MSS issues in Europe

Hans van der Marel

ASTRON / CRAF

Current MSS issues

- Iridium satellites are causing detrimental interference in 1610.6-1613.8 MHz (primary RAS allocation)

- Inmarsat MES and AES will start operation in 1670-1675 MHz, adjacent to 1660-1670 MHz (primary RAS allocation). Coordination required.

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Iridium

- "Big LEO" satellite system
  - 66 satellites
  - ~780 km altitude
- Operated by Iridium LLC
- Licensed by FCC in 1995
- In operation since 1998
- Upgrade to Iridium NEXT from 2015

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Frequencies

Region 1
1 610.6-1 613.8 MOBILE-SATELLITE (Earth-to-space) 5.351A RADIO ASTRONOMY AERONAUTICAL RADIONAVIGATION 5.149 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.371 5.372
1 613.8-1 626.5 MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Mobile-satellite (space-to-Earth) 5.208B 5.341 5.355 5.359 5.364 5.365 5.366 5.367 5.368 5.369 5.371 5.372

The RAS has a **primary** allocation in the band **1610.6-1613.8 MHz**. Two footnotes are applicable in this band:

- **5.149** :"....administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference"

- **5.372** :"Harmful interference shall not be caused to stations of the radio astronomy service using the band 1610.6-1613.8 MHz by stations of the radiodetermination-satellite and mobile-satellite services (No. 29.13 applies").

Mobile-Satellite (Earth-to-Space) is allocated in the band **1610.0-1626.5 MHz** and Mobile-Satellite (Space-to-Earth) has a **secondary** allocation in the band **1613.8-1626.5 MHz**.

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Iridium license 1995

ORDER AND AUTHORIZATION

Adopted: January 31, 1995; Released: January 31, 1995

14. Section 25.213(a)(2) of the Commission's rules,[31] requires that space stations transmitting in the space-to-Earth direction in the 1613.8-1626.5 MHz band take whatever steps are necessary to prevent harmful interference to the United States' radio astronomy facilities during periods of observation.[32] Motorola indicates that it will fully coordinate Iridium's operations with the radio astronomy community.[33] It provides a copy of a Memorandum of Understanding (MOU) between itself and the National Radio Astronomy Observatory, which outlines the conditions under which Iridium may operate in the United States.[34] The MOU, however, only applies to two of the fifteen radio astronomy sites identified in Section 25.213(a). Motorola represents that similar agreements will be negotiated with respect to the other radio astronomy sites. We require Motorola to complete all radio astronomy site coordination before it initiates operation of the Iridium system. We also remind Motorola that it will have to terminate operations if unacceptable interference should occur to Radio Astronomy observation.

