light imaging, system reliability (through redundancy)

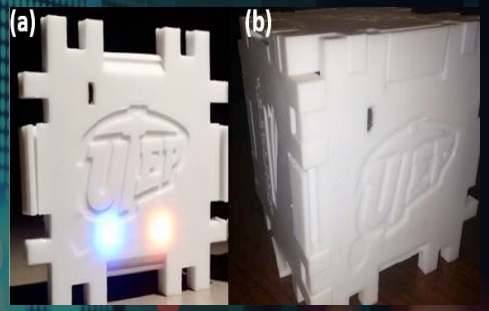
Multi-Mission Satellites: Modular and flexible architecture generating multi-mission opportunities.

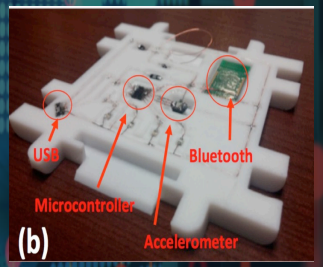
Increasing adoption: Enhanced functionalities and new applications at an 'affordable' cost to create new genre of satellite owners- both Military & Commercial

Space Democratization



- Constellations/Mega Constellations
- Trains
- Clusters
- Nanosatellites
- Fractionated spacecraft
- Hosted payloads
- Formation flying
- Additive Manufacturing
- Sat systems parallel computing
- Autonomous cooperative systems



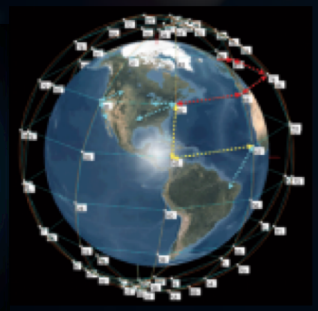


Additive Manufacturing

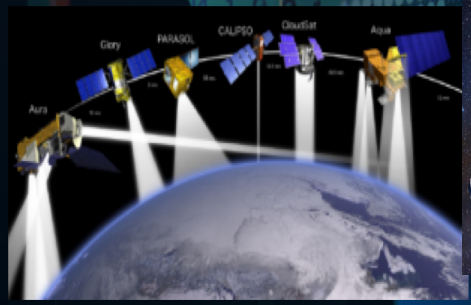
3D Printed Electroncis

Cubesat

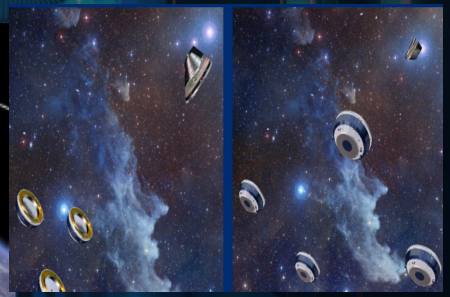
Const's



Megaconst's



Trains



Clusters

Swarms

Space Democratization

Globalization

Higher Competition level

- ***Globalisation is affecting the space economy*** **at different levels.**
- **In the 80s, only a limited group of countries had the capacity to build and launch a satellite. Many others are presently engaged in Space related activities with increasing trend**
- ***Supply chains*** **(development and operation of Space systems) are increasingly evolving at the international level, though the sector remains heavily influenced and shaped by strategic considerations.**
- ***Many Space technologies are dual use*** **which tends to constrain international trade though the research on global value and supply showsa rapid internationalization process**

- **More actors seek to enter global value chains, then competition on the relatively small commercial open markets is more difficult for incumbents.**

Space Democratization

Mega Trends

New Innovation Dynamics

R&D Centers Universities stronger impact

- Scientific and technological innovations render Space applications more accessible
- New Actors (Research Center and Universities) now can buy off-the-shelf technologies and equipment to build micro-satellites with growing complexity functionality.
- Innovative cross cutting industrial processes are promising to potentially inject disruptive breakthroughs in the Space manufacturing.
- This, coupled with globalization, could increasingly impact the Space activities particularly for incumbent industrial actors.

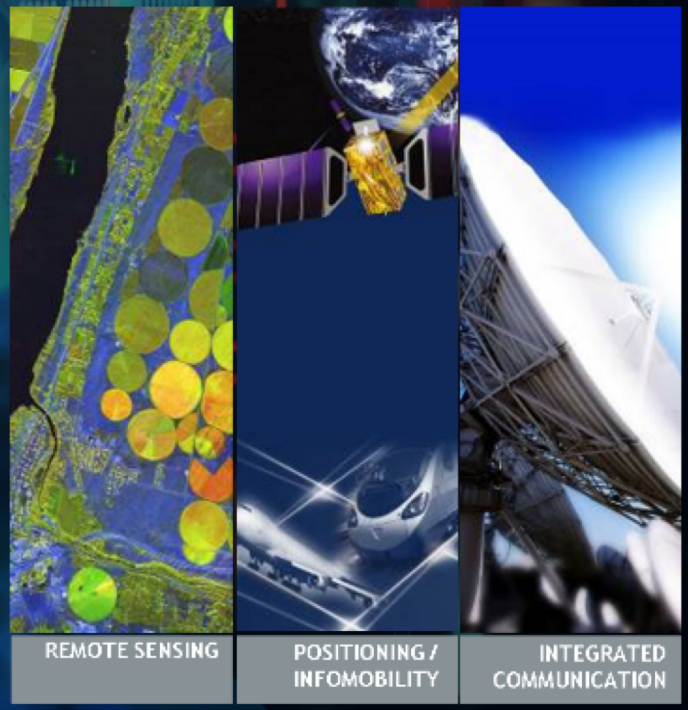
Space Democratization

- **The downstream sector:** satellites operators and providers of Space products and services with/in complement to other forms of enabling infrastructures and/or services

- **Services use a specific satellite capacity** (bandwidth or imagery) as inputs to provide a more global service to consumers (business, government or retail)

- **Downstream services** are various and are traditionally **divided into 3 application domains:**

  - a) TELECOMMUNICATIONS
  - b) EARTH OBSERVATIONS/REMOTE SENSING
  - c) NAVIGATION

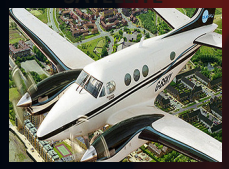


Space and Democratization

From data → Generating info → To customized platforms


GEOSPATIAL

SATELLITE


AERIAL / UAV


NAVIGATION

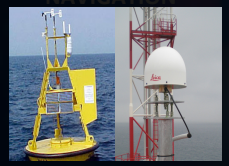

IN SITU SENSORS

IMAGE CONTENT

REPORTS

GEO CONTENTS


LAND


DEFENCE


MARITIME


AGRICULTURE


EMERGENCY

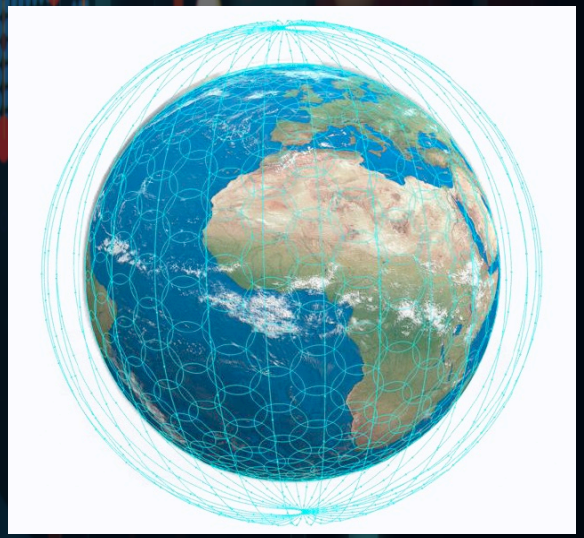

ENVIRONMENT

The new Space race – Global Connectivity

- The Demand for ever-faster broadband internet connections setts new architecture and technology limits towards increasingly powerful *High-Throughput Satellites* (HTS)

- The dominance of geostationary HTS is tested by the emerging *mega constellations*, fleets of hundreds or even thousands of relatively small satellites orbiting at significantly lower altitudes.

