Updates related to NGSO

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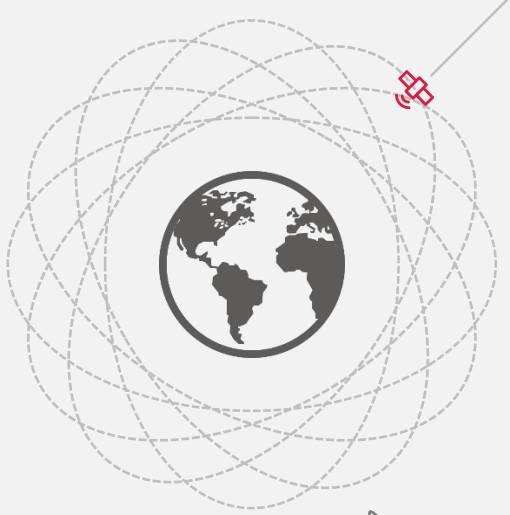
NGSO

Non-geostationary satellite systems



How to ensure protection from NGSO systems?

NGSO shall not cause unacceptable interference to / not claim protection from GSO FSS & BSS (Art. 22 No. 22.2)

No. 22.2 obligation fulfilled if comply with **EPFD** limits (Art. 22 No. 22.5I)

How to define unacceptable interference?
How to get agreement from all GSO satellite networks worldwide?

Defines level of acceptable interference
Meet EPFD limits, meet No. 22.2 requirements
GSO satellites get needed protection

What do we need to know about EPFD?

EPFD Equivalent power-flux density

Sum of power flux-densities (PFD) produced by all transmit stations within NGSO system at a GSO earth station or at GSO (Taking into account receive antenna directivity)

Source: No. 22.5C.1 of Article 22

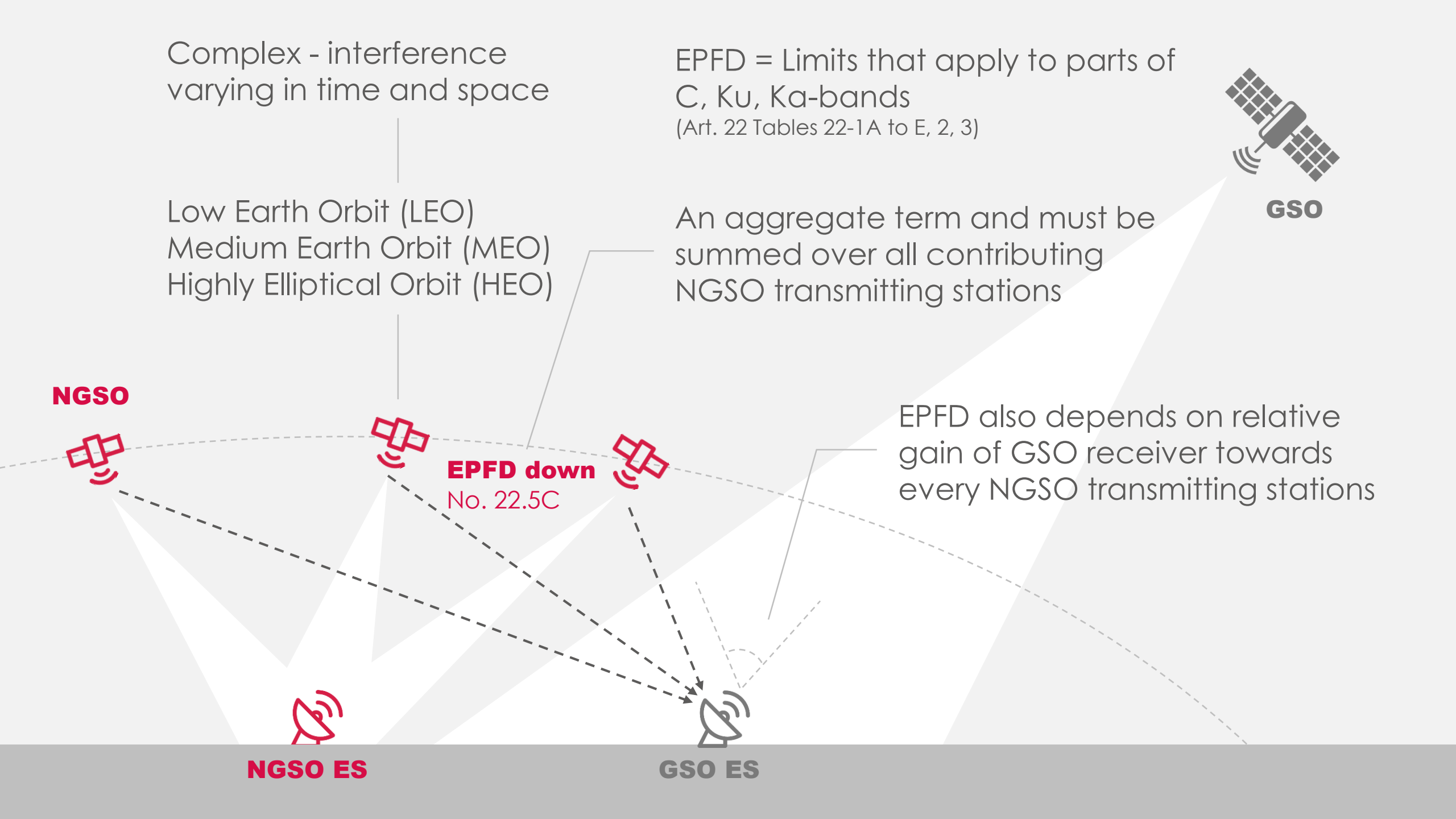
Complex - interference varying in time and space

