



International Committee on
Global Navigation Satellite Systems

Report of
*“Seminar on GNSS Spectrum Protection
and Interference Detection Mitigation”* during
ICG Expert Meeting in December 2015

IDM Workshop on
GNSS Spectrum Protection and Interference Detection and Mitigation
Saint Tropez Hotel, Changsha, China
17 May 2016

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Overview (1 of 2)

- The ICG Experts Meeting on GNSS Services was held in December 2015
 - ▶ To increase knowledge and expertise relating to GNSS capabilities
 - ▶ To emphasize the benefits of GNSS to the world user community
- During this ICG Expert Meeting, a two-day seminar was held to describe the importance of GNSS spectrum protection
 - ▶ Introduction to the regulatory aspects of spectrum management
 - ▶ Discussion of technical aspects such as detection technologies and mitigation techniques of radio frequency interference



Overview (2 of 2)

- The ICG Experts Meeting had participants from more than 30 countries representing governments, colleges, research labs and space agencies etc..
- Through an interactive session at the beginning of the seminar, all participants recognized the benefits and importance of GNSS
- Interactive feedback at the seminar end confirmed that it had achieved the objective to inform participants about GNSS spectrum protection and the importance of good national spectrum management for continued access to GNSS benefits



Fundamentals of GNSS (1 of 2)

- A brief history of GNSS was provided
- GNSS navigation principles, its application, each GNSS system signals and receiver fundamentals were introduced.
- Through the interview, all participants agreed on the benefits and importance of GNSS.
- One important point - Since GNSS signals are weak compared to terrestrial radio sources, they are very susceptible to radio frequency interference (RFI). Therefore, it is necessary to protect GNSS signals through proper spectrum management to ensure economic benefits from having access to interference-free GNSS.



Fundamentals of GNSS (2 of 2)

- Signal Power Level Comparison -

- GNSS receivers expect to receive and can operate at signal levels even below the natural background radiation level, the "noise floor"
- **GNSS receivers** need a minimum power level "**-130dBm**"
- **Mobile phones** (eg GSM) expect a minimum "**-104dBm**"
 - **Around a thousand times higher than GNSS!**
- This difference in expected receive signal levels makes GNSS reception vulnerable to RFI



Interference and Spectrum Management (1 of 3)

Minimize Interference, Maximize Benefits

- In addition to the interference from co-primary radio services, other types of interference such as out-of-band emissions, spurious emissions and adjacent band interference should also be taken into account.
- To avoid interference, the **ITU Radio Regulations** (treaty material: See separated slides for details) allocate the spectrum appropriately (e.g., frequency separation, power constraints etc.)
- National implementations usually align with the **ITU Radio Regulations**



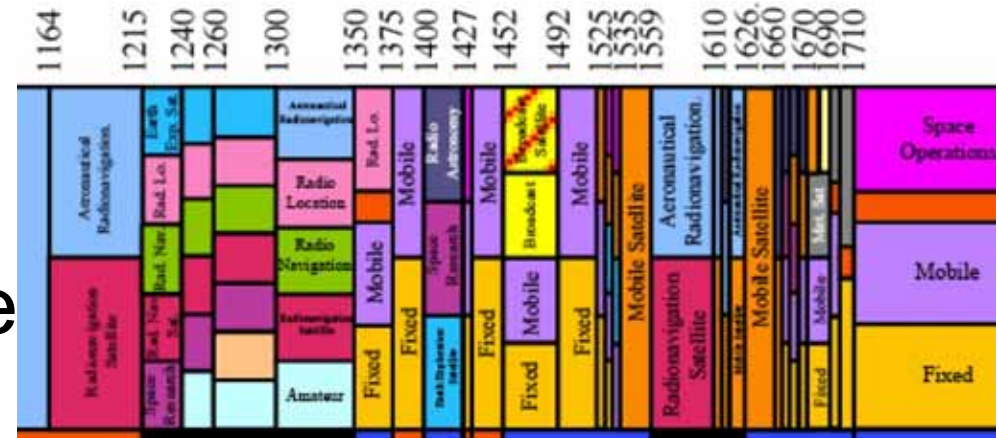
Interference and Spectrum Management (2 of 3)

Examples of Allocations (International, Domestic)

- Radio Regulations Allocations (L-band)

