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ITU Radio Regulation & Space Traffic Management

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ITU Radio Regulation
&
Space Traffic Management

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STM Concept

- Space Traffic management (**STM**) means the set of technical and regulatory provisions for promoting safe *access into outer space, operations in outer space and return from outer space to Earth* ***free from*** physical or **radio-frequency interference**

- Other terms are used, whenever applicable, in definitions provided by legal/regulatory texts (in particular UN, ITU, ICAO)

ITU Radio Regulations (RR)

- Created in **1906** for different radio services
- **1963** ***first*** extra-ordinary Administrative WRC to allocate frequency bands for ***Space*** *radiocommunication purposes*

- Intergovernmental *Treaty* – ***legal bindings*** on all Member states, governing the use of *spectrum/orbit* resources by *administrations*

- Define the ***rights*** and ***obligations*** of Member States in respect of the use of these resources

- *Following the ITU RR - Any* frequency assignments of transmitting and receiving earth and space stations *shall be notified* to the Bureau (No. **11.2**) if:
  - *Capable of causing harmful interference;* or
  - Used for international radiocommunication; or
  - Seeking to obtain international recognition; or
  - Non conforming assignment under No. 8.4 seeking to be recorded into MIFR for information purposes only

Space Operation Service

Space Operation functions

- Tracking
- Telemetry
- Telecommand

Failure or improper use of Space Operation functions could lead to loss or degradation of service, reduced operational lifetime of satellite, harmful interference, potential for collisions, debris generation

Regulatory Definitions

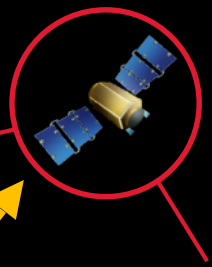
Article 1 of ITU Radio Regulations

No. 1.23	**Space Operation**	… service concerned exclusively with the operation of spacecraft, in particular space tracking, space telemetry and space telecommand. …
No. 1.133	**Space Telemetry**	… transmission from a space station of results of measurements made in a spacecraft, including those relating to the functioning of the spacecraft.
No. 1.135	**Space Telecommand**	… transmission of signals to a space station to initiate, modify or terminate functions of equipment on an associated space object, including the space station.
No. 1.136	**Space Tracking**	Determination of the orbit, velocity or instantaneous position of an object in space by means of radiodetermination, … for the purpose of following the movement of the object.

Satellite

Tracking

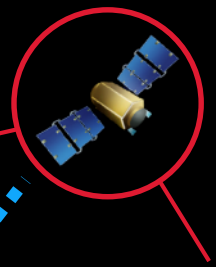
To determine the orbit, velocity or instantaneous position of spacecraft



For orbit control (transfer orbit, station keeping, fleet management and maneuvering, End Of Life) Surveillance and safety functions

Earth Station

Satellite



Telemetry

For maintenance of spacecraft by monitoring its condition and payload using measured data:

- Temperature
- Magnetic field for instantaneous attitude or rotation speed
- Moving units measurement
- Inertial measurements for attitude and station keeping
- Measurements in relation to Earth, Sun, stars
- Current, voltages
- Condition of components
- Acknowledgement of reception and execution of command