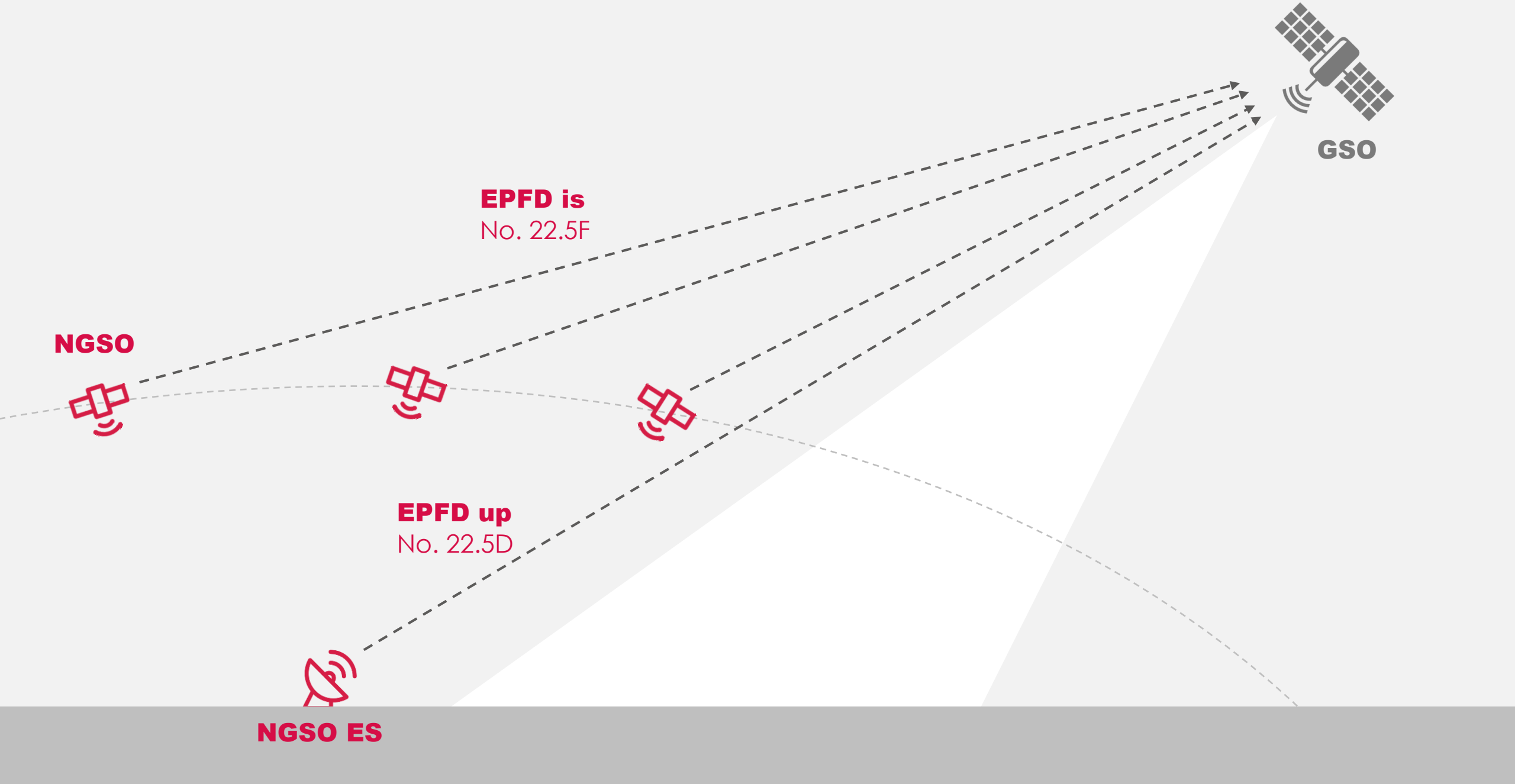
Low Earth Orbit (LEO)
Medium Earth Orbit (MEO)
Highly Elliptical Orbit (HEO)