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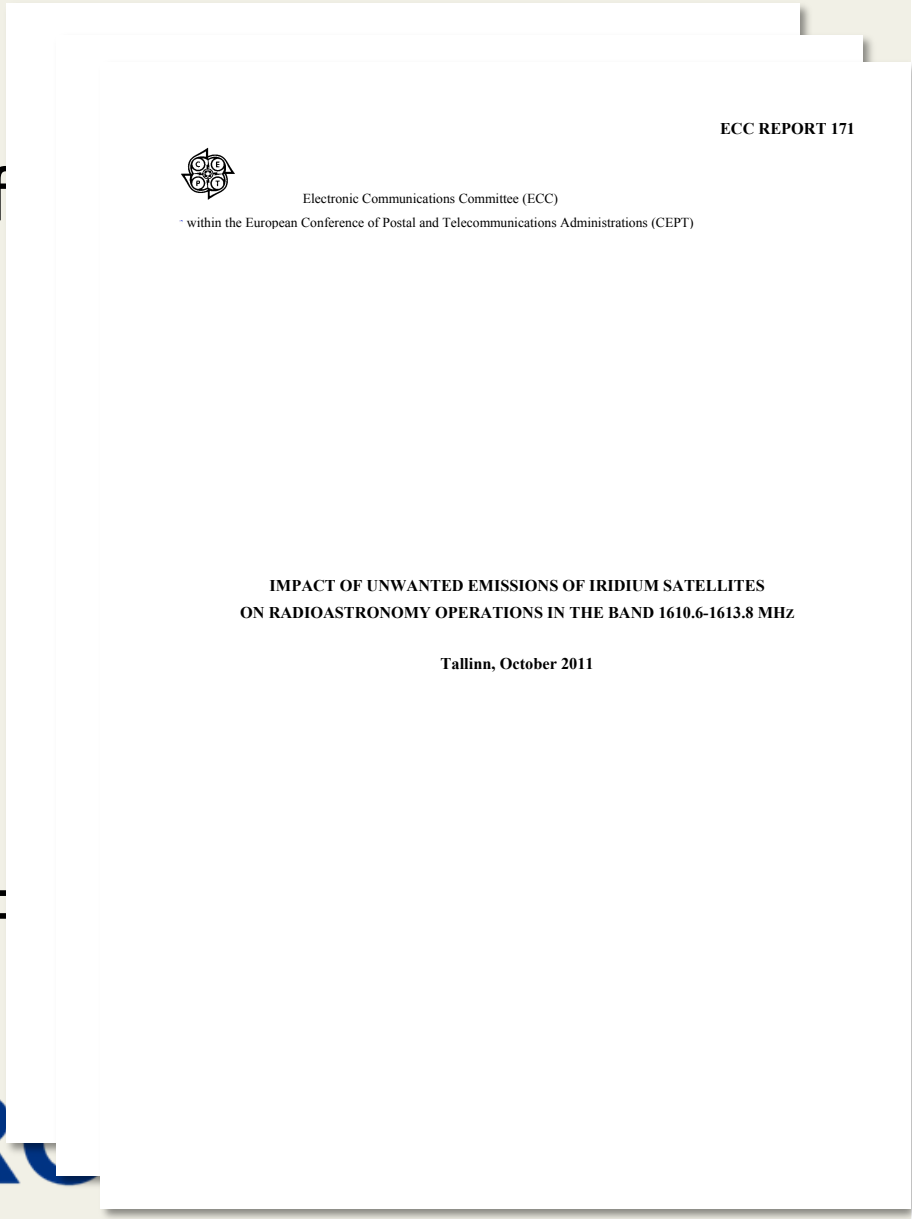
Interference in 1610.6-1613.8 MHz

- RAS experiences interference from start of operation of Iridium
- Several reports e.g.:
  - ERC Report 50 (1997)
  - ECC Report 112 (2007)
  - ECC Report 171 (2011)
- Letters sent by administrations and CRAF
- FCC never responded



ECC REPORT 171

Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

IMPACT OF UNWANTED EMISSIONS OF IRIDIUM SATELLITES
ON RADIOASTRONOMY OPERATIONS IN THE BAND 1610.6-1613.8 MHz

Tallinn, October 2011

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Framework agreement

- Agreement between ESF/CRAF and Iridium for period 1 May 1999 to 1 January 2006
- Some kind of coordination during this period
- Collaboration to solve interference by enhancing satellite operation and RAS observations
- From 1 January 2006 interference free observations for RAS

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Leeheim space monitoring station

Parameter	Antenna 1			
frequency band per feed (GHz)	1.5-1.8	2.1-2.3	4.3-8.5	10.7-12.75
antenna type	full motion Az/El Cassegrain beam waveguide			
antenna size	12 m Ø			
polarization	LX LY	LX LY	LX, LY RHC LHC	LX, LY RHC LHC
polarization adjustment	no	no	yes	yes
antenna gain (dBi)	44	47	49-56	61-62
figure of merit (dBK^{-1})	17	21	27-33	39-41
max. ang. velocity	Az. 16°/s El. 3.5°/s			
max. acceleration	$10°/s^2$			
antenna tracking	monopulse		-	mono-pulse
	manually, program track			
uncertainty rss* error	1,6 dB (95% confidence level)			