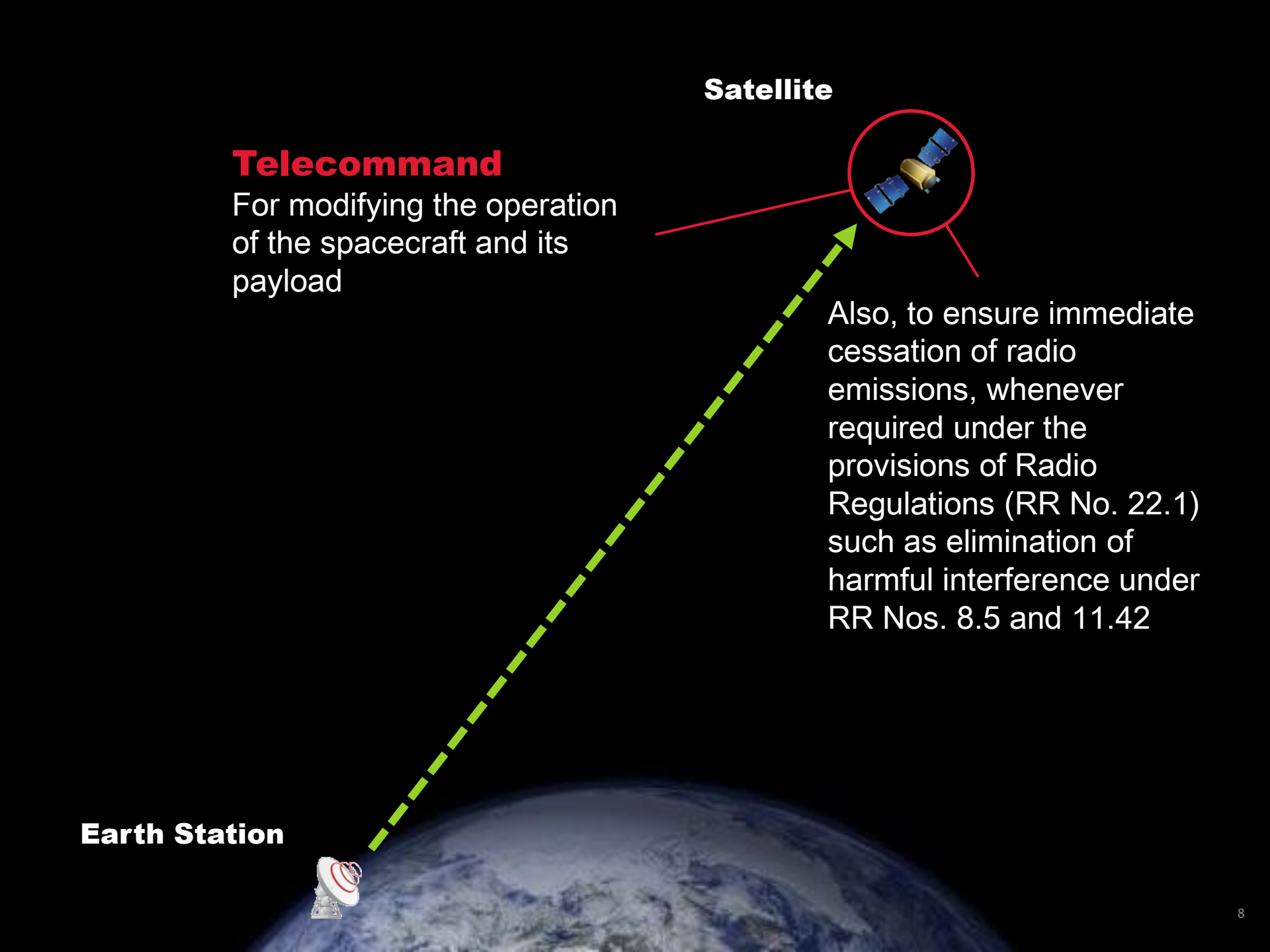
To ensure proper operational conditions, optimizing the spacecraft and payload mission facilities and analysing unforeseen situations

Earth Station

Satellite

Telecommand

For modifying the operation of the spacecraft and its payload



Also, to ensure immediate cessation of radio emissions, whenever required under the provisions of Radio Regulations (RR No. 22.1) such as elimination of harmful interference under RR Nos. 8.5 and 11.42

Earth Station

Frequency band selection

- Preferred bands of frequencies for Space Operation are between 1 and 8 GHz
- As an exception, bands above 10 GHz are technically suitable for use for Space Operations during re-entry of satellites into Earth's atmosphere to ensure greatest reliability and flexibility during routine, launch or other critical phases

