ANATEL

Agência Nacional de Telecomunicações

Satellite Radiomonitoring by Anatel in Brazil

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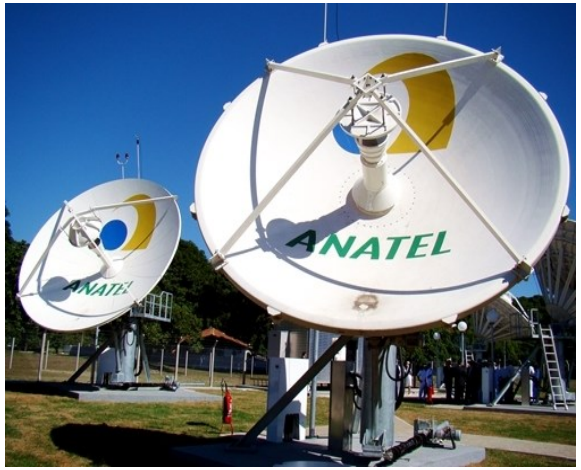
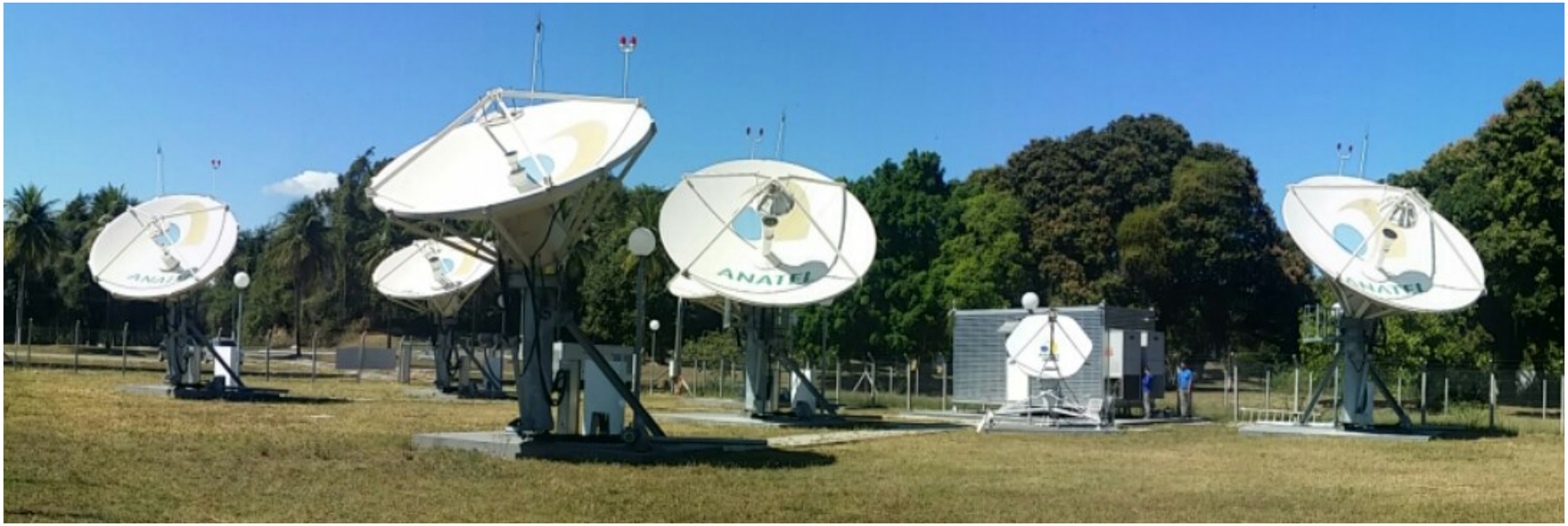
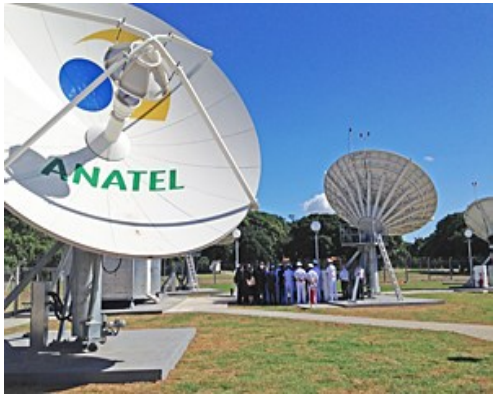
About ANATEL EMSAT