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Measurements at Leeheim (ECC rep 171)

- Tracking Iridium satellites
- Data recorded with FFT Spectrometer from MPIfR
- Calibration: on-off measurements on Cas A and Cyg A
- Direct (static) analysis
- EPFD (dynamic) analyis

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Rec ITU-R RA.769

1610.6-1613.8 MHz:

- Threshold pfd = -194 dB(W m^{-2})

  ➜ spfd = -238 dB(W m^{-2} Hz^{-1}) for 2 000 s integ.

Scaling: $$S_{769} = 10^{\frac{-238+260}{10}} \cdot \sqrt{\frac{2000\,\mathrm{s}}{t_{int}} \cdot \frac{20\,\mathrm{kHz}}{\delta f}}$$

Non-GSO satellites: epfd calculation according to Rec ITU-R M.1583 with 2% threshold

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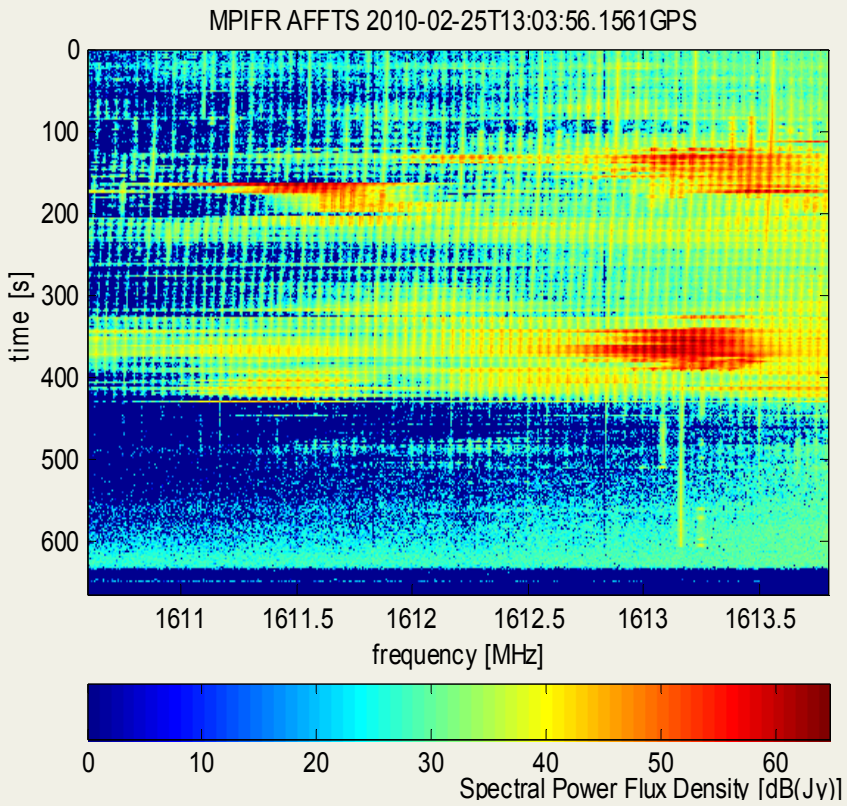
Calibrated measurement Ir-97



