

# GNSS Interference Detection and Mitigation

COPUOS Scientific and Technical  
Subcommittee Meeting  
07 February 2017



UNITED NATIONS

# JOURNAL

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COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE

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SCIENTIFIC AND TECHNICAL SUBCOMMITTEE  
FIFTY-FOURTH SESSION

Vienna, 30 January-10 February 2017

MONDAY, 6 FEBRUARY 2017

No. 7

**Programme of Meetings and Agenda for  
Monday, 6 February 2017**

10.00 a.m.-1.00 p.m.

865<sup>th</sup> meeting

Board Room D

*Agenda Item*

*Item No.*

General exchange of views

[3]

United Nations Programme on Space Applications

[4]

Disaster management support

[8]

**Special Presentations on Outer Space Activities**

At the end of the morning meeting (865<sup>th</sup>) of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space, today, 6 February 2017, there will be three special presentations on “ESA and Climate Change” by Mr. Josef Aschbacher of the ESA, on “Cassini Mission: the Grand Finale” by Mr. Enrico Flamini of Italy, and on “GNSS Interference Detection and Mitigation” by Mr. Rick Hamilton of the United States in Board Room D.

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At the end of the afternoon meeting (866<sup>th</sup>) of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space, today, 6 February 2017, there will be three special presentations on “Space Generation Advisory Council – Next Generation Perspectives” by Ms. Stephanie Wan of the SGAC, on “Satellite Industry Interaction with Government for the Long Term Sustainability of Space” by Ms. Charity Weeden of the United States, and on “GNSS spectrum protection and IDM in China”, by Mr. Jun Shen of China in Board Room D.



72 member countries  
in attendance

# 5 elements

- Spectrum Management in the U.S.
- Status of IDM research in the U.S.
- Spectrum Enforcement Actions
- IDM Reporting
- IDM activities through the ICG

# The Problem

- A jammer can *block all radio communications* on any device that operates on radio frequencies within its range.
- Generally *does not discriminate* between desirable and undesirable communications.
- Jammers can:
  - prevent your cell phone from making or receiving calls, text messages, and emails;
  - prevent your Wi-Fi enabled device from connecting to the Internet;
  - prevent your GPS unit from receiving correct positioning signals; and
  - prevent a first responder from locating you in an emergency.



# Reported Incidents of Interference

- Jammers overwhelm anti-theft devices on cars and trucks enabling undetected movement
- Have been used in vicinity of airports disrupting air traffic
- Illegally establishing quiet zones and text-free zones in Churches and Schools



- Facilitating criminal activity
- Used to defeat attempts to document road use for taxes



- Used to defeat the fleet tracking devices in company cars and trucks
- Interfering with port operations
- **These uses of jammers are all illegal in the U.S.**