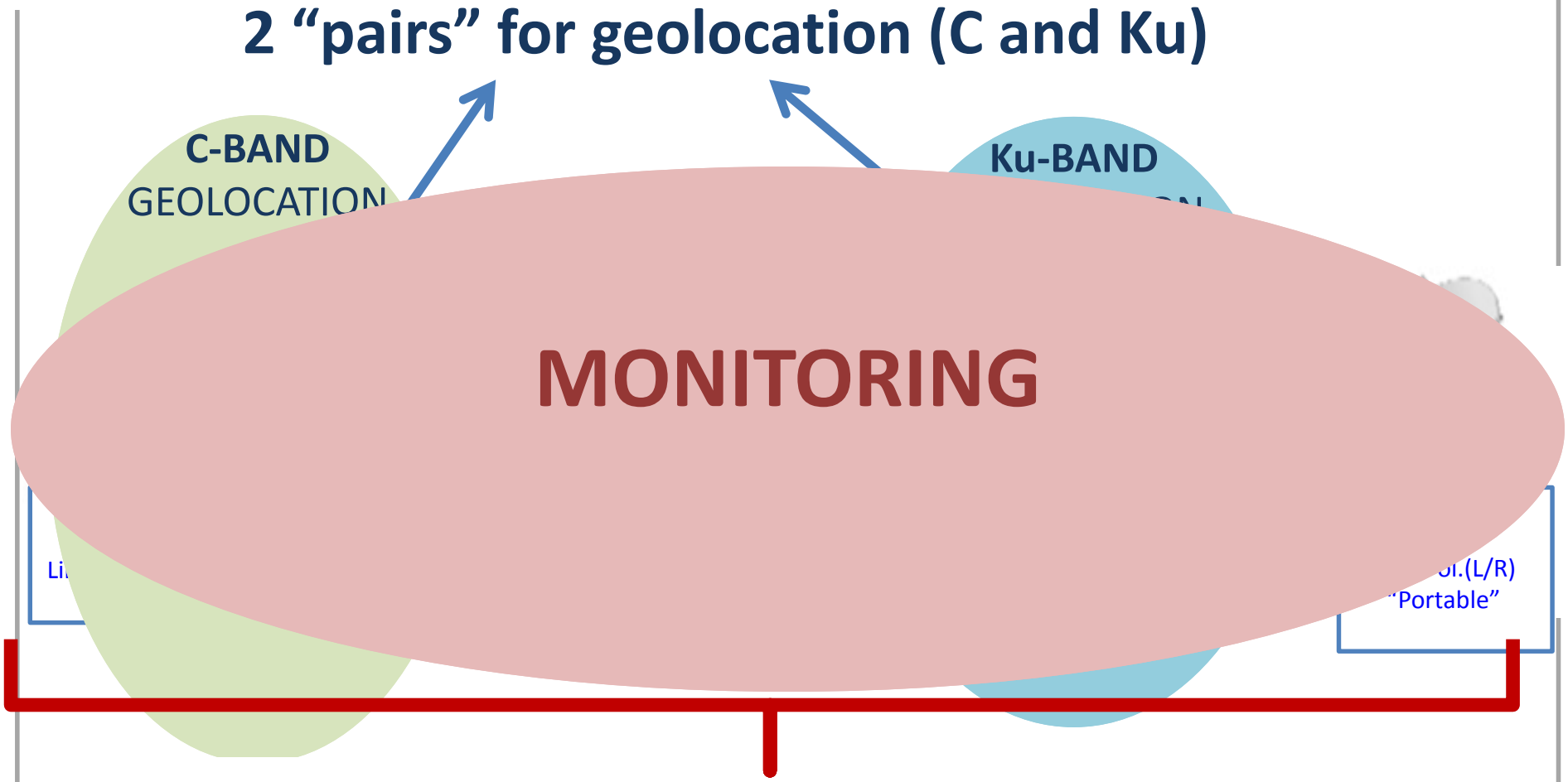
- ✓ Anatel is one of **10 regulators** in the world operating its own "EMSAT" - satellite radiomonitoring earth station (1st bellow equator line)
- ✓ Located in Rio de Janeiro city. Project deployed in 2nd half 2014.
- ✓ Current facilities: Geostationary satellites in C, Ku and Ka bands
- ✓ First challenges : spectrum control supporting satellite operations for major events in Brazil (e.g. FIFA World Cup 2014 and Rio 2016 Olympics)