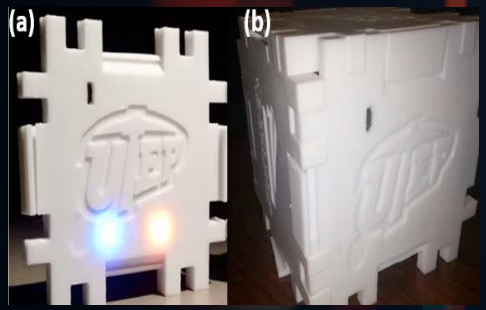
- LEO & MEO broadband satellites promise nearly fiber-optic speeds and global coverage with low latency, fully integrated in hyper connected systems

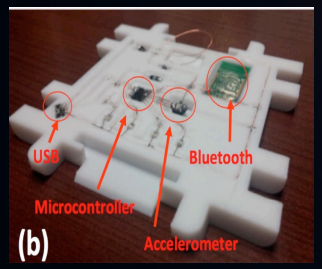


Mega constellations are a fundamental tool in Space democratization and an opportunity to contribute to Space activities for a broad range of institutions, including emerging innovative Startups, Research Centers and Universities.

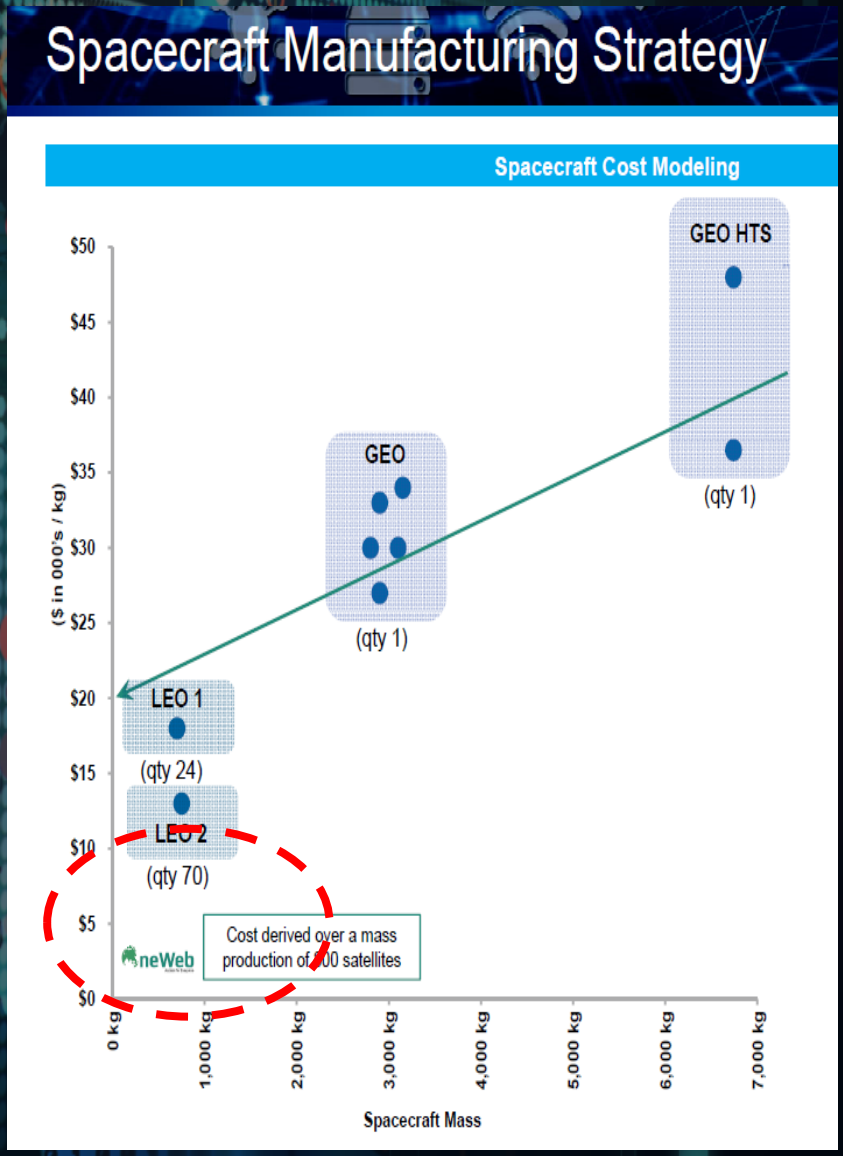
The new Space race – global connectivity

- **A new class of Space services and applications allow to build cost effective microsatellite constellations and clusters**
  (miniaturization of on board functions)





Additive Manufacturing
3D Printed Electroncis
Cubesat



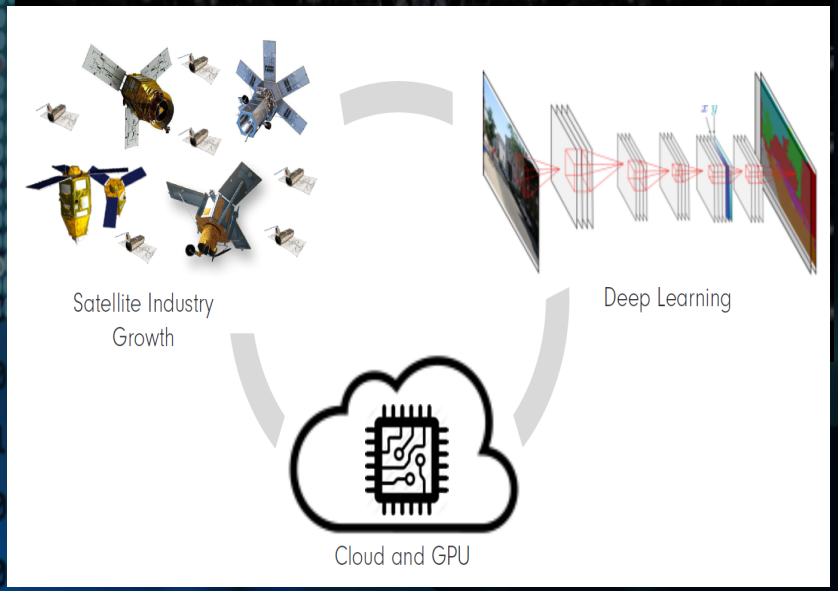
The new Space race – global geospatial

- Complementing EO Space systems based on large Space infrastructure and very high performance payloads and sensors allows:
  - to conceive very high revisit observation capabilities,
  - to obtain a quasi-persistent surveillance in perspective
  - to feed a new generation of service and application platforms with an exponentially growing amount of data