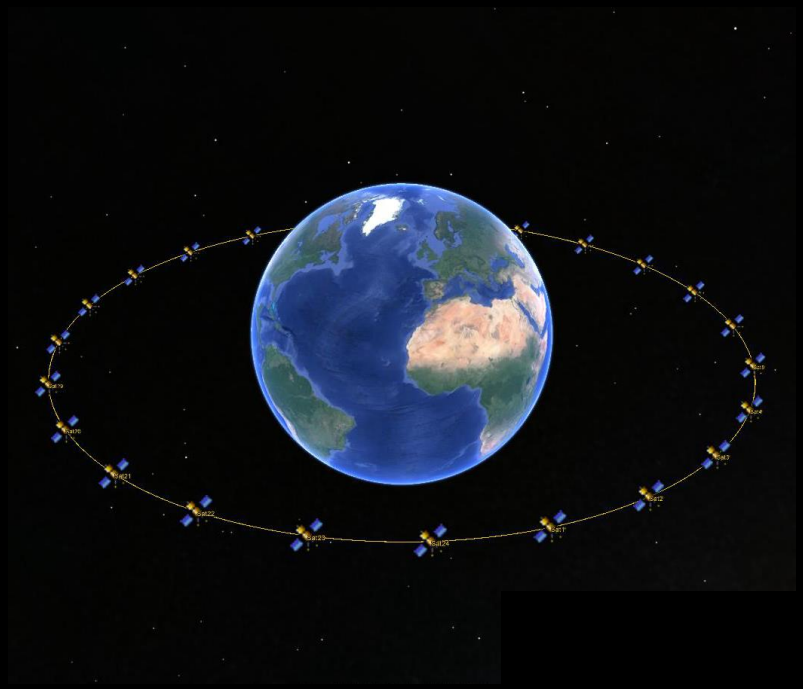
Source: **Rec. ITU-R SA.363-5**

New/Upcoming non-GSO FSS Satellite Projects

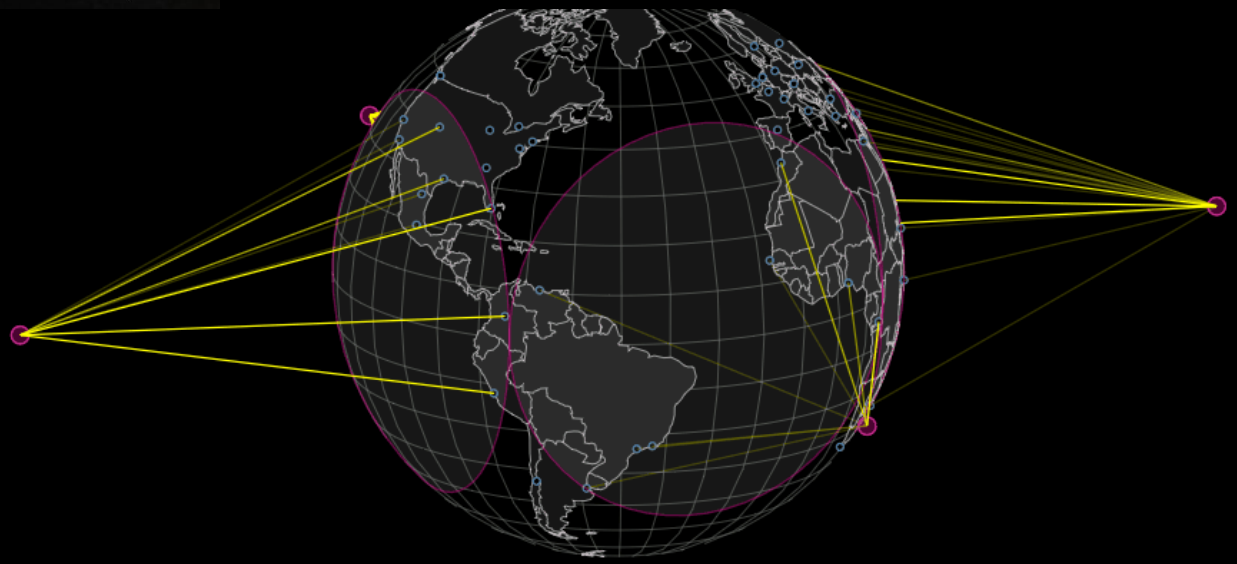
O3B	**12 MEO Satellites**
OneWeb	**700 LEO Satellites**
SpaceX	**4000 LEO Satellites**