About ANATEL EMSAT





ANATEL EMSAT antennas - setup



ANATEL EMSAT – main specs

C-BAND

Parameter	Antennas 1 and 2	Antenna 3	Antenna 4
Antenna type	Gregorian	Gregorian	Displaced-axis-ellipse
Frequency range	C Band	C Band	C Band (AP30B)
	3625MHz-4200MHz	3625MHz-4200MHz	4500MHz-4800MHz
Antenna diameter	6 m	6 m	4.5 m
Polarization	Linear	Circular	Linear
Tasks	Monitoring and Geolocation	Monitoring and Geolocation*	Monitoring
Antenna gain (dBi)	46.7	46.7	45
Figure of Merit (G/T)	27.8 dB/K	27 dB/K	26.8 dB/K
Orbital Positions	110ºW to 10ºW	96ºW to 1ºW	80ºW to 17ºW

Ku and Ka BANDs

Parameter	Antennas 5 and 6	Antenna7*
Antenna type	Displaced-axis-ellipse	Offset
Frequency range	Ku Band	Ka Band
	10.7 GHz – 12.75 GHz	17.7 GHz – 21.2 GHz
Antenna diameter	4.5 m	2.4 m
Polarization	Linear	Circular
Tasks	Monitoring and Geolocation	Monitoring
Antenna gain (dBi)	53.2	51.4
Figure of Merit (G/T)	30.9 dB/K	27.2 dB/K
Orbital Positions	110ºW to 29ºW	110ºW to 40ºW*

*portable facility, can be placed to reach further orbital positions.

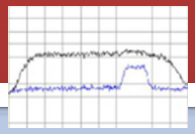
OPERATION TOOLs – general view

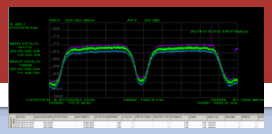
AUTOMATION

- Automation
- Platform elements management
  - ACU (antenna control)
  - LNA, LNB
  - NTP
  - Power generator
  - No Break
  - GPS

SPECTRUM MONITORING

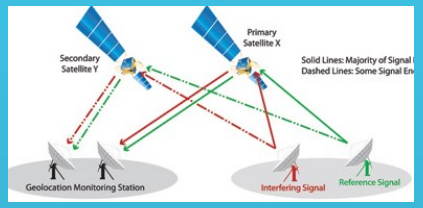
- Monitoring Plans and measurements DB storage
- Spectrum analysis
- Traces
- Carrier detection
- RF parameters threshold alarms
- Modulation analysis
- Calibration System
- Carrier under Carrier





EARTH STATION GEOLOCATION

-"Dual satellites Geolocation technology"



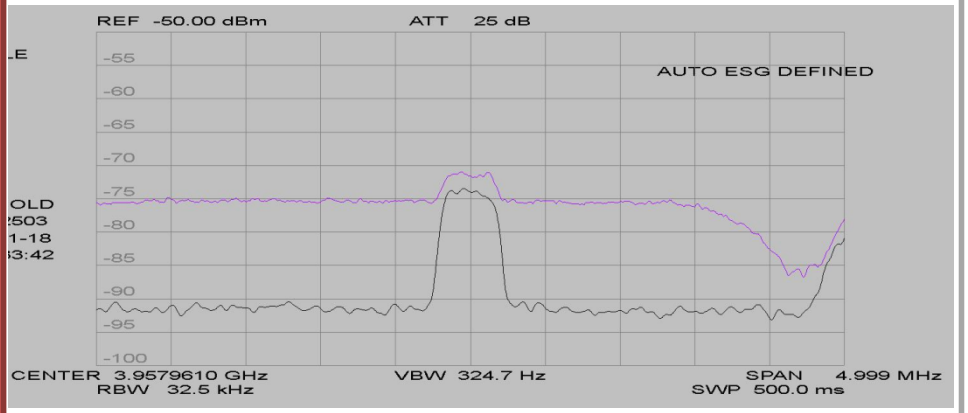
- FDOA + TDOA lines and Geolocation ellipsis for target signal location