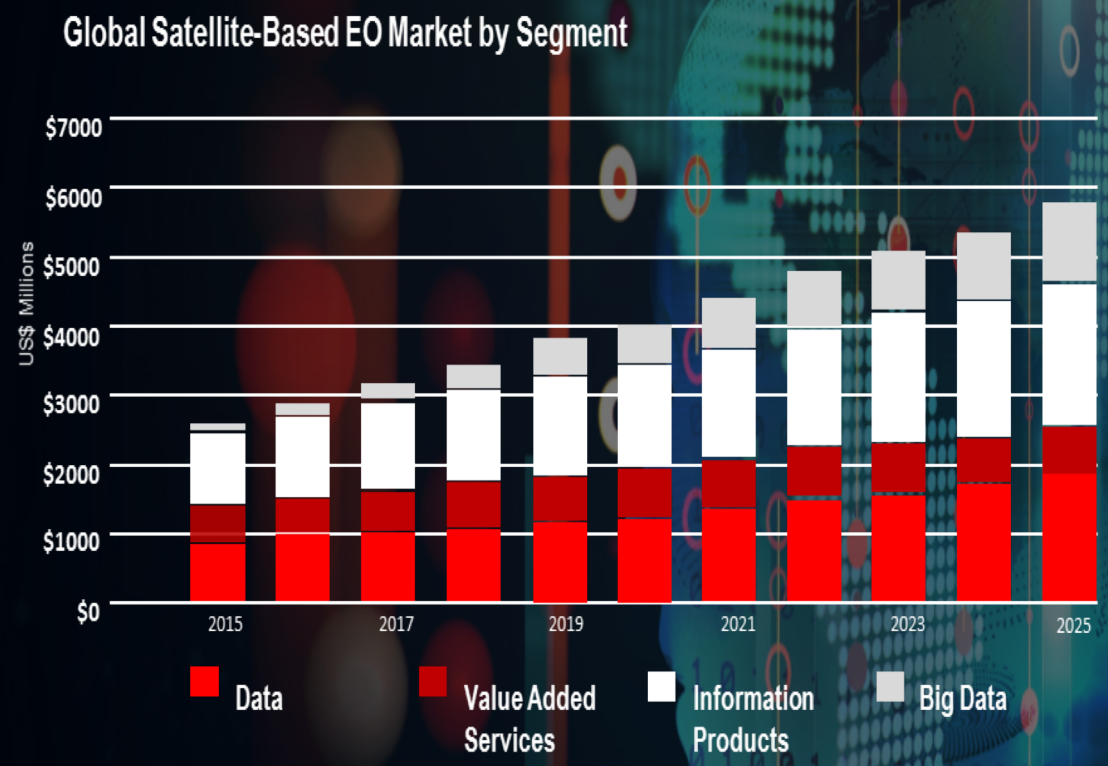
- Data, more and more, are just a part of the game

- Convergence with IT and data analytics boosts a new information driven market

- EO Geospatial business is today an inherent part of IoT



Geospatial Information Market Trends



high growth rate in information products and big data analytics

- Price of the **Optical** data is decreasing
- Use of **Radar** technology is growing
- **Number** of satellites is growing, with a large variety of sensors
- **Constellations** add temporal resolution dimension
- Huge amount of EO space data is generated
- **Big Data and Data Analytics** is fully integrated in geo-information applications

New Space Trend

From data  **Generating info**  **To customized Information Products and BDA** 

Orbital Insight

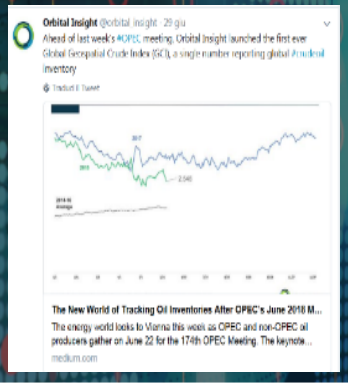
Orbital Insight Data Now Available on the Bloomberg Terminal

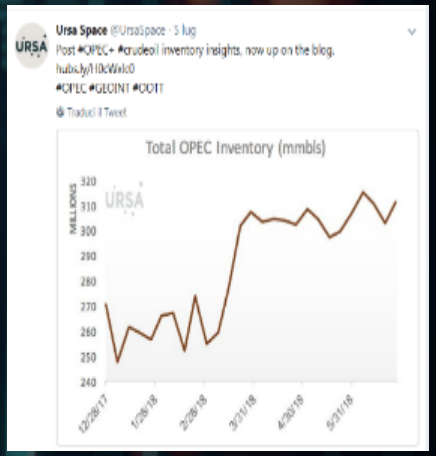
Bloomberg Terminal subscribers can now access daily geospatial analytics to make more informed investment decisions

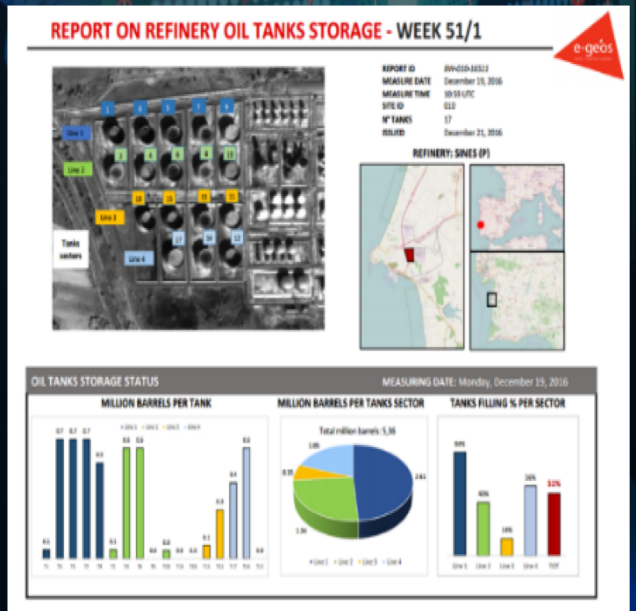
PALO ALTO, Calif., July 18, 2018 (GLOBE NEWSWIRE) -- Orbital Insight, the leader in geospatial analytics, announced today that its U.S. Consumer Retail product is now available via the Bloomberg Terminal. Bloomberg subscribers can now access daily car counts for 80 U.S. retailers. Year-over-year comparisons for the past five years are also available to better contextualize changes.

"The financial services industry relies on the Bloomberg Terminal for trusted data, and geospatial analytics adds a timely and accurate source that brings additional value," said A.J. DeRosa, Orbital Insight's Executive Vice President and Head of Global Sales. "With this integration, we can better meet the needs of buy side traders, analysts, risk professionals, and others who are looking to generate alpha."