Source: OneWeb Ltd

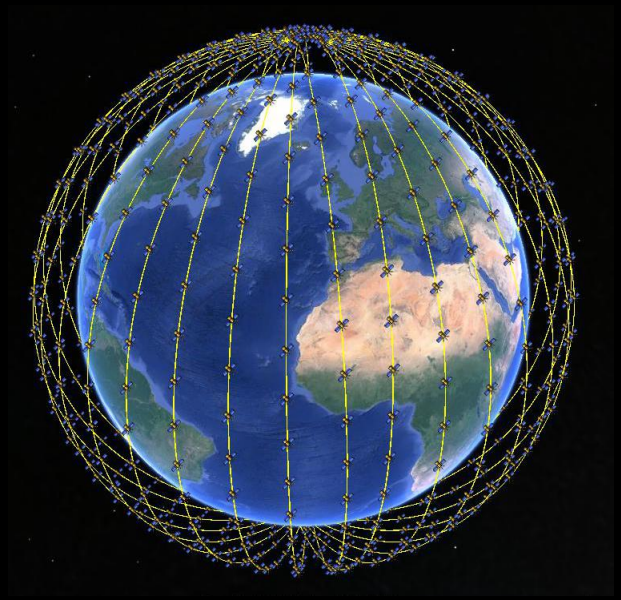
O3B



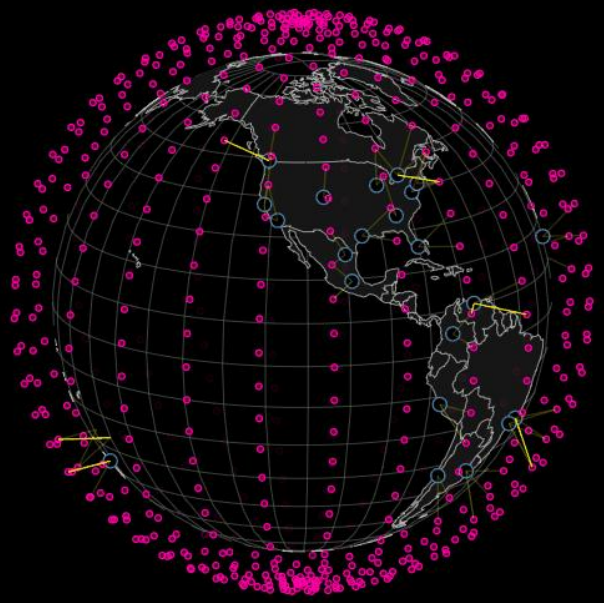
- Equatorial plane
- Orbit 8 065 km
- 12 satellites in orbit plus 8 more in 2017-2018
- Service ±45º Latitude