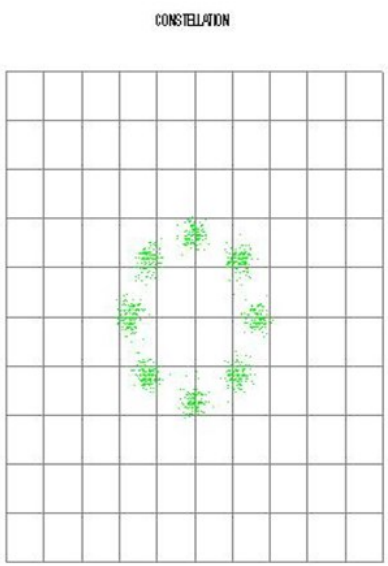
- Signal under Carrier

RF Monitoring Parameters

Main parameters

- EIRP downlink / PFD
- Center Frequency
- Bandwidth





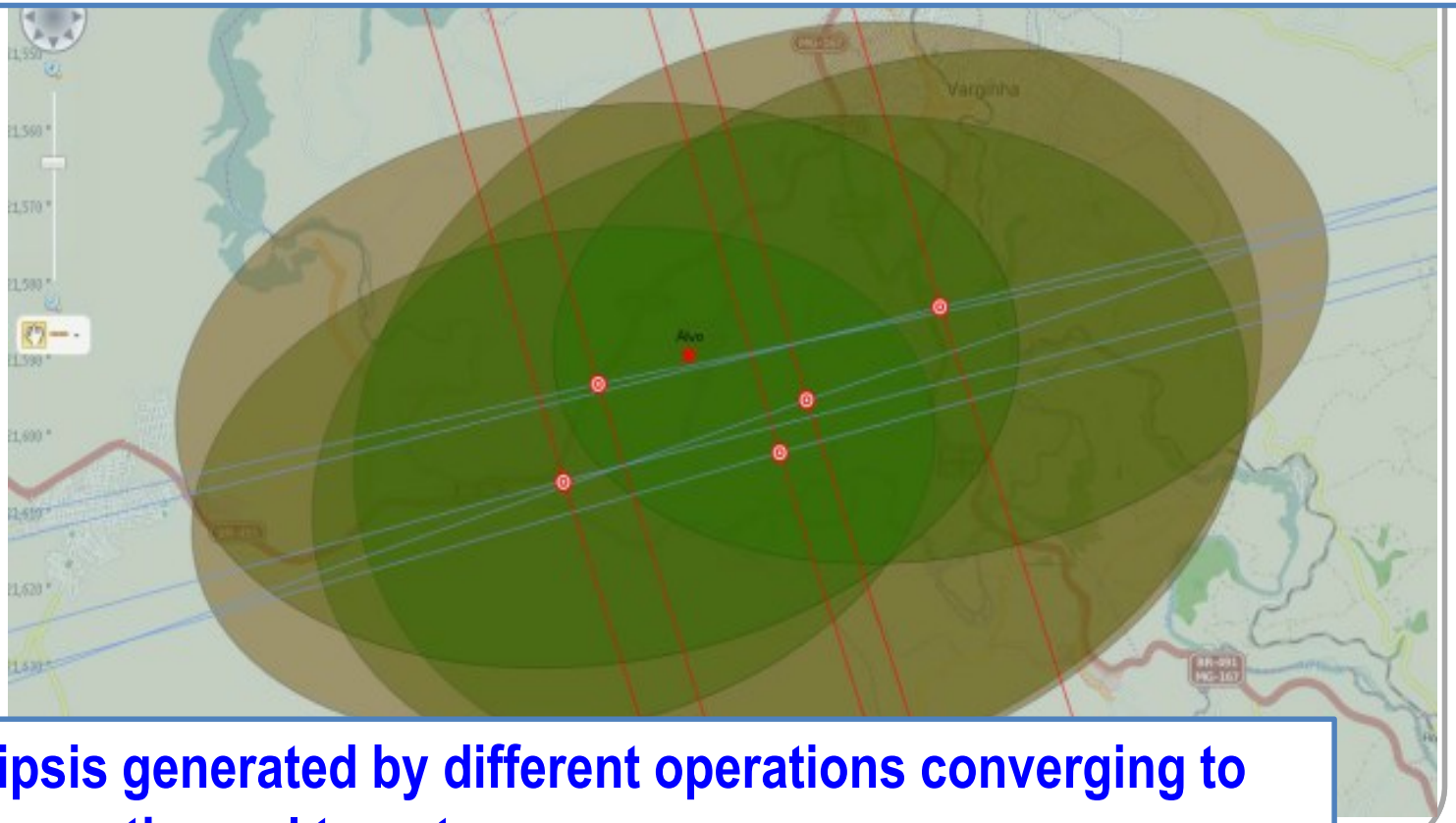
Further possible parameters

- C/N
- C/No
- Eb/No
- Modulation type and Constellation
- Symbol Rate
- BER

GEOLOCATION - example

“Dual Satellite” Geolocation technology

– TDOA (Time Difference of Arrival) combined with FDOA (Frequency Difference of Arrival) technology

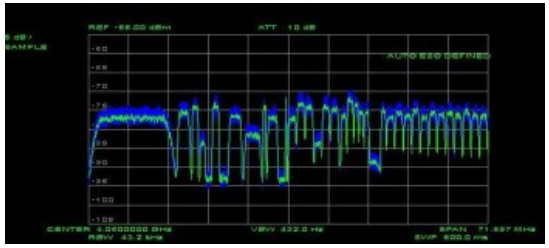


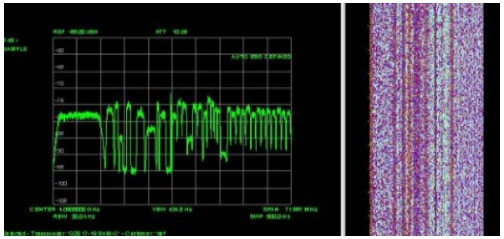
5 Geolocation ellipsis generated by different operations converging to the same region, near the real target.

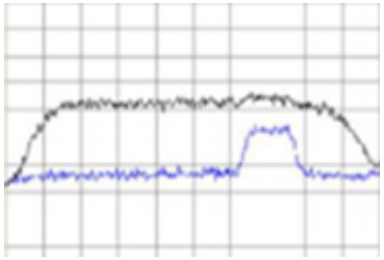
ANATEL EMSAT main functions