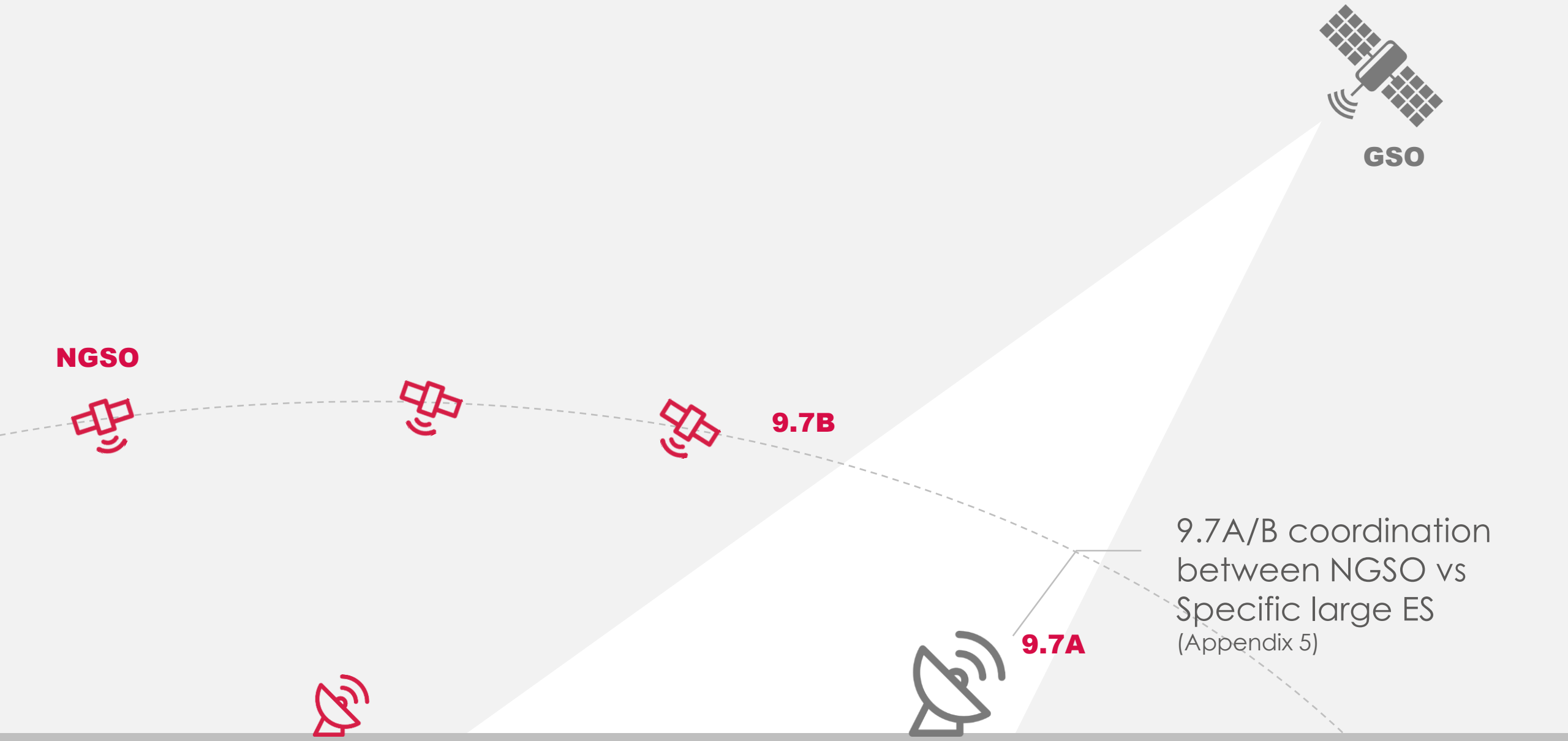
EPFD = Limits that apply to parts of C, Ku, Ka-bands
(Art. 22 Tables 22-1A to E, 2, 3)