Subscribers can download Orbital Insight's data or use data visualizations directly on the Bloomberg Terminal to measure against traditional investment metrics by accessing ORBT <GO>.







THE VALUE CHAIN FOR THE NEW VALUE ADDED SERVICES

More value addition/processing to the raw data

High

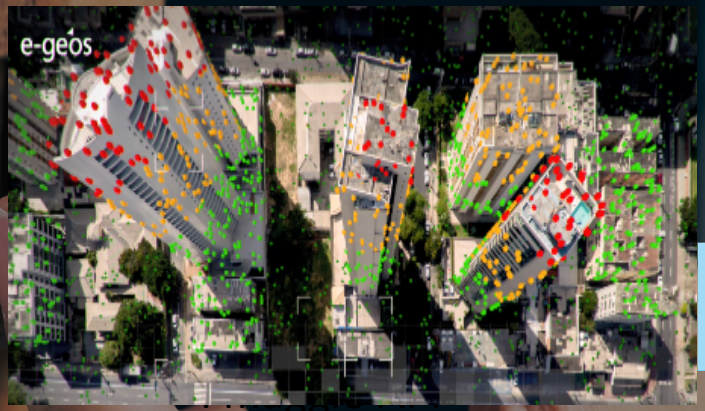
Big data analysis

Information Products

Value Added Services

Data

Low



Services for Financial user comunity

THE BIG DATA PROMISE – DATA IS THE NEW OIL

GEO Big Data + IA + Analytics are changing the game in the data consumption

AI

Machine learning

Deep learning

Big Data

Self Program

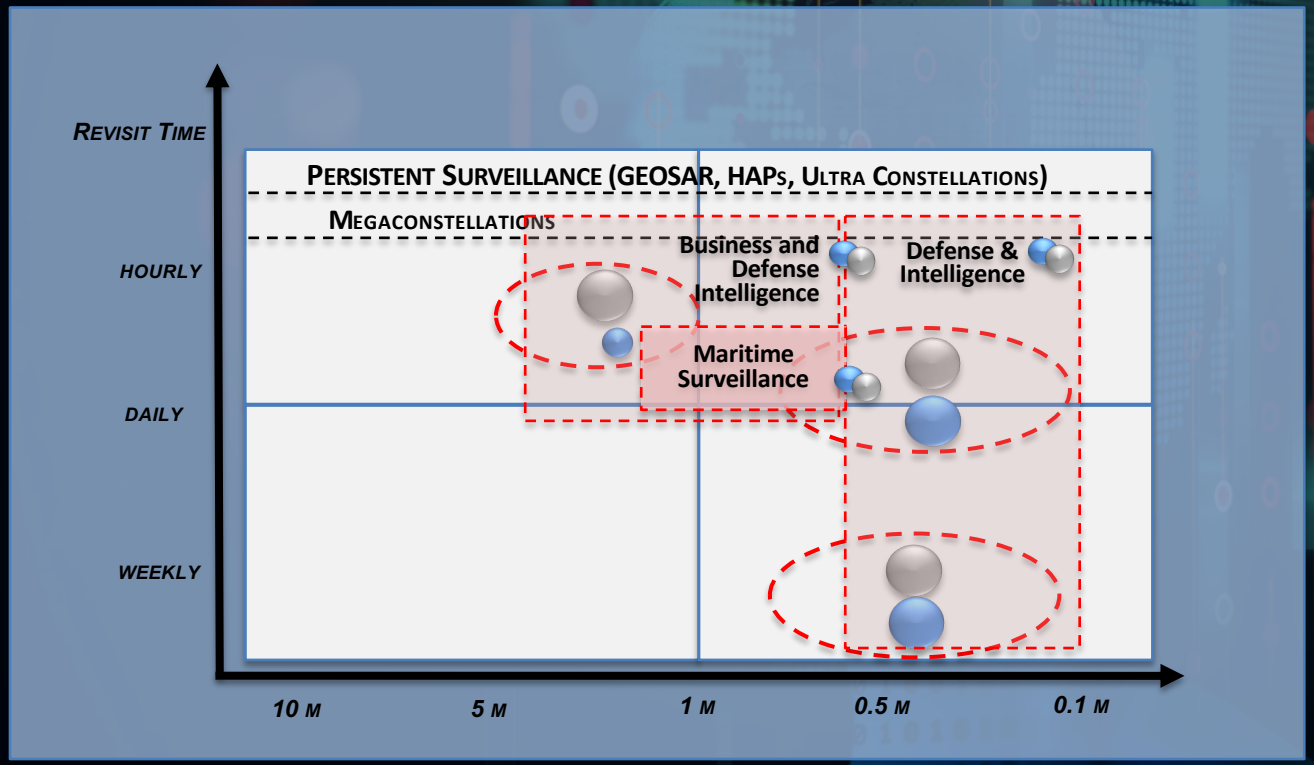
Predictive Analysis

Prescriptive Analysis

Automated action

- **Big Players envisage a role to the Geo-Information Analytics driven solutions in their business model and plan significant investments**
- **New information driven markets (big data, data analytics apps) drive increase in revenues for sat operators**
- **Industrial landscape is going to have a strong evolution with consolidation in place and a growing strong momentum in the evolution of partnership models**

Defense & Intelligence will largely benefit from a higher data variety as well as of advanced methods to derive timely information flow