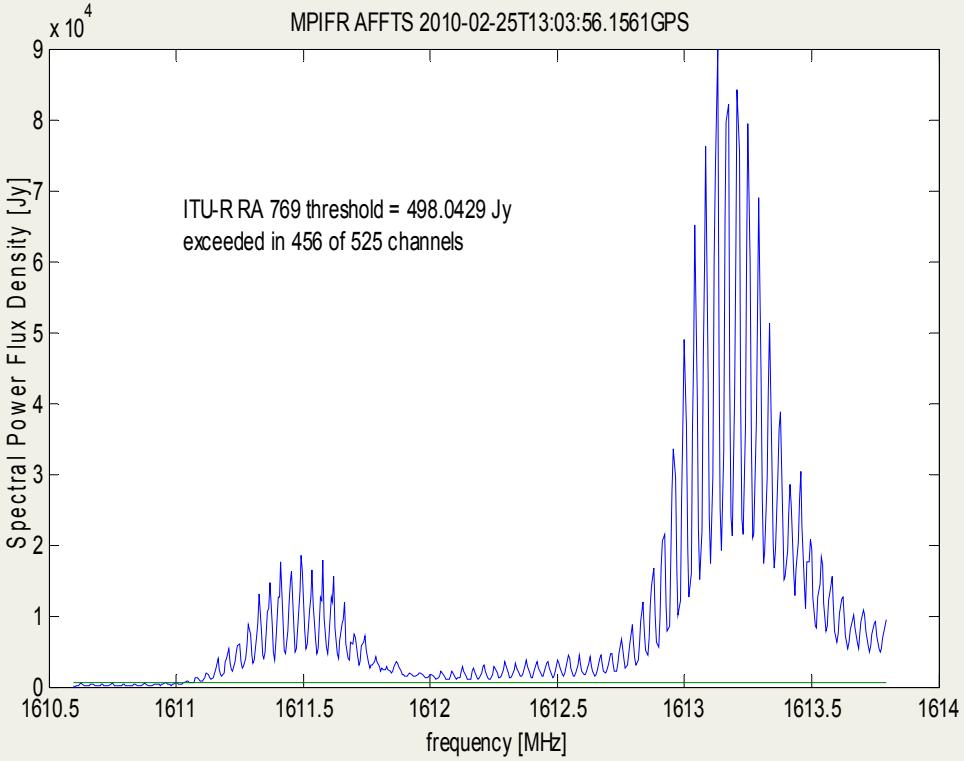


Fig. 11 from ECC report 171