An aggregate term and must be summed over all contributing NGSO transmitting stations

EPFD also depends on relative gain of GSO receiver towards every NGSO transmitting stations




GSO
EPFD is
No. 22.5F
NGSO
EPFD up
No. 22.5D
NGSO ES


GSO
NGSO
9.7B
9.7A
9.7A/B coordination between NGSO vs Specific large ES
(Appendix 5)
NGSO ES
Specific Large ES

Summed for all NGSO transmitting stations

Receive gain of GSO receiver towards NGSO transmitting station

$$epfd = 10 \log_{10} \left[\sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_t(\theta_i)}{4 \pi d_i^2} \cdot \frac{G_r(\varphi_i)}{G_{r,max}} \right]$$

PFD of NGSO transmitting station

$$epfd = \mathrm{PFD}.\ \mathrm{G}r,rel(\varphi)$$

Based on ITU-R Rec S.1503-2

"Functional description to be used in developing software tools for determining conformity of NGSO FSS system networks with limits contained in Article 22"
www.itu.int/rec/R-REC-S.1503/en

EPFD validation software developed by Agenium/Transfinite, available for testing

www.itu.int/en/ITU-R/software/Pages/epfd.aspx

Source: CR/405 of 03.06.2016

NGSO system characteristics in Appendix 4
(orbit parameters, frequency assignments etc.)

PFD/EIRP masks
(permits some flexibility to NGSO within the mask & simplifies EPFD formula)
www.itu.int/ITU-R/go/space-mask-XMLfile

Article 22 EPFD limits, % time, frequency band, antenna diameter, service, ref. BW

Source: CR/405 of 03.06.2016

Determines Worst Case Geometry (masks & orbital parameters)

Generates CDF of EPFD statistics

Compare with EPFD Limits

Single NGSO system verification for all pointing directions for all GSO systems

Results
(EPFD CDF & Pass/Fail)

Source: CR/405 of 03.06.2016

What were the issues, outcome and updates following WRC-15?

4 issues

#1 Constellation Flexibility

Issue

Various configuration at coordination stage

NGSO systems with

- Simultaneous operation of all orbital characteristics
- Mutually exclusive operation - Different orbital characteristics but only one set will be notified
- No clear indication of actual use

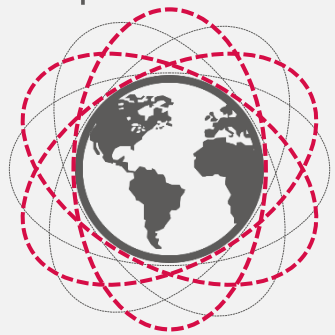
WRC-15

ROP to be drafted to limit flexibility to simultaneous or mutually exclusive operation at coordination stage and finally one configuration at notification

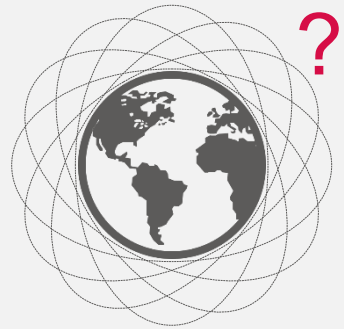
Draft Rules of Procedures

Limit receivability to simultaneous or mutually exclusive operations

Simultaneous operation



Mutually exclusive



Unknown

Source: Doc. CMR15/4(Add.2), Doc CMR15/505 8th Plenary Minutes , CCRR/57 Draft RoP

#2 NGSO vs NGSO Coordination

Issue

Identified based on frequency overlap (No. 9.12)
No methodology to assess compatibility
How much changes allowed without losing priority date?