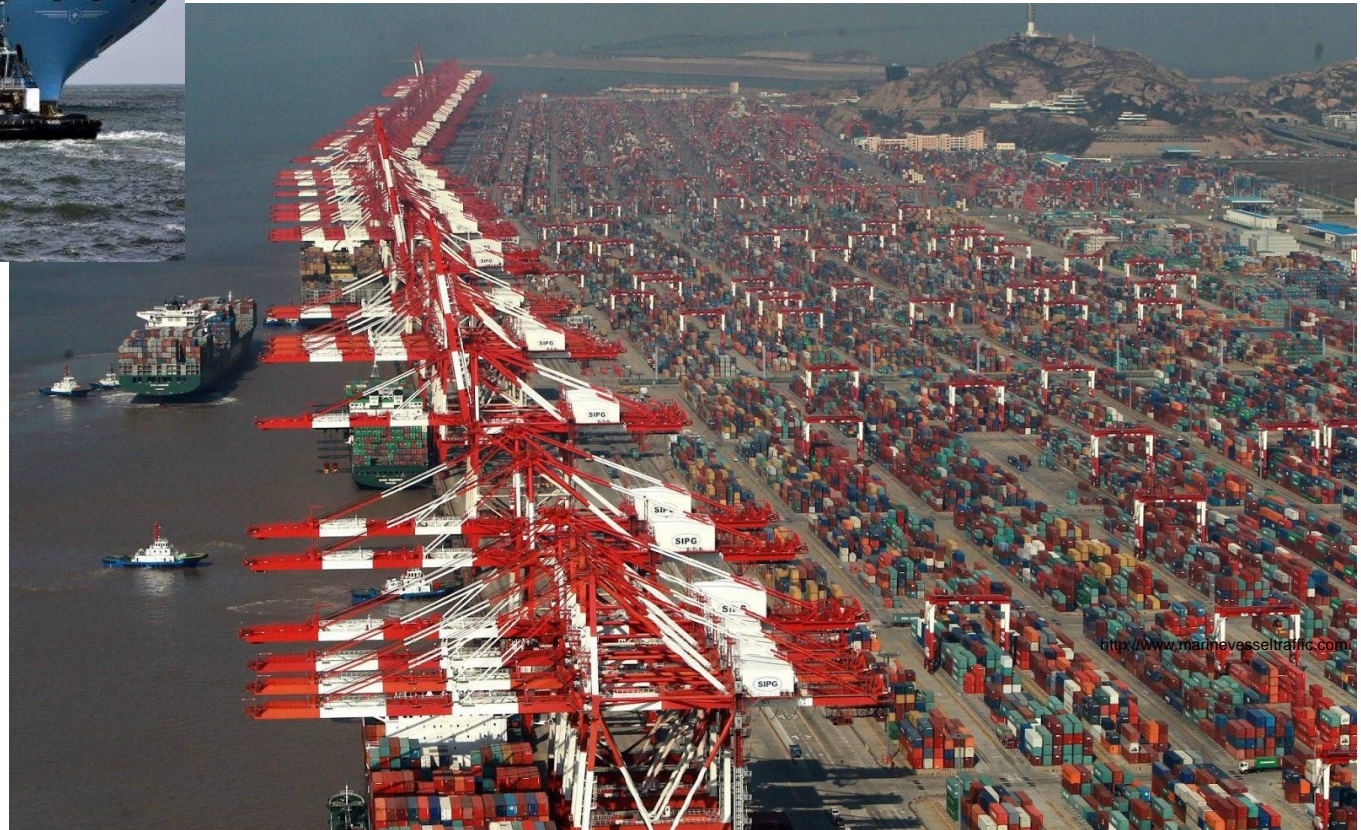


# Interference at a Highly Automated Container Port facility

Port of Shanghai throughput:  
33.62 million TEUs in 2013

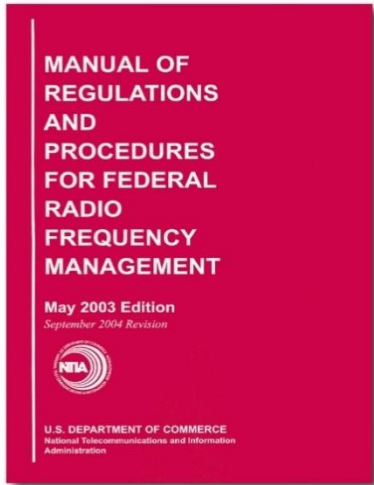


One ship  
can bring as  
many as  
19,000 20ft  
containers



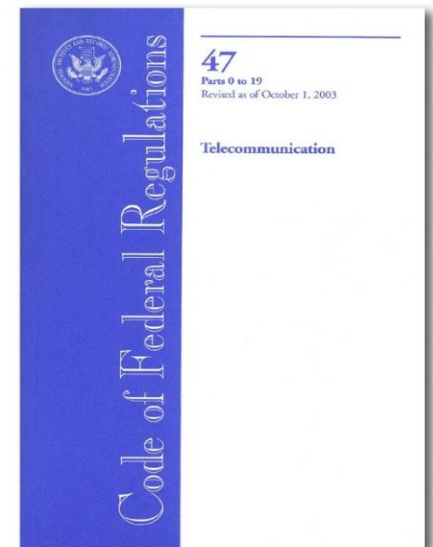
TEU = One 20 ft container

# International and National Allocations



- In general, national frequency allocations are aligned with the ITU table of frequency allocation

- However, though they are not identical since each nation has sovereign rights to manage its own spectrum, the U.S. pursues harmonized use of the radio frequency spectrum”.





# Best Practices

In the past 2 years the U.S. has released 2 best practices for mitigating the effects of a localized GPS disruption.

- Best Practices for Improved Robustness of Time and Frequency Sources in Fixed Locations 6 January 2015
- Improving the Operation and Development of Global Positioning System (GPS) Equipment Used by Critical Infrastructure
- Find these documents at: [www.GPS.gov](http://www.GPS.gov)  
**Look for: Guidance for Critical Infrastructures**

# Spectrum Enforcement Actions

Complaint from a cell provider in Florida that its cell phone tower sites had been experiencing interference:

- Forfeiture Order affirms proposed \$48,000 forfeiture against a man for using a cell phone signal jammer in his car while commuting to and from work on a Florida highway over a 16-24 month period.