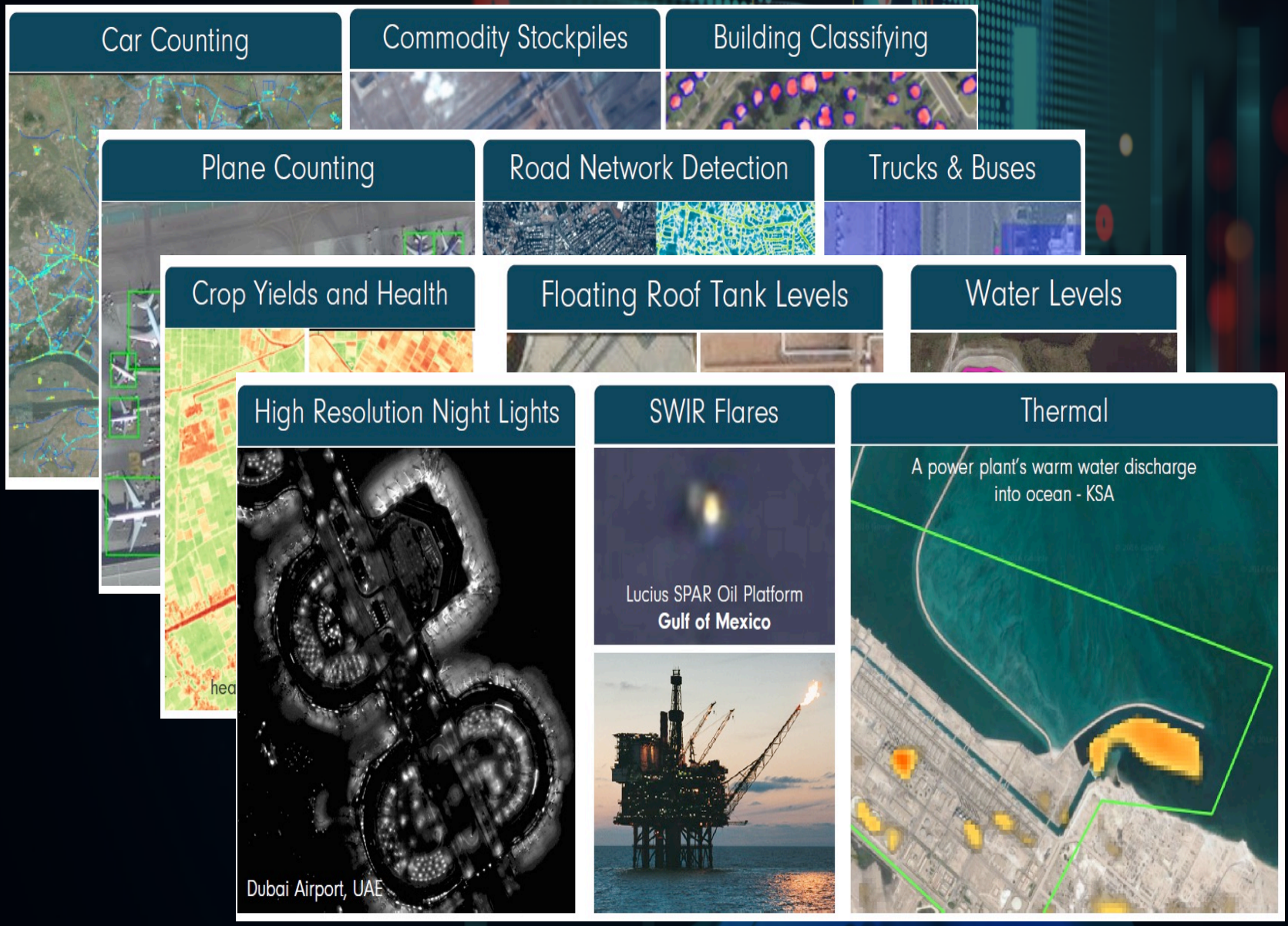
monitor daily

discover trends

deliver insight

e-geos

Space Democratization

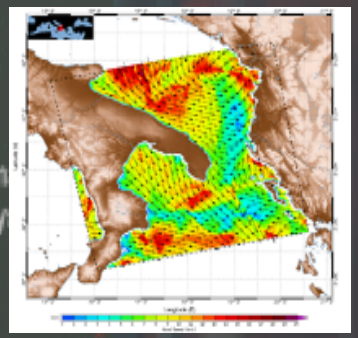


Space Democratization

Vessel detection

Oil Spill Detection

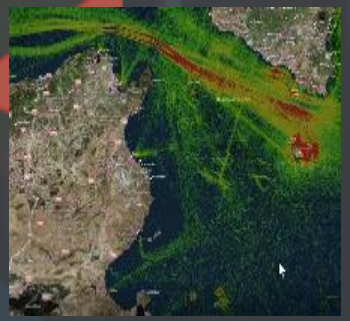
Wind & Wave



Activity Report

Geospatial Analysis and Alert Notifications

Exact Earth



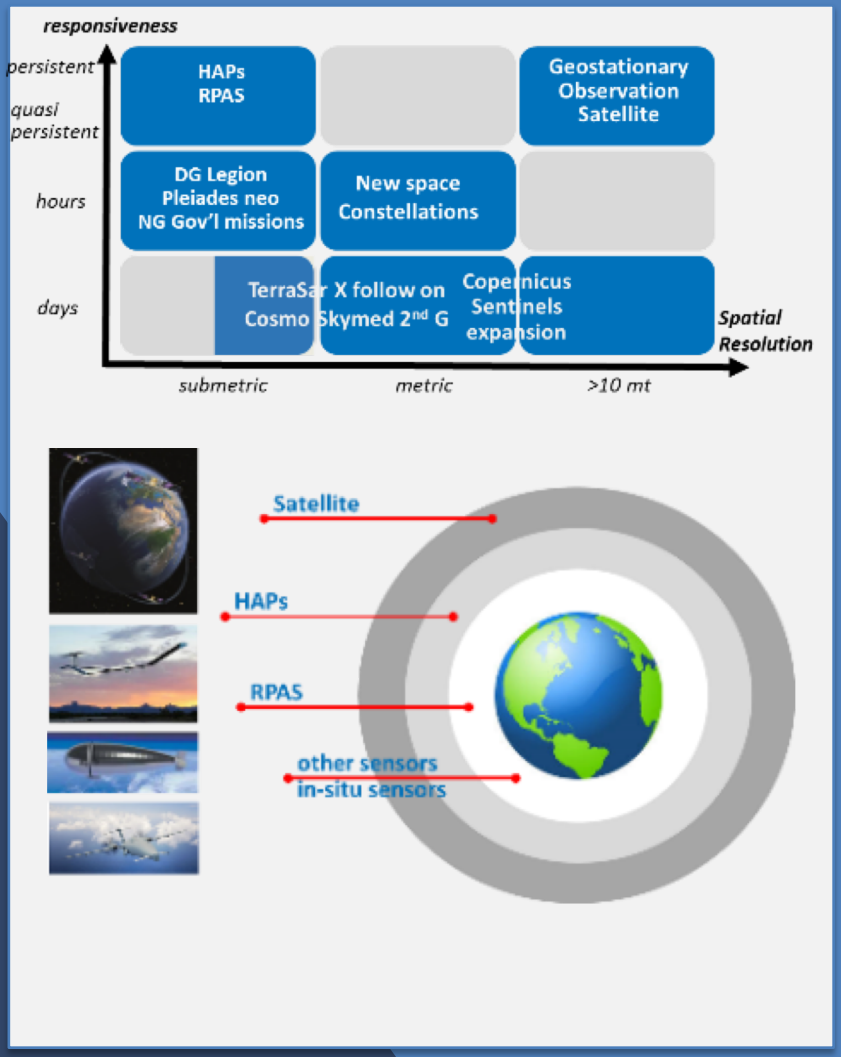
PIATTAFORME STRATOSFERICHE D'ALTA QUOTA
HAP (High Altitude Platforms)
LE SFIDE TECNOLOGICHE

A range of geospatial application platforms leverage the federation and data fusion from satellite - radar, optical and other sensors - and other platforms including UAV and in perspective HAPs

A major goal is to benefit of the complementary features to address e persistent or quasi-persistent surveillance mostly for D&I users

Services enabled by asset federation on specifically by Satellite/HAPs data fusion are image intelligence and surveillance in maritime, land, border control, critical infrastructure, territory and industrial monitoring