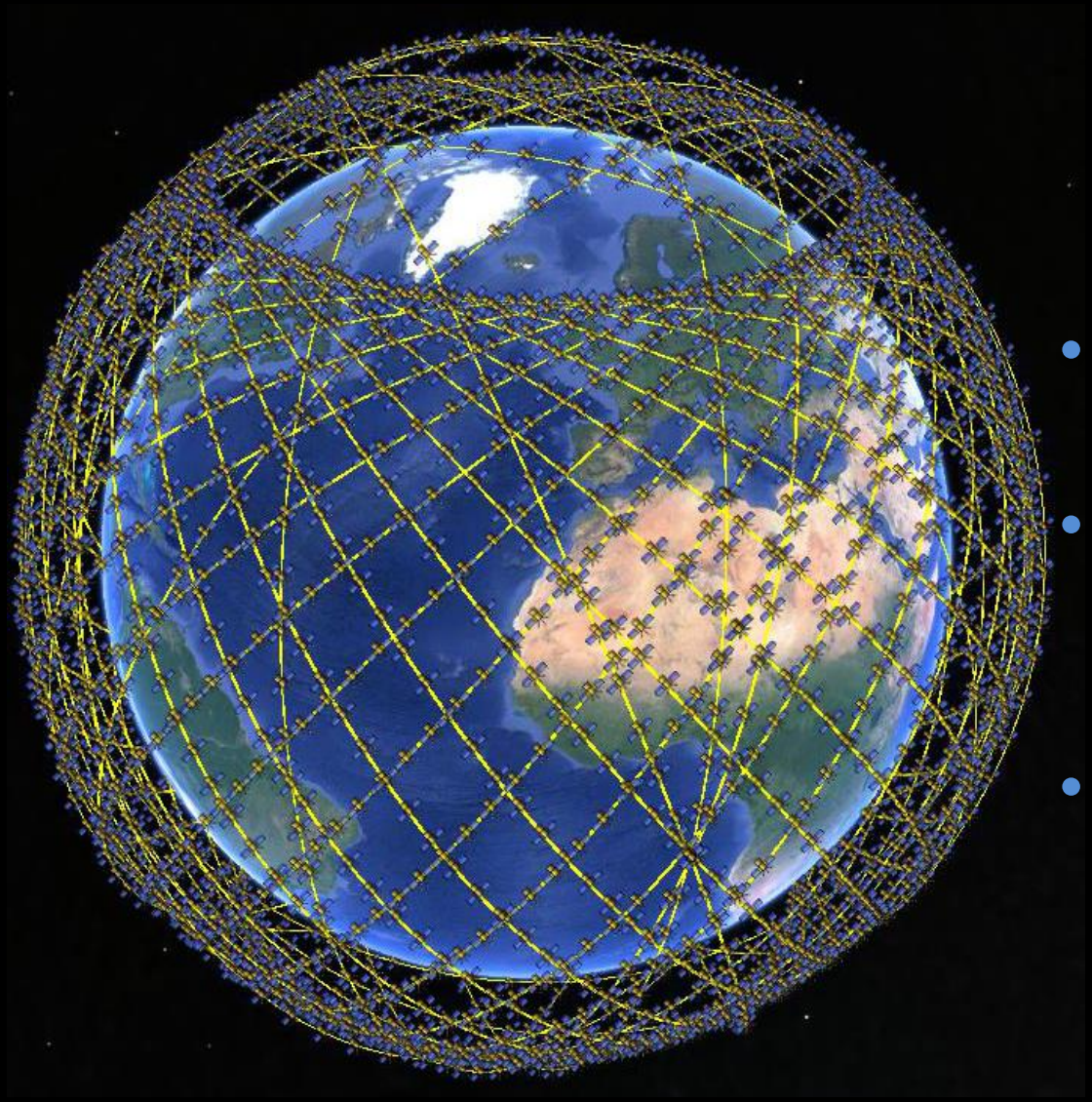
OneWeb



- Circular orbit
- Orbit 1200 km
- 648 satellites in 18 planes
- Complete initial deployment in 2020