Allocation to services		
Region 1	Region 2	Region 3
1 525-1 530 SPACE OPERATION (space-to-Earth) FIXED MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A Earth exploration-satellite Mobile except aeronautical mobile 5.349 5.341 5.342 5.350 5.351 5.352A 5.354	1 525-1 530 SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A Earth exploration-satellite Fixed Mobile 5.343 5.341 5.351 5.354	1 525-1 530 SPACE OPERATION (space-to-Earth) FIXED MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A Earth exploration-satellite Mobile 5.349 5.341 5.351 5.352A 5.354
1 530-1 535 SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A 5.353A Earth exploration-satellite Fixed Mobile except aeronautical mobile 5.341 5.342 5.351 5.354	1 530-1 535 SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A 5.353A Earth exploration-satellite Fixed Mobile 5.343 5.341 5.351 5.354	
1 535-1 559	MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A 5.341 5.351 5.353A 5.354 5.355 5.356 5.357 5.357A 5.359 5.362A	
1 559-1 610	AERONAUTICAL RADIONAVIGATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.208B 5.328B 5.329A 5.341 5.362B 5.362C	

- UK Allocations (L-band) as an example



Interference and Spectrum Management (3 of 3)

Spectrum Management at National Level

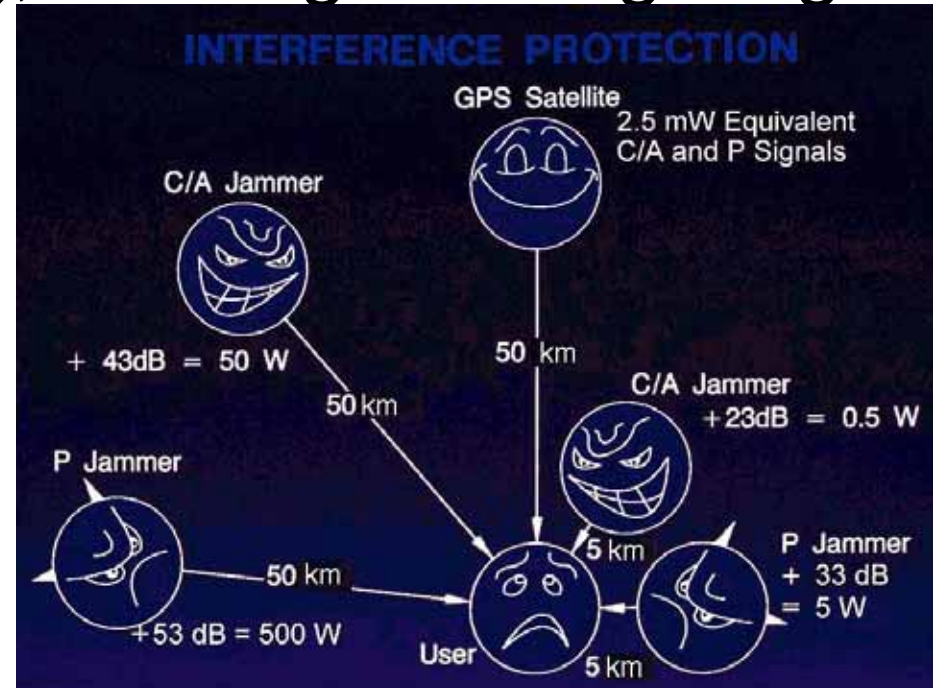
- National Spectrum Agencies' activities were introduced with their role to maintain/improve the safety and reliability of radio use.
- Differences in spectrum allocation and protection among different National Spectrum Agencies were also illustrated. In particular, different regulations/guidelines (e.g., allowable emission levels) for non-radio service emissions such as ISM (e.g., escalators) emissions and Short Range Device (e.g., UWB) emissions exist among different National Spectrum Agencies.



Possible Danger at Present (1 of 3)

GNSS Jammer

- GNSS Jammers are a radio frequency transmitters that intentionally prevent GNSS receivers from acquiring, tracking or navigating with GNSS signals.
- GNSS Jammers are used by thrill seekers, privacy protectors, criminals and terrorists etc.
- Spoofing, which is to fool GNSS receivers with false PNT information is also problem.