WRC-15

Adms may mutually agree multilateral coordination meetings
NGSO coordination can be further studied in ITU-R
Any modifications to procedures, can be submitted under WRC-19 AI7

Source: Doc. CMR15/4(Add.2), RoP No. 9.6, Article 9, Doc CMR15/505 8th Plenary Minutes

2014

NOR
ASK-1

F
MCSAT-2 HEO-1
MCSAT-2 LEO-1
MCSAT-2 LEO-2
MCSAT-2 MEO-2

72,576 satellites

G
L5

F
MCSAT-2 HEO

CAN
COMMSTELLATION

F
MCSAT LEO

LIE
3ECOM-1

F
MCSAT-2 MEO-1

NOR
STEAM-1
STEAM-2

2015

CAN
CANPOL-2

G
L5

USA
HIBLEO-2FL2

F
AST-NG-C-1

CAN
COMMSTELLATION

G
O3B-C

LIE
3ECOM-3

G
L5

F
ES-SAT-2

CYP
ANDROMEDA-A

NOR
NORSAT-H1

D
COURIER-3

F
AST-NG-C-2

CHN
TXIN

CAN
102

F
MCSAT-2 LEO-2

2016

LUX
CLEOSAT

RUS
SKY-F

Source: SRS database dated 12.08.2016

NGSO Characteristics

Ku, Ka-bands etc. (Art. 22 EPFD limits + No. 9.7B apply)
Fixed-Satellite Services
Large no. of assignments / orbits
LEO, MEO, HEO
Various configurations of operation

Source: Doc. CMR15/4(Add.1,2), LEO 680-1425km, MEO 7000-23500 km, HEO including TAP, Tundra, Molniya

Adm	Satellite Name	No. of Sats	LEO	MEO	HEO	Ku	Ka	Others	Max DBIU
CAN	102	774	LEO				Ka		27.05.2022
	CANPOL-2	51	LEO		HEO		Ka		19.04.2020
	COMMSTELLATION	891	LEO				Ka		06.05.2018
CHN	TXIN	60	LEO				Ka	Other	30.12.2021
CYP	ANDROMEDA-A	48	LEO				Ka		04.06.2021
D	COURIER-3	72	LEO				Ka	Other	13.06.2021
F	AST-NG-C-1	797	LEO	MEO			Ka	Other	08.04.2021
	AST-NG-C-2	4672	LEO				Ka	Other	04.12.2021
	ES-SAT-2	1428	LEO	MEO		Ku	Ka	Other	27.06.2021
	MCSAT LEO	774	LEO				Ka		18.12.2019
	MCSAT-2 HEO	312		MEO			Ka		29.01.2021
	MCSAT-2 HEO-1	36			HEO	Ku	Ka		29.01.2021
	MCSAT-2 LEO-1	72576	LEO			Ku			29.01.2021
	MCSAT-2 LEO-2	2772	LEO				Ka		29.01.2021
	MCSAT-2 MEO-1	1104		MEO		Ku			29.01.2021
	MCSAT-2 MEO-2	744		MEO		Ku	Ka		29.01.2021
G	L5	2692	LEO			Ku	Ka		27.11.2019 14.03.2020 18.07.2021
	O3B-C	840	LEO	MEO		Ku	Ka		02.09.2021
LIE	3ECOM-1	288	LEO			Ku	Ka		10.06.2021
	3ECOM-3	288	LEO			Ku	Ka		18.09.2021
LUX	CLEOSAT	60	LEO				Ka	Other	12.05.2022
NOR	ASK-1	7			HEO	Ku	Ka	Other	28.06.2020
	NORSAT-H1	4			HEO	Ku	Ka	Other	11.11.2021
	STEAM-1	3993	LEO			Ku			27.06.2021
	STEAM-2	3993	LEO				Ka		27.06.2021
RUS	SKY-F	24		MEO			Ka		05.10.2022
USA	HIBLEO-2FL2	66	LEO				Ka		09.06.2018 29.07.2021

Source: SRS database dated 12.08.2016

#3 EPFD Validation Software

Update

Final stages of testing

When ready, BR to

- Review findings with respect to EPFD limits
- Reestablish coordination requirements under No. 9.7A/B (NGSO FSS vs GSO E/S)

WRC-15

Res 85 (WRC-03) continues to be applied when software cannot adequately model certain NGSO

Source: Doc. CMR15/4(Add.1,2), Res85, Rec ITU-R S.1503-2, Doc CMR15/505 8th Plenary Minutes