SpaceX



- Circular LEO orbit
- Different orbit altitudes
- Around 4000 satellites

Detailed New/Upcoming non-GSO FSS satellite filings

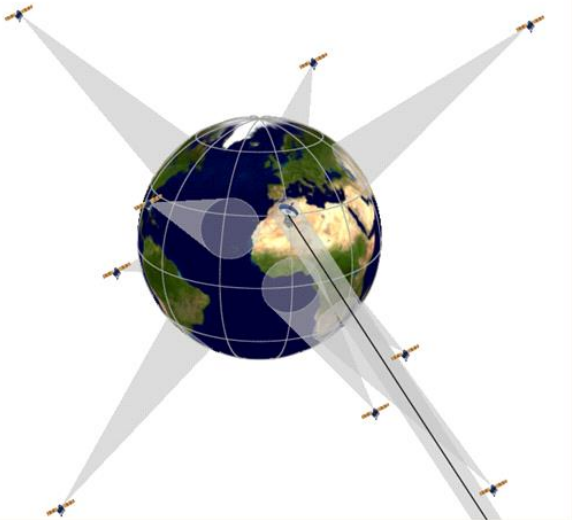
Adm/Org	Satellite Name	Number of unique orbit types	Number of satellites per type
USA	USCSID-P	1	8
J	QZSS-1	1	1
CAN	CASCADE-CX	1	1
G	O3B-B	1	24
IND	INSAT-NAVR-GS	1	4
CAN	CANPOL	1	2
CAN	COMMSTELLATION	3	891
G	L5	4	2692
CAN	CANPOL-2	2	51
G	O3B-A	1	24
NOR	ASK-1	2	7
LIE	3ECOM-1	1	288
F	MCSAT-2 HEO	5	312
F	MCSAT LEO	1	774
NOR	STEAM-1	3	3993
NOR	STEAM-2	3	3993
F	MCSAT-2 LEO-1	14	4500
F	MCSAT-2 LEO-2	4	2772
F	MCSAT-2 MEO-1	10	624
F	MCSAT-2 MEO-2	4	744
F	MCSAT-2 HEO-1	3	36
G	O3B-C	7	840
LIE	3ECOM-3	1	288

Adm/Org	Satellite Name	Number of unique orbit types	Number of satellites per type
F	ES-SAT-2	30	1428
CYP	ANDROMEDA-A	1	48
NOR	NORSAT-H1	2	4
CAN	102	1	774
G	O3B-B	1	24
RUS	SKY-F	2	24
NOR	SE-6-HEO-1	1	2
NOR	SE-6-HEO-1A	1	2
HOL	DREBBELSAT	1	24
NZL	APOG	1	18
G	THEO	1	882
CAN	MAPLELEAF-1	1	60
RUS/IK	IK-NGSO-A10K-1	4	160
CAN	MULTUS	3	80
CAN	CANSAT-LEO	2	117
NOR	STEAM-2B	1	1600
RUS/IK	IK-NGSO-A10K-2	4	160
USA	USASAT-NGSO-3C	1	1600
USA	USASAT-NGSO-3D	1	1600
USA	USASAT-NGSO-3E	1	400
USA	USASAT-NGSO-3F	1	400
NOR	NORSAT-H1	2	4

Adm/Org	Satellite name	ACT CODE	Date of receipt	IFIC	Nr. of orbits	Nr. of sats.
F	MCSAT-2-HEO	M	17.10.2017	‘as received”	19	312
USA	USASAT—NGSO-6	A	04.10.2017	‘as received”	3	12
F	AST-NG-C-4	A	05.10.2017	‘as received”	604	8832
CHN	ACONNECT	A	29.09.2017	‘as received”	6	54
CHN	ACONNECT-T	A	29.09.2017	‘as received”	6	54
ISR	NSL-1	A	11.09.2017	‘as received”	19	19
CHN	FORTRAN-2	A	25.08.2017	‘as received”	4	5
G	L5	M	13.06.2017	‘as received”	36	1980
G	THEME	A	29.03.2017	2855/03.10.2017	16	1280
F	ZIP	A	22.03.2017	2855/03.10.2017	16	1280
CAN	CANPOL-3	A	09.02.2017	2854/19.09.2017	2	6
USA	USASAT-NGSO-4	A	01.01.2017	‘as received”	8	112
USA	USASAT-NGSO-3B-R	A	01.01.2017	2853/05.09.2017	43	2425
USA	USASAT-NGSO-3A-R	A	01.01.2017	2853/05.09.2017	43	2425