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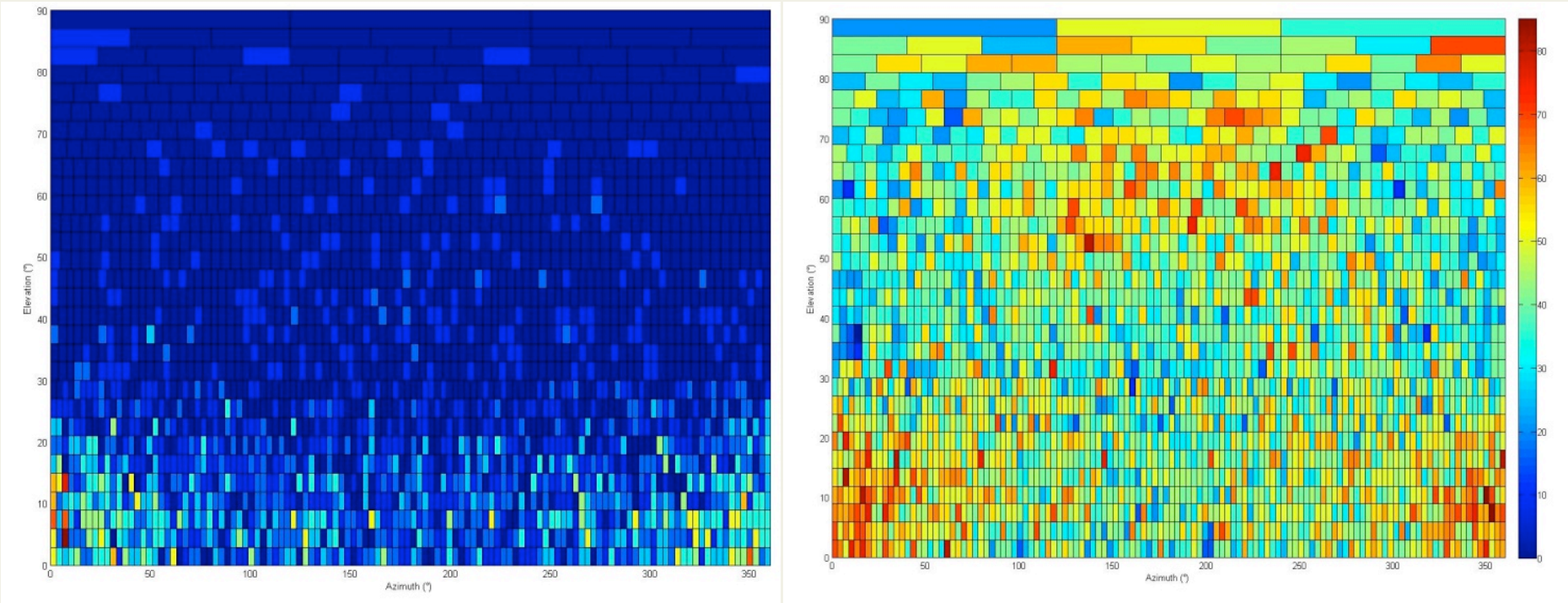
Epfd analysis