Possible Danger at Present (2 of 3)

GNSS Jammer Examples

The screenshot shows a website with a navigation menu at the top: Home, Why Buy From Us, Contact Us, About Us, F.A.Q., Articles, Manuals, Customer Testimonials, Privacy Policy, Shipping, Returns. On the left, there is a 'Categories' sidebar listing: Cell Phone Jammers, Portable, Portable Accessories, GPS Jammers, Prison, Vehicle, Signal Detectors, IED and VIP Protection, Laser Radar, WiFi, High Powered, Indoor, Outdoor, and Government Contracts. Below the categories are security logos for 'SECURITY VERIFIED & SECURED', 'McAfee Site Advisor', and 'FREE'. The main content area is titled 'GPS Jammers' and includes a 'Sort by: Bestselling' dropdown. A descriptive paragraph states: 'To prevent GPS monitoring on your person, cell phone, or vehicle, a GPS signal blocker will stop tracking signals. Maintain your privacy, keep your movements private, and avoid unauthorized surveillance by utilizing a jamming device.' Several product listings are shown:

- GPS Jammer:** Price: ~~\$199.00~~ \$119.00. Description: 'For car, truck, bus, van, or even boat security, stop GPS tracking signals by simply plugging this into any cigarette lighter or vehicle power outlet. With up to 10 meter coverage, it will protect you from being logged...'
- Cell and GPS:** Price: ~~\$299.00~~ \$199.00. Description: 'One of our most popular, silence all nearby mobile phones as always on local signals...'
- High Power Component:** Not Rated. Description: 'If you need a large area of coverage for your business or home, this high power unit will cover up to 1000 meters with its aluminum alloy case that is...'
- GPS Mini:** Price: ~~\$239.00~~ \$139.00. Description: 'One of the best GPS signal units available for sale, this pocket model will help you defeat GPS tracking. Block tracking signals on your person or vehicle in a 10 meter (30 foot) radius. Give those following your...'
- GPS Tracker Detector:** Price: ~~\$229.00~~ \$179.00. Description: 'Locate Bugs with a GPS Tracking Detector Concerned about a covert GPS tracking device on your person or vehicle? Locate them with this GPS tracking detector. This high sensitivity GSM and GPS detector will not...'
- Cell GPS Mini:** Price: ~~\$239.00~~ \$159.00. Description: 'This combination mini model is a fusion of our popular cell phone blocker mini and GPS mini units. Simultaneously create a silent zone and prevent unauthorized tracking signals up to 30' away with the flip of a...'

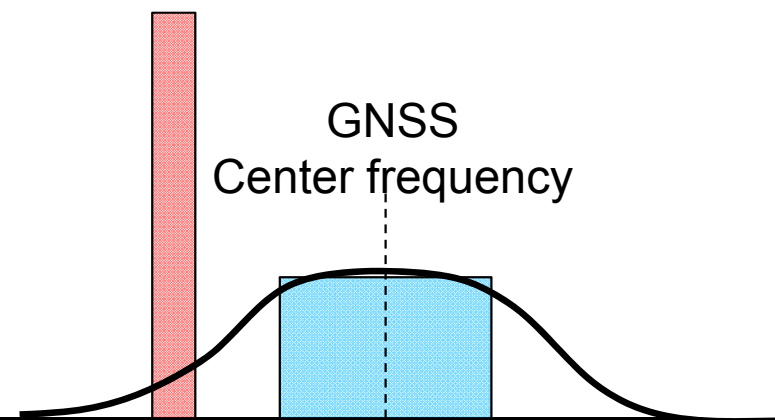
On the right side of the website, there is a 'Currency Converter' section with options for Default Currency, EURO, and GBP. Below that is a 'Our Newsletter' section with a 'Subscribe to Our Mailing List Get a \$5 Coupon Instantly!' offer and a 'Your First Name:' input field.



Possible Danger at Present (3 of 3)

Adjacent Band Interference Concerns

- Applicable in cases when high powered service, for example, terrestrial, is planned adjacent to GNSS bands.
- Potential for 1) front-end compression and 2) undesired responses created by mixing an out-of-band signal with a GNSS local oscillator
- Front-end filtering can help reduce this effect but high power adjacent band sources will still be problematic



Spectrum Protection Activities in ICG

- ICG provides a forum that can facilitate and encourage the protection of GNSS spectrum
- Topics discussed at ICG:
 - Electromagnetic Emissions
 - Interference Detection and Geo-Location Capabilities (challenge of detecting weak interferers, such as GNSS jammers, because those interfering levels are weak but still stronger to impact on GNSS reception)
 - Critical Infrastructure



ICG Expert Meeting Materials

- The materials of ICG Expert Meetings can be found in the following web-site:

http://www.unoosa.org/oosa/en/ourwork/icg/activities/2015/icg-experts-meeting_presentations.html