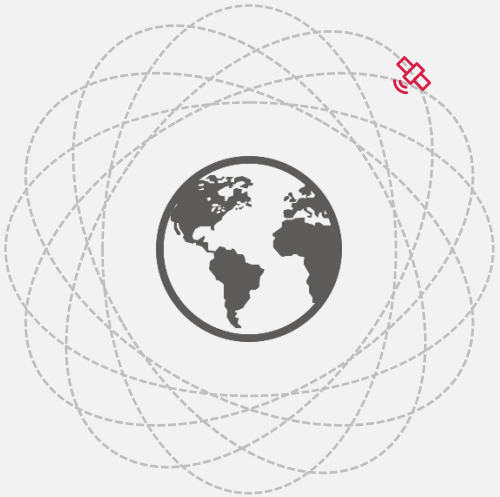
#4 Bringing into Use

Issue

Lack of clear provision, current practice:

- At least one NGSO satellite at one orbital plane
- Capable to transmit or receive frequency assignment
- 90 days of operation

Possible spectrum warehousing / "fictitious frequency assignments"



WRC-15

ITU-R invited to examine provisions requiring additional milestones beyond normal notification and BIU procedure

Consider implications on NGSO systems BIU after WRC-15

Draft Rules of Procedures

Current practice + deployment plan at end of 7y period + minimum number of satellites for service

Source: Doc. CMR15/4(Add.2), Doc CMR15/504 7th Plenary Minutes, CR/389 of 29.01.2016, CCRR/57 Draft RoP

What are the NGSO issues at WRC-19?

#1 Agenda Item 1.6 (NGSO in V-bands)

Regulatory framework for NGSO FSS in 37.5-39.5 GHz (s-E), 39.5-42.5 GHz (s-E), 47.2-50.2 GHz (E-s), 50.4-51.4 GHz (E-s) Res 159 (WRC-15)
No regulatory provisions for sharing NGSO vs GSO
No ITU-R defined protection requirements for GSO
WP4A responsible group:
- Ensure protection of GSO FSS, MSS, BSS, EESS (passive), RA
- Develop EPFD to protect GSO

#2 Agenda Item 9.1.3 (NGSO in C-Band)

Study provisions for NGSO in C-Band Res 157 (WRC-15)
WP4A responsible group:
- Ensure protection of existing NGSO HEO, AP30B, Fixed, Mobile
- Ensure protection of GSO from unacceptable interference

#3 Agenda Item 7 Issue A (BIU of NGSO)

BIU of frequency assignments for NGSO systems subject to coordination

www.itu.int/en/ITU-R/study-groups/rcpm/Pages/wrc-19-studies.aspx

Is it coming?