Data loss over the sky (elevation vs azimuth) for a 30s integration time for the channel at 1610.6199 MHz (4.7%) and the channel at 1613.7878 MHz (43.5%). (Fig. 16 from ECC report 171)

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ECC/DEC/(09)02

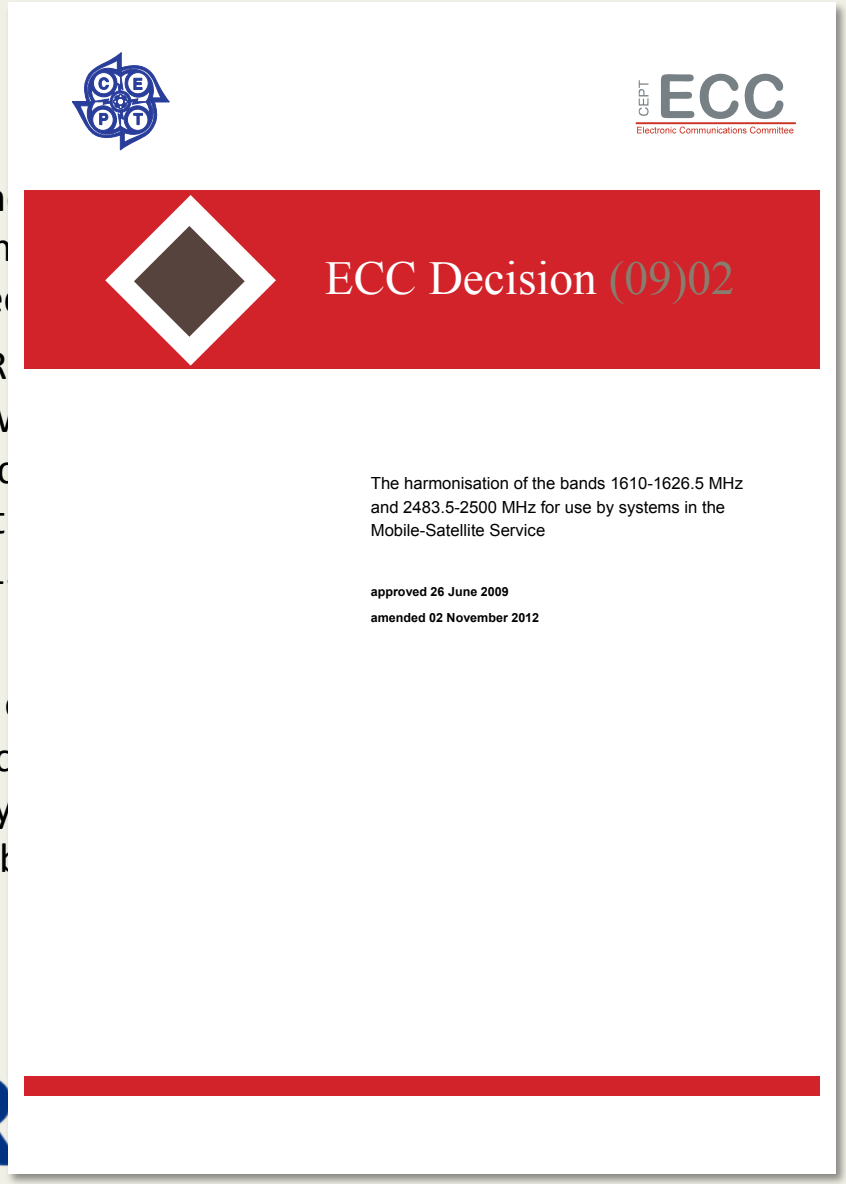
DECIDES

4. that, after 1 January 2016, in order to protect th
band 1610.6- 1613.8 MHz, administrations shall on
stations under the control of MSS systems provide

• that in accordance with Recommendations ITU-R
at radio astronomy stations is limited to -238 dB(W
exceeding this limit is ≤ 2% in one or more 20 kHz c
1610.6-1613.8 MHz at the location of the radio ast
system using downlinks in the frequency band 161

⋮

5. that the compliance with the conditions for use
MSS systems in the band 1613.8-1626.5 MHz (spac
the frequency band 1610.6- 1613.8 MHz caused by
once a year) by a competent body and the results b



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Iridium NEXT

- New satellites built by Thales Alenia Space (France)
- To be launched from 2015
- Equipped with additional payloads
- Still intermods due created in analogue beam-forming network
- In default mode still above RA.769 levels
  ➜ coordination needed to switch to so-called RASP mode?

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RASP mode

- 3 day notification time
- Maximum of 12 subbands
- Europe: 12:00 – 18:00 high traffic (>12 subbands)
- Nearly half of daily revenue is generated in the 6 busy hours of the day
- RASP mode can be tolerated for short periods to limit impact on quality of service and revenue
- Switchover to RASP mode up to Iridium?