- ✓ **Mitigation of satellite networks interferences,** supporting the sector on geolocating interfering or non authorized sources

- ✓ **Spectrum monitoring** (monitoring plans scheduling, major events, prevention of interference cases...)



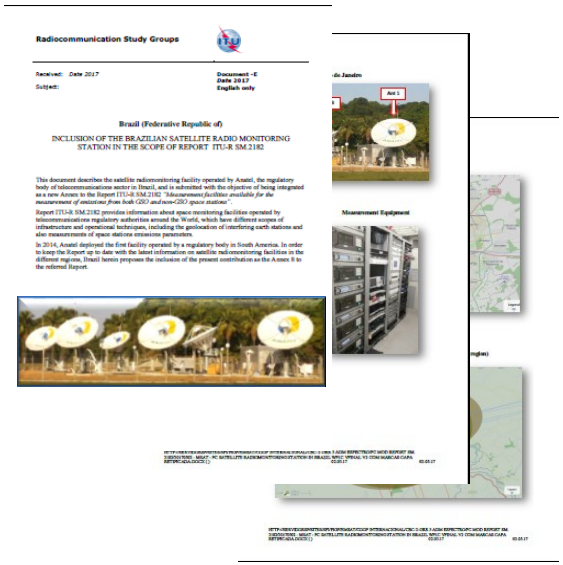




- ✓ **Support for evaluation of the usage of spectrum and orbit resources**, including transponder and orbital positions occupancy ("support tool" for efficient use of satellite resources)

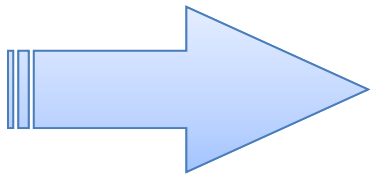
EMSAT further specs

- ✓ **ITU-R Report SM.2182 "***Measurement facilities available for the measurement of emissions from both GSO and non-GSO space stations***"**
- ✓ Brazilian contribution including Anatel EMSAT as new annex (forecast : next WP1C meeting, june/2017)