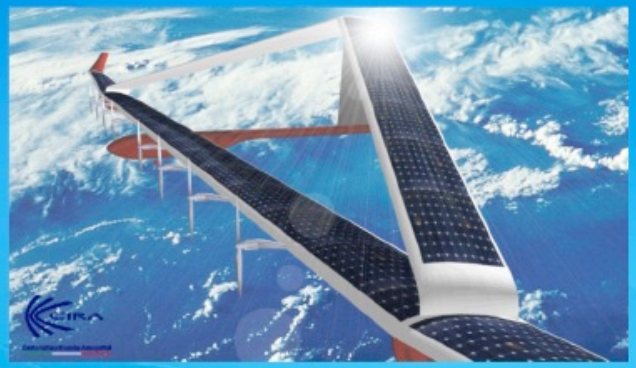
Those services are in the intereset fo EU entrusted entities (EMSA, Frontex, EU SatCen), National and International Military organization ad finally industrial sector



PIATTAFORME STRATOSFERICHE D'ALTA QUOTA

LE SFIDE TECNOLOGICHE

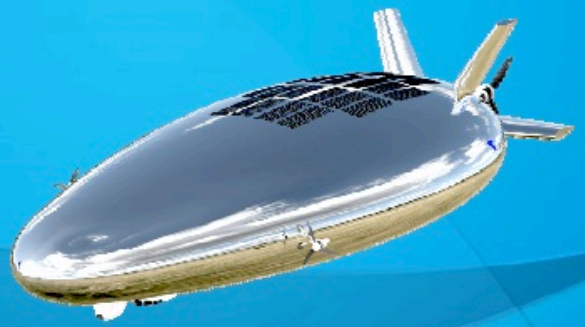
2002-2010
Heavy Lift Stratospheric Balloon Test



2006-2008
LVR –HALE project
Preliminary design of a HAPS Joined-wing

CIRA Activity on HAPS

New CIRA Project
2016-2021
HA² - High Altitude Hybrid Airship
Design, Realization and Flight-Demostration of a new concept of High Altitude Pseudo-Satellite



g.persechino@cira.it - v.baraniello@cira.it - r.borsa@cira.it

PIATTAFORME STRATOSFERICHE D'ALTA QUOTA

LE SFIDE TECNOLOGICHE

Study on Application Requirements

Analysis of Payload Requirements

Optical – Hyperspectral – Infrared – Radar

Platform Requirements

Platform Requirements

Payload	100 kg (12 % MTOW)
Altitude	20000 m
Energy System	Rechargeable Batteries with Solar Energy
Power	Propellers powered by Electric Engines
Cruise Airspeed	16 m/sec
Night Duration	15 h
Mass category	< 1000 Kg
Mission Duration	4 months

Operative Environment →

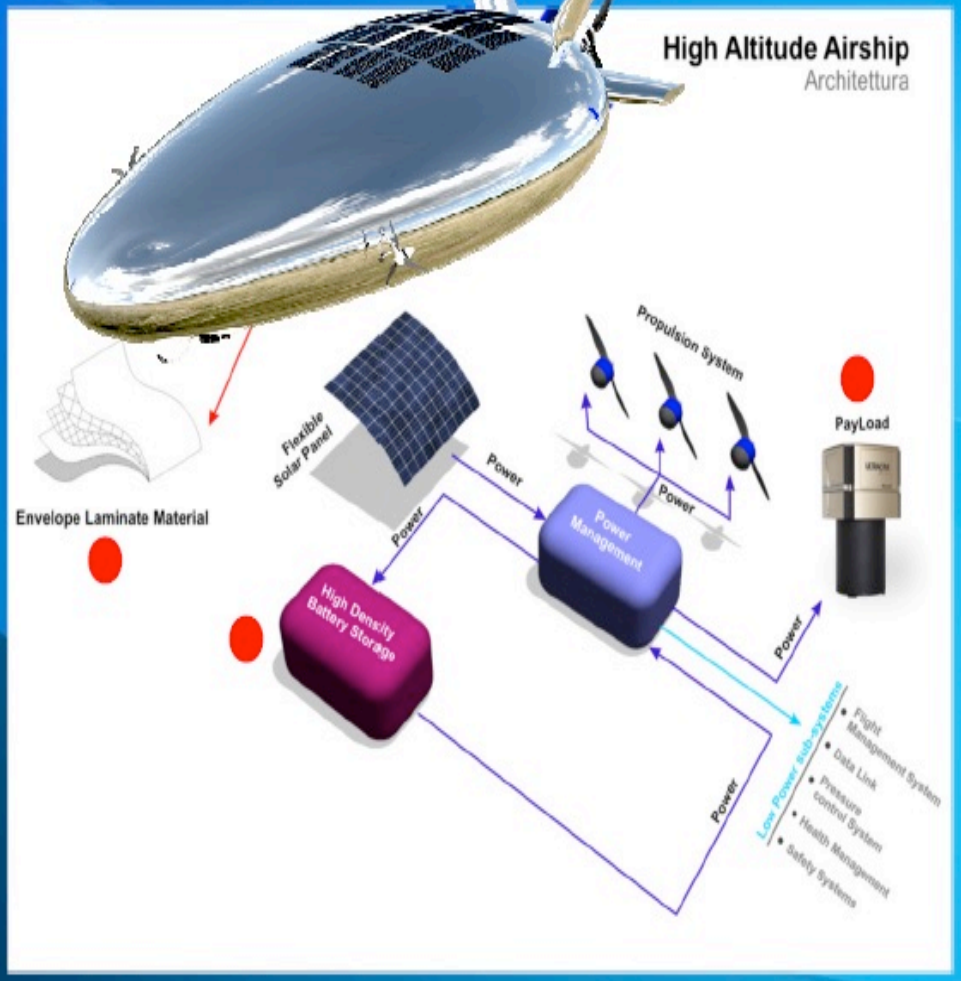
Airworthiness →

← Safety First

← Easy Operation

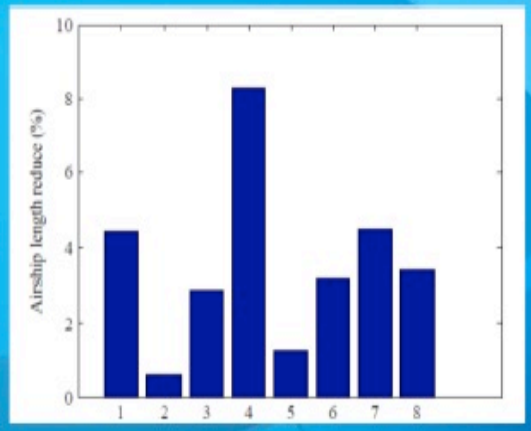
← Low Cost

g.persechino@cira.it - v.baraniello@cira.it - r.borsa@cira.it



Mark	Component
1	Envelope mass/area ratio (g/m^2)
2	Air-filled ballonet mass/area ratio (g/m^2)
3	Solar cell mass/area ratio (g/m^2)
4	RFC energy/mass ratios (Wh/kg)
5	Propeller power/mass ratios (W/kg)
6	Solar cell efficiency (%)
7	RFC efficiency (%)
8	Propeller efficiency (%)