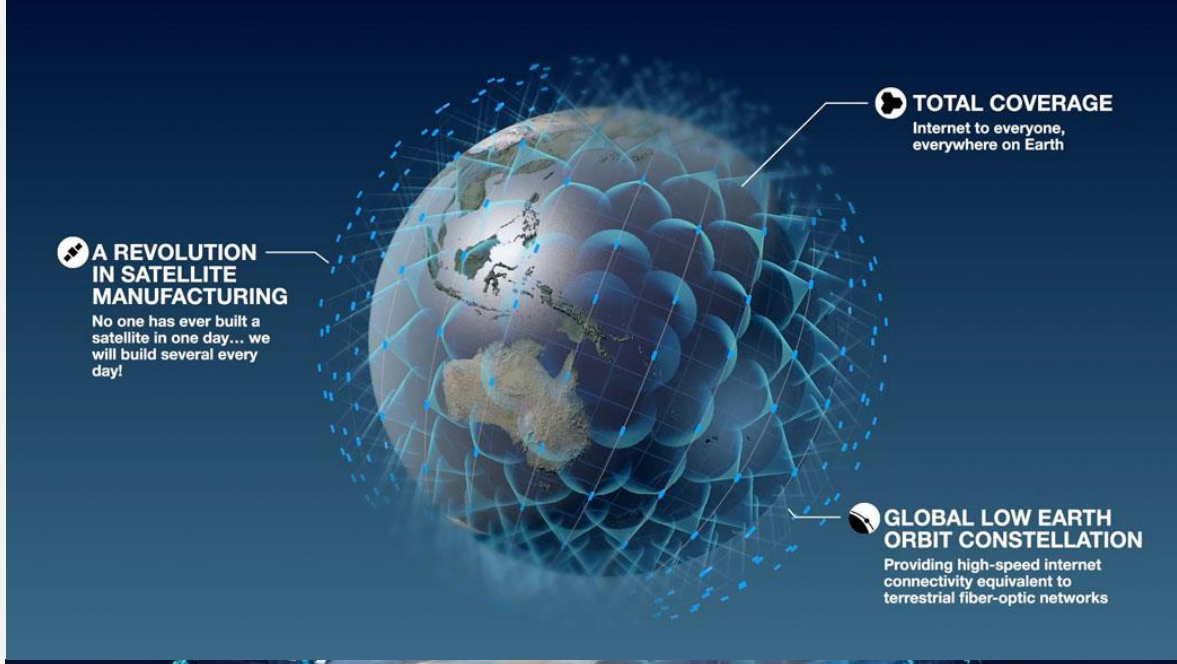
Ensure existing services protected

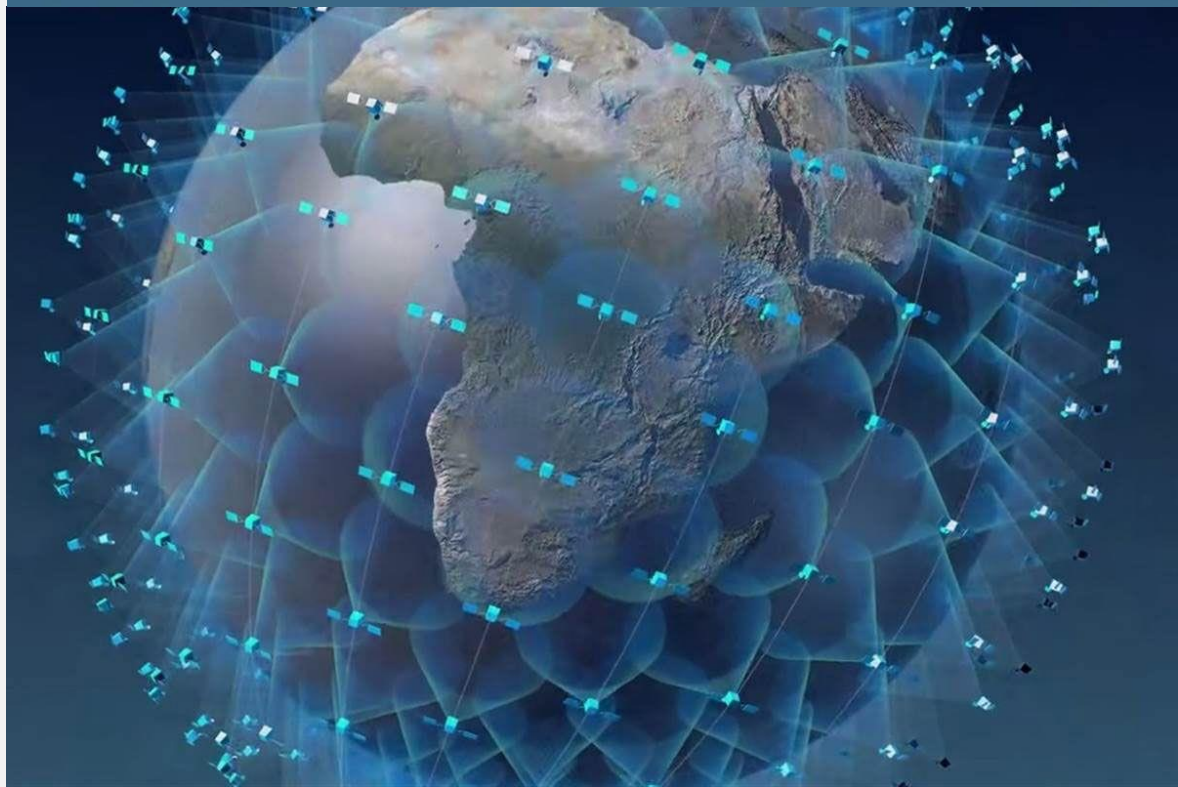
Considerable interest in NGSO FSS systems

Prevent spectrum warehousing or “fictitious frequency assignments”

Provide real opportunity to use spectrum/orbit resource more efficiently

Further discussions at WP4A





Initiate work on establishing technical characteristics of potential NGSO & GSO FSS systems in V-bands for compatibility studies

1st WP4A meeting
(13 - 22 April 2016)

Next meeting

2nd WP4A meeting
(28 September – 6 October 2016)

Updates related to NGSO

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