Radiocommunication Study Groups

Brazil (Federative Republic of)

INCLUSION OF THE BRAZILIAN SATELLITE RADIO MONITORING STATION IN THE SCOPE OF REPORT ITU-R SM.2182



MSAT – Satellite Radiomonitoring Strategic Project

PHASE 1 (2015-16) Structure and Learning

Human Resources & Knowledge

* Recruitment and Capacity building (under ITU project)

Supporting Tools (Report systems & Earth Station maps)

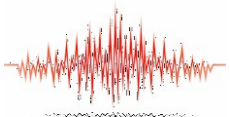
Databases & Maps

EMSAT Maintenance

- Reduced downtimes (from weeks to less than 1 day)

MSAT learning Operations

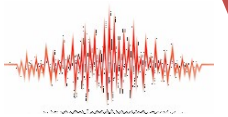
- Geolocation tests (higher accuracy)
- Interference resolution support

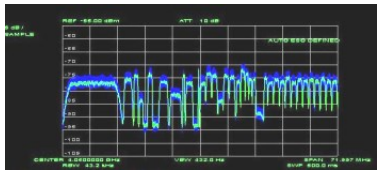


PHASE 2 (jun-oct/2016) Satellite Spectrum Control Operation for Rio2016

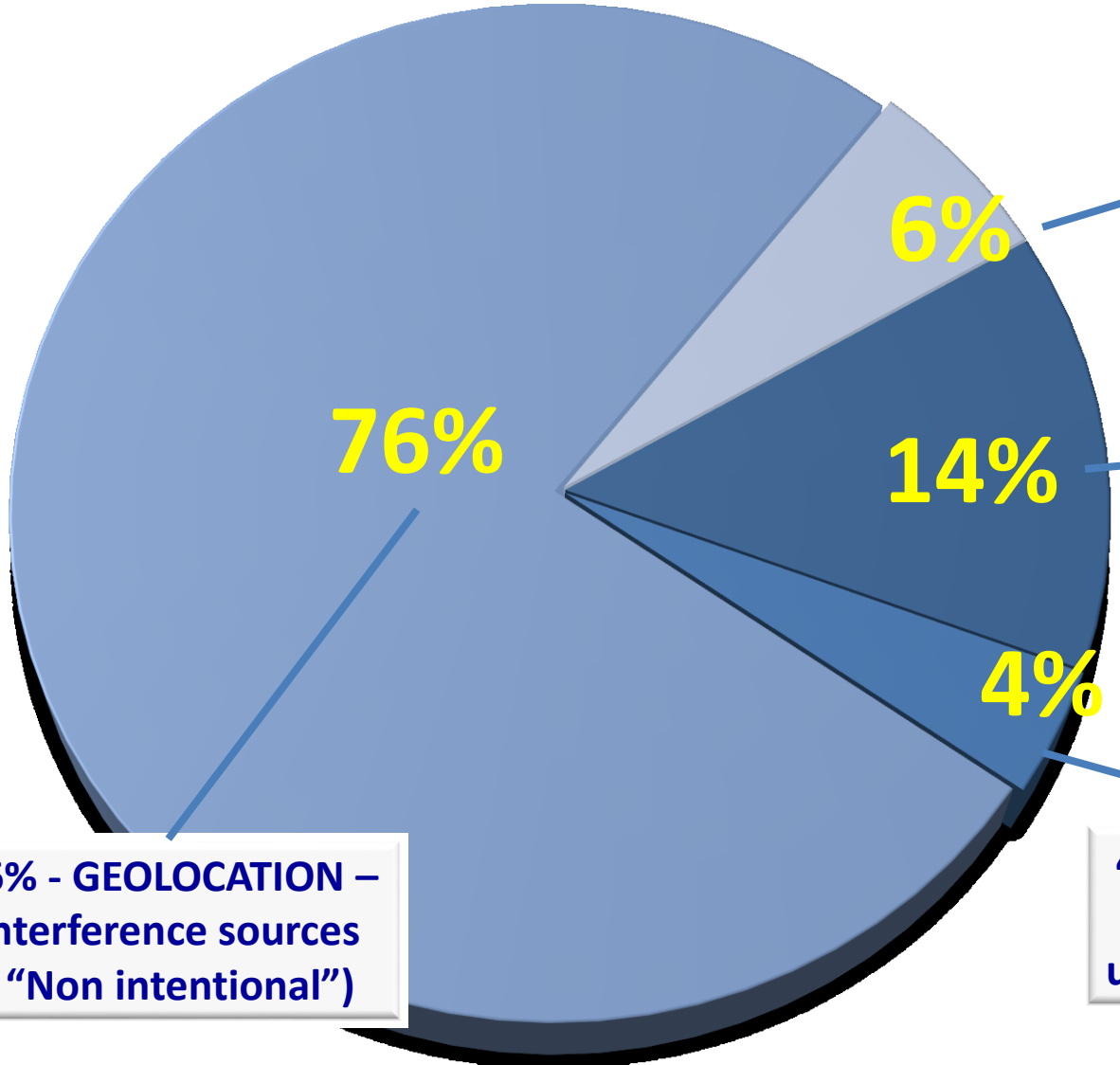
PHASE 3 (2017) Support for Spectrum and Orbit resources management