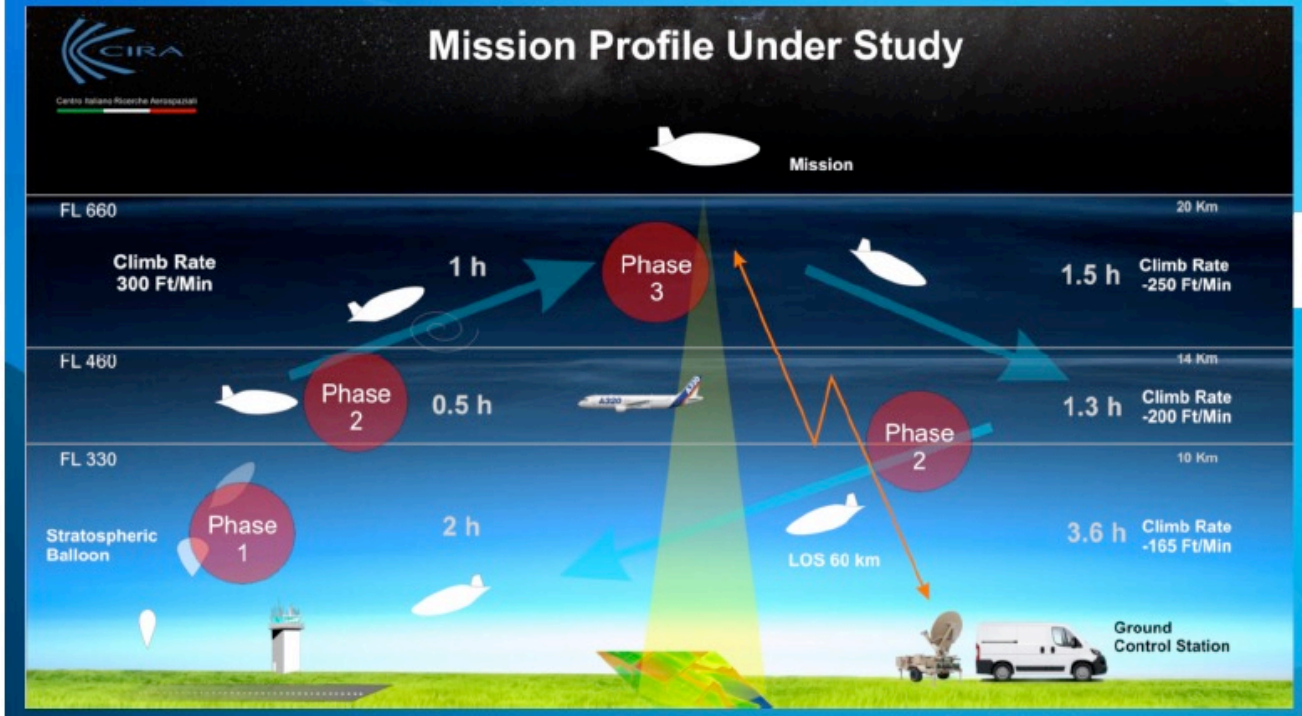
Key Technologies



g.persechino@cira.it - v.baraniello@cira.it - r.borsa@cira.it

PIATTAFORME STRATOSFERICHE D'ALTA QUOTA

LE SFIDE TECNOLOGICHE



Operational Aspect

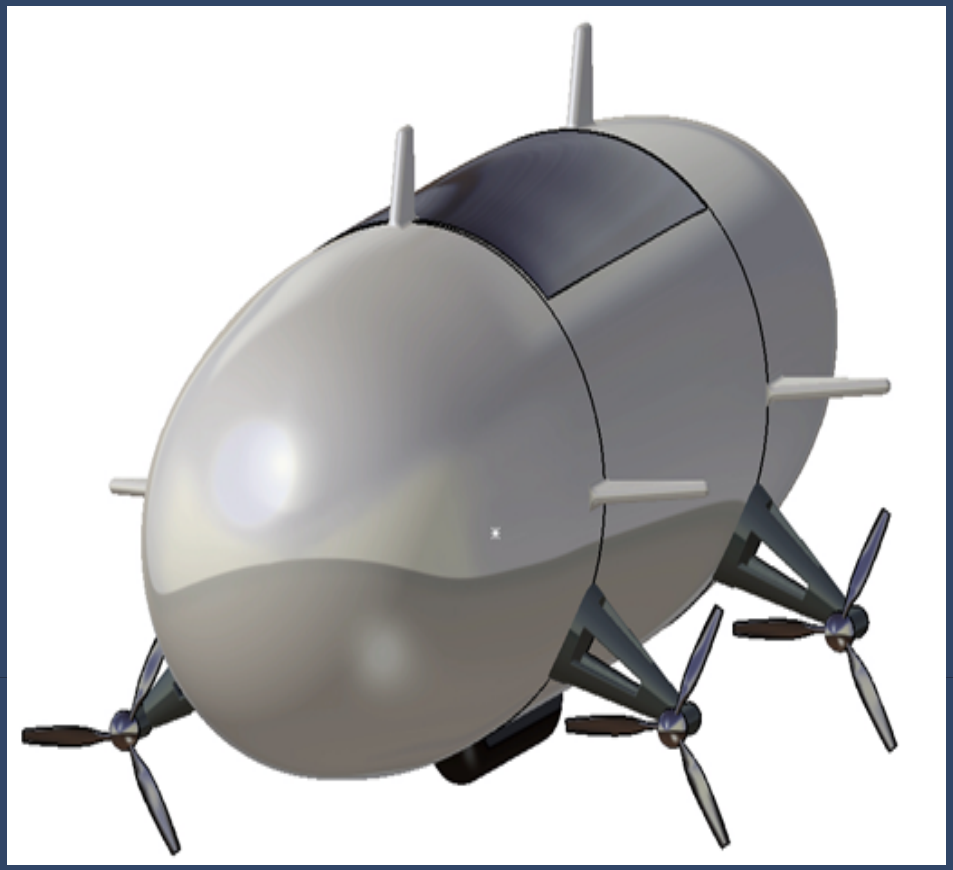
Advantages in the Employment of Hybrid Airships as HAPS

g.persechino@cira.it - v.baraniello@cira.it - r.borsa@cira.it

HAAP-SI
(High Atmosphere Air-ship Platform - Space Italy)

Piattaforma Stratosferica Stazionaria HAAP-SI T

(Osservazione Elettro-Ottica, Radar, IR, Campi e.m., Data Relay, ecc.)