Anonymous complaint alleging that a company was operating signal jammers to prevent its employees from using phones:

- The company will pay \$20,500 in civil penalties for unauthorized use for over 2 years of a signal jamming device purchased and mounted in the company's warehouse to prevent employees from using the cell phones while working.

# Comprehensive GNSS jamming prohibition provisions must be incorporated under four different authorities:

- *National Statutes – Legislation*
- *Telecom Agency Rules*
- *The Criminal Code*
- *International Treaties*

# Interference Reporting

U.S. process starts with problem report to NAVCEN, FCC or FAA

- Different than ITU form
  - Problem Rpt vs After Action Rpt
- Service Center triage to confirm problem
- Initial interagency conference call to provide for a coordinated government response/Discussion on way fwd
- Priority assigned will determine level of response and agencies involved

**Purpose:** The Coast Guard Navigation Center will use this information to disseminate navigation safety notices and updates to individuals upon request and to receive reports of aid to navigation outages, issues or discrepancies.

**Routine Uses:** Coast Guard personnel will use this information to disseminate safety notices and updates and to aid in the repair or investigate reports of navigation outages, issues or discrepancies. Any external disclosures of data within this record will be made in accordance with DHS/ALL-002, Department of Homeland Security General Contact Lists, 73 Federal Register 71659, November 25, 2008, and DHS/USCG-013, Marine Information for Safety and Law Enforcement System of Records, 74 Federal Register 30305, June 25, 2009.

**Disclosure:** Furnishing this information is voluntary; however, failure to furnish the requested information may hinder your request for navigation safety related information.

\* Denotes a required field

1) \* Your Name:

2) \* Email Address:

3) \* Telephone number: [i.e. - (703) 313-5900]

4) Preferred method and time to be contacted if additional information is necessary:

5) \* What was the start time and date of the GPS disruption? Date:   Time:

Zone:

6) \* Is the GPS disruption ongoing?

7) \* Where did the disruption occur? (LAT/LONG; Nearest City or landmark)

Lat	Long	City/Landmarks
<input type="text"/>	<input type="text"/>	<input type="text"/>

8) GPS user equipment make and model (receiver manufacturer and model, antenna type, etc...)?

Remaining Characters

9) GPS installation type (aviation, marine, surveying, agriculture, transportation, timing)?  Other:

10) What was the elevation of the GPS antenna?   Above Ground Level  Above Sea Level

11) What GPS frequency are you using? (press Ctrl while selecting to select multiple satellites)

L1 (1575.42 MHz)   
L2 (1227.6 MHz)

12) How many satellites were being tracked at the time of the disruption?

13) Which satellites were being tracked at the time of the disruption? (press Ctrl while selecting to select multiple satellites)

Don't Know   
SVN23/PRN32   
SVN24/PRN24

## Interference Report Form:

<https://www.navcen.uscg.gov/?pageName=gpsUserInput>

# IDM and the ICG

- At the inception of the ICG, the Working Group on Compatibility and Interoperability was tasked to develop a strategy supporting mechanisms to detect and mitigate sources of electromagnetic interference, taking features of GNSS signals and existing regulatory mechanisms into consideration
- An IDM Task Force was formed by the working group to undertake this work
- Under the newly structured ICG Working Group on Systems, Signals and Services, IDM efforts have been combined with Compatibility and Spectrum Protection under a Sub-group chaired by Japan and the EU
- 5 IDM workshops and 2 IDM& Spectrum seminars have been conducted to date

# Cooperation and Information Sharing Between Provider Service Centers

Name	Country	URL
Information Analysis Center	Russia	<a href="http://glonass-iac.ru/en/">http://glonass-iac.ru/en/</a>
US Coast Guard Navigation Center	U.S.	<a href="http://www.navcen.uscg.gov/">http://www.navcen.uscg.gov/</a>
William J. Hughes Technical Center WAAS Test Team	U.S.	<a href="http://www.nstb.tc.faa.gov/index.htm">http://www.nstb.tc.faa.gov/index.htm</a>
European GNSS Service Centre	EU	<a href="http://www.gsc-europa.eu/">http://www.gsc-europa.eu/</a>
iGMAS Service Center	China	<a href="http://www.csno_tarc.com">http://www.csno_tarc.com</a>
QZ-vision	Japan	<a href="http://qz-vision.jaxa.jp/USE/en/index">http://qz-vision.jaxa.jp/USE/en/index</a>
	India	
IGS portal	IGS	<a href="http://igs.org/">http://igs.org/</a>

# Significant IDM Technologies

## UK Research into GPS Jamming



Handheld Detection



JammerCam™ testing in the UK



**Chronos Technology Research Projects with