Non-GSO EPFD

- Equivalent power-flux density (EPFD) takes into account the aggregate of the emissions from all Non-GSO satellites in the direction of any GSO earth station, taking into account the GSO antenna directivity
- EPFD considers pointing of a victim receiving antenna with respect to any source of interference
- Complex calculation methodology considers an interference varying in time and space



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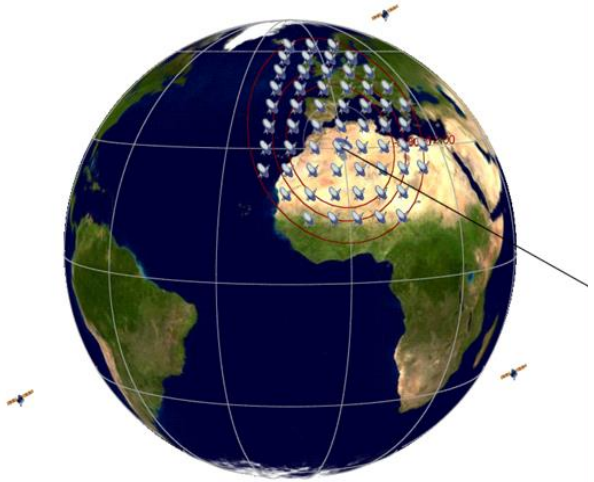

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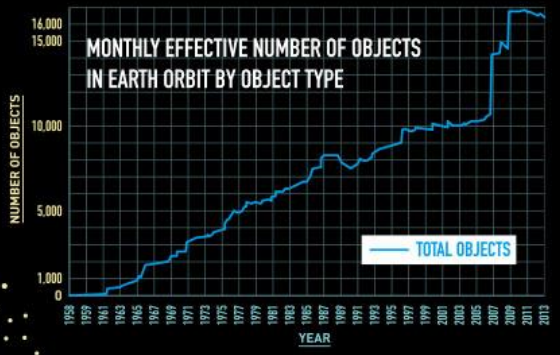
SPACE DEBRIS

ASTROSCALE

Space debris issue is a social problem caused 100% by mankind, unlike global environmental problems such as climate change. The growing number of space debris is threat to the vital satellites orbiting around the earth.

WHEN

The severity of the space debris issue is aggravating as collisional chain reactions increases debris population at an increasing rate; outpacing the natural rate of orbital decay into our atmosphere.



WHAT

Space debris are made of man-made objects such as rocket upper bodies, non-functioning satellites, metal fragments etc.