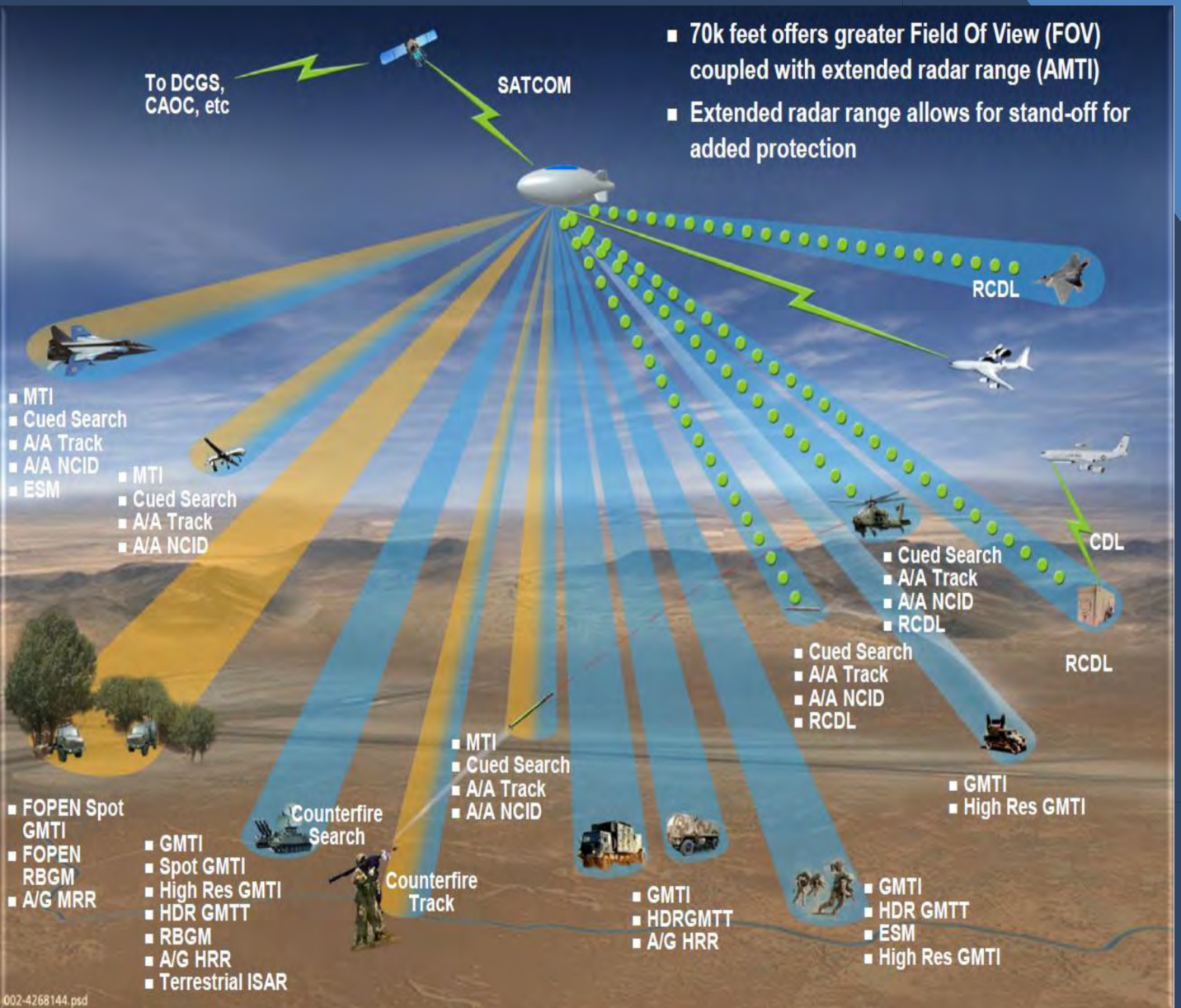


CARATTERISTICHE PRINCIPALI

	HAAP-SIT
Massa PL (Kg)	100
Pot. Elettr PL (Kw)	3
Lung. In quota (m)	66
Lung. al suolo (m)	46
Diametro(m)	22
Endurance Mission (mesi)	> 6

SPACE ITALY

HAAP
POSSIBILI APPLICAZIONI IN SETTORI DIFESA



Prepared by

the Office of the Assistant Secretary of US Defense for Research and Engineering, Rapid Reaction Technology Office- 2012

-LIGHTER-THAN-AIR VEHICLES

SPACE ITALY

THANK YOU

Massimo Comparini

e-GEOS – Chief Executive Officer
Telespazio – Director Line of Business GeoInformation
Chairman - Space Innovation in Italy

Ezio Bussoletti

Area Coordinator
Space & Aeronautics,
National Research Plan
MIUR

UNITED NATIONS
Office for Outer Space Affairs
www.unoosa.org • @UNOOSA

APPLICAZIONI

Le principali applicazioni di HAAP-SI sono:
- Settore ICT (es. Telecomunicazioni) e
- Remote Sensing, sia militare sia civile (es. Osservazione, Identificazione emissioni elettromagnetiche).

VANTAGGI ICT

- Rispetto alle stazioni di Terra hanno una più larga copertura, minore interferenze dovute agli ostacoli (edifici e rilievi montuosi)
- Rispetto ai satelliti hanno minore latenza del segnale (ritardo del segnale) e la possibilità di una manutenzione periodica poiché la piattaforma può ritornare a Terra.

VANTAGGI REMOTE SENSING

- Le Piattaforme stratosferiche operano a quote più basse dei satelliti con la possibilità di rimanere in posizione stazionaria sulla stessa area
- Immagini a più alta risoluzione in quanto più vicine al target.

PIATTAFORME STRATOSFERICHE D'ALTA QUOTA

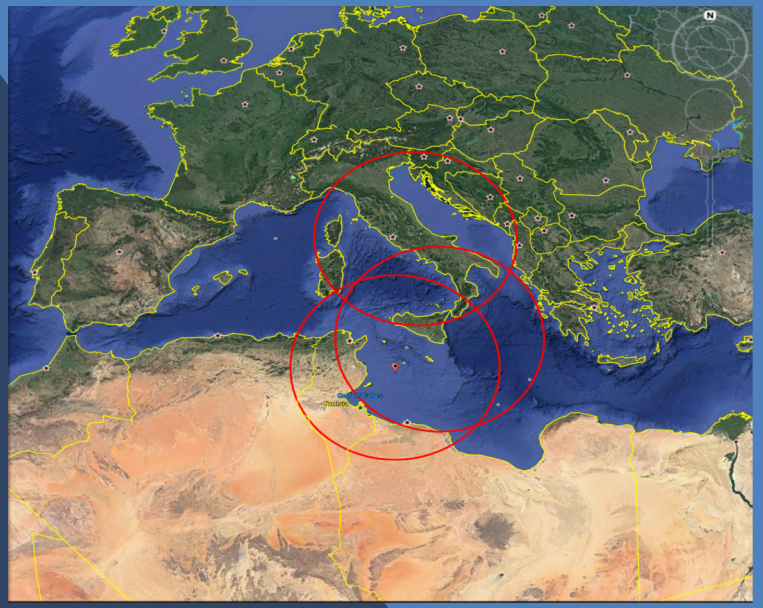
LE SFIDE TECNOLOGICHE

La realizzazione di una piattaforma stratosferica tipo AIRSHIP necessita di nuove tecnologie

I tentativi di sviluppo di vari paesi, anni 2000-2008, non sono stati di successo

Dal 2013 ripartite nuove iniziative tutte nazionali (Russia, Cina, Francia,…) ancora in corso utilizzando tecnologie comuni anche in settori diversi dall'Aerospazio:

- polimeri barriera e film rinforzati da fibre ad alte prestazioni
- batterie di nuova generazione
- celle fotovoltaiche ad alto rendimento
- microelettronica
- sistemi di guida e controllo per droni
- e molto altro…..



Una piattaforma a 20 Km di quota copre aree da 1000 km di diametro (cfr. cerchi in rosso)