IN PROGRESS





50 Radiomonitoring operations since 2015



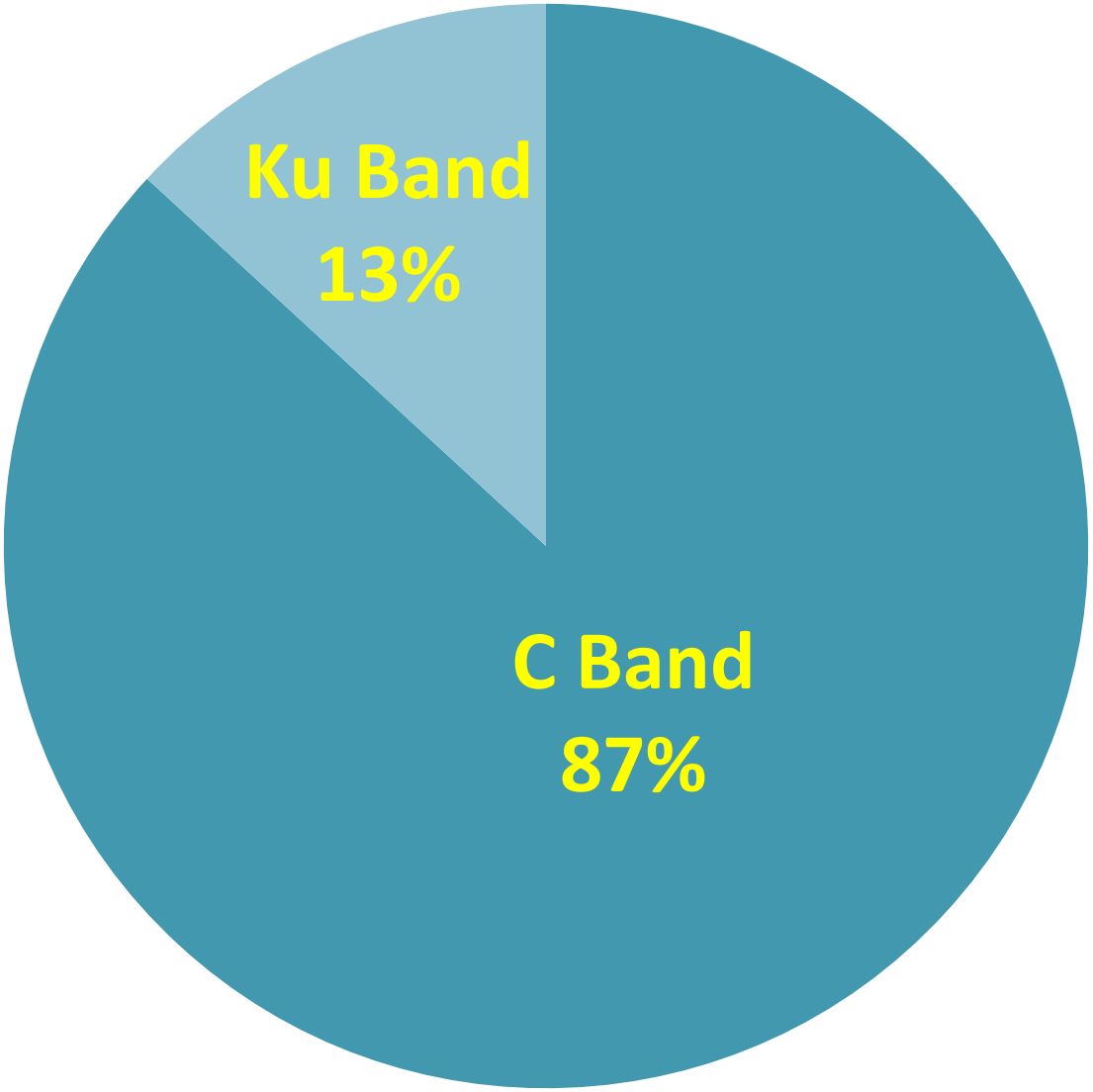
6% - FURTHER RADIOMONITORING OPERATIONS

14% - TESTING – development of knowledge, techniques & procedures

4% - GEOLOCATION – Non authorized use of GSO satellites

76% - GEOLOCATION – Interference sources (“Non intentional”)

38 Interference cases (uplink)



Highlights on some Satellite Radiomonitoring Operations - Rio 2016

Rio2016 Olympic and Paralympic Games Satellite Radiomonitoring operations

- Anatel ensured governmental spectrum guarantees for the event, (Rio 2016 spectrum management plan)
- Temporary licensing and previous testing and tagging of earth stations
- Support to spectrum incident and further Rio2016 Olympic spectrum teams
- Continuous radiomonitoring process and uplink geolocation for periodic validation of previously configured geolocation scenarios, allowing for fast response in case of uplink interference !)

Rio 2016 Olympic Park

Rio 2016 Olympic Park – SATELLITE FARM

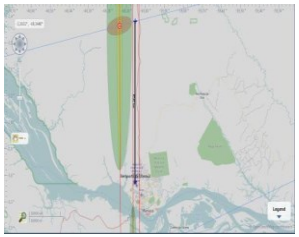
Highlights on some Satellite Radiomonitoring Operations – International interference case

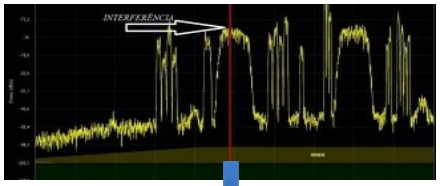
-International Uplink interference in Brazilian Star One C4, Ku Satellite.
-Argentinean adjacent satellite (ARSAT-1) chosen as secondary (geolocation)
-Earth Station in Chile interfering

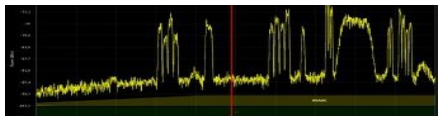
Good example that cooperation between regulators from neighboring countries is important (for both sides)

Highlights on some Satellite Radiomonitoring Operations – Interference to air control support system

Resolution of interference affecting air control support system (south and northeast regions of Brazil)







Ongoing initiatives

- ✓ **Development of formal procedures for regulatory radiomonitoring operations**
- ✓ **Cooperation with ITU**
  - ✓ Memorandum of Cooperation for space stations radiomonitoring.
  - ✓ Trial operations already performed with ITU, currently finishing to revise the terms of MoU
- ✓ Open for collaboration with regulators in neighboring countries (common goal = efficient use of spectrum)

Upcoming challenges (ideas for the future ?)

- ✓ Increase the level of integration of EMSAT with licensing system and satellites databases
- ✓ Study possibilities for expansion to NGSO radiomonitoring and further frequency bands (high cost!)
- ✓ Additional airborn geolocation system for last mile geolocation (radiomonitoring by DRONE)
- ✓ Mobile facilities for Ka band radiomonitoring on remote spotbeams (Brazil = huge territory)
- ✓ Ubiquitous earth stations in Ka band and possible new interference scenarios
- ✓ Cost benefit analysis for deploying more EMSAT in other regions of the country (similar to China strategy)

THANK YOU !