20,000 ~ 22,000 OBJECTS

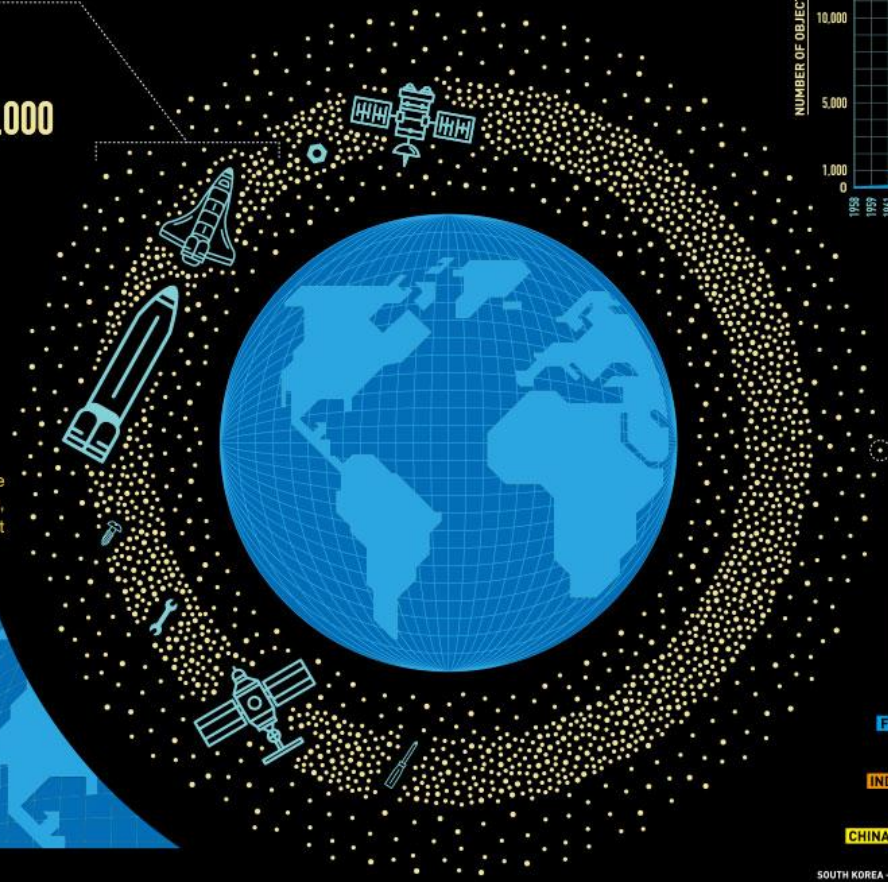
1,000,000 or more OBJECTS

100,000,000 OBJECTS

10 cm

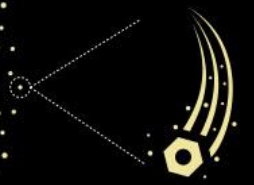
1 cm

There are currently more than 20,000 large trackable space debris orbiting Earth, along with estimated hundreds of thousands more untraceable ones.



HOW

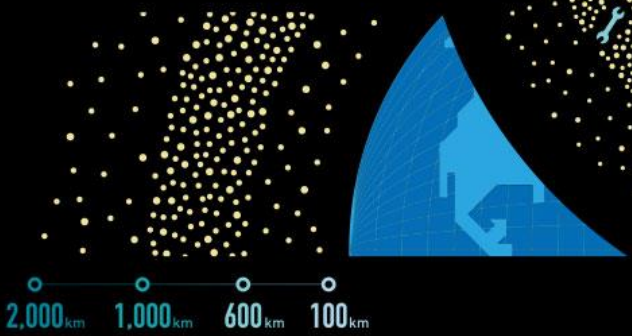
Space debris are orbiting around the earth up to 8km per second, that is 20 times faster than the speed of bullets.



8 km per second

WHERE

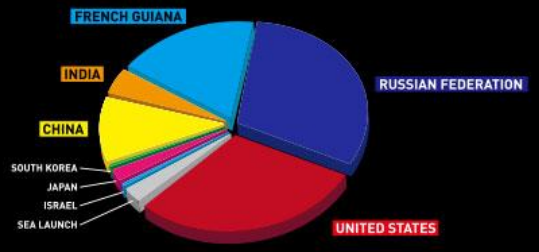
Most of the active satellites are situated at LEO (low earth orbit, 800-2000km) and it is where most of the space debris is found.



Low Earth Orbit

WHO

Since 1957, 7757 satellites have been launched to the space. Below is the breakdown of satellite launches by sites.



ASTRO SCALE ASTROSCALE PTE. LTD.

Sources: NASA, US Space Surveillance Network, ESA Debris Office, National Geographic, Space.com

Conclusion

- STM is an essential concept to promote *rational, equitable, efficient and economical* use of the orbit/spectrum resources by all radiocom services
- Space Operation functions are critical for proper management of the satellite, especially when orbits are becoming more congested, *to maintain its intended service free from harmful interference during its lifetime*

ITU - STM info - FREE download !

ITU RR @2016 *http://www.itu.int/pub/R-REG-RR/en*

SRS Communication Handbook

https://www.itu.int/pub/R-HDB-43

ITU-R Recommendations

https://www.itu.int/rec/R-REC-SA/en