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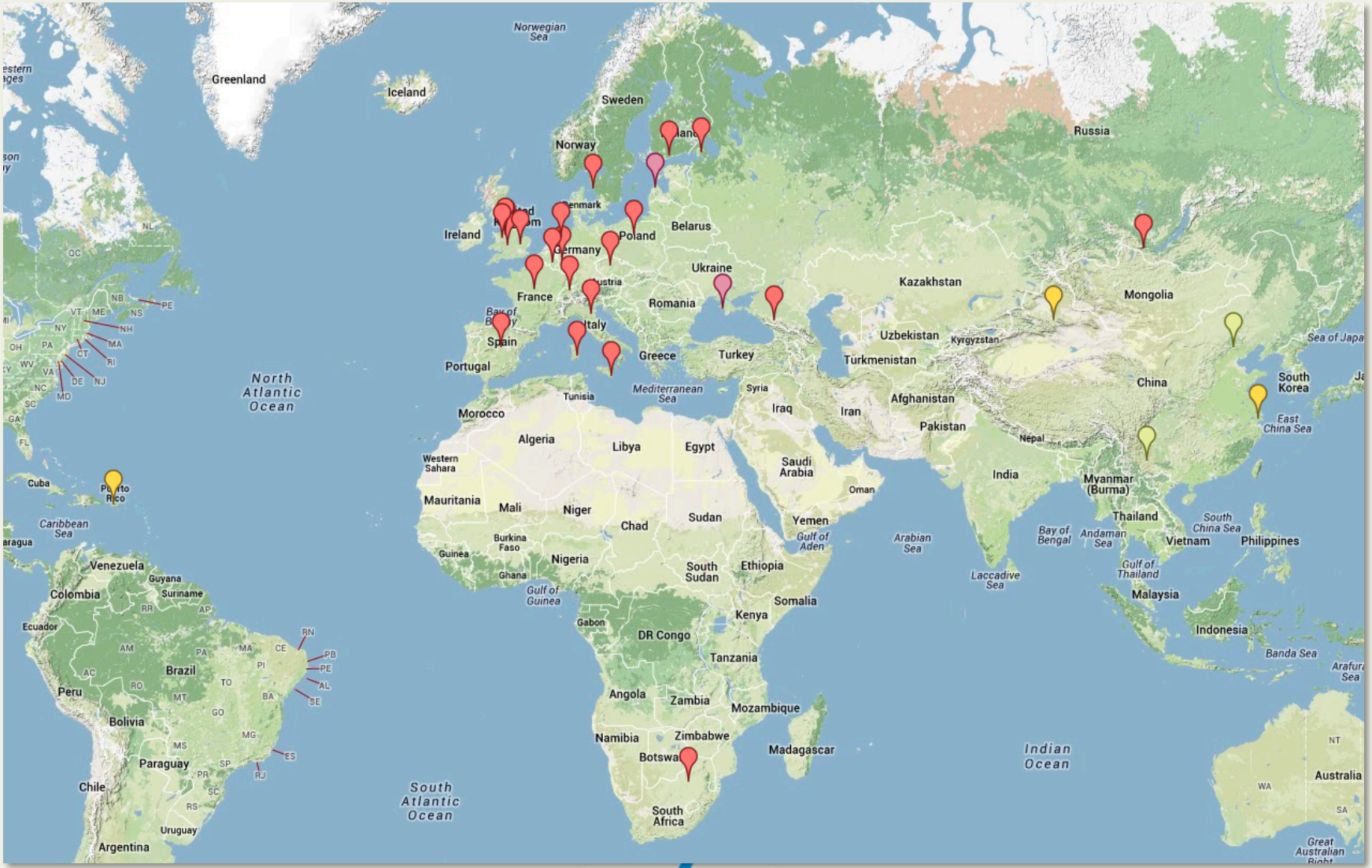
RAS sites Europe + South-Africa + EVN



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Lead time of observations

- Varies greatly among telescopes
- Some telescopes apply day-to-day scheduling
- Several telescopes prepare longer-term schedules ranging from 3 days to 4 months
- All telescopes apply dynamic scheduling or rescheduling with lead times of 1 minute – 1 day

➢ 3 days notification not acceptable

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Status in Europe

- CEPT WG FM has tasked CRAF and Iridium to have technical discussions whether ECC/DEC/(09)02 can be obeyed
- First meeting in January 2014:
  - CRAF prepared typical observation scenario (sent)
  - Iridium will perform simulations
  - CRAF receives detailed description of simulation algorithm for validation (high-level description received)
- Next meeting in April?
- Report at WG FM (end of May)

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Article in PolicyTracker:

Europe's radio astronomers want action over Iridium interference

Mar 20, 2014 by Toby Youell

Iridium's plans for its new constellation of satellites appear to scuttle radio astronomers' hopes that they will be able to use the 1610.6–1613.8 MHz band without restrictions.

Satellites developed for US giant Iridium do not take account of radio frequency interference mitigation solutions proposed by the Electronic Communications Committee (ECC), according to Europe's Committee on Radio Astronomy (CRAF). This means the current interference caused by Iridium's mobile satellite service (MSS) to radio astronomy activities in the adjacent band is likely to continue, CRAF says.

> The FCC is not carrying out its duty according to the Radio Regulations and is ignoring the existence of CEPT and the ECC. It is a scandal

https://www.policytracker.com/headlines/iridium-could-flout-itu-r-radio-regulations-and-stymie-science-in-forthcoming-satellite-launch

To be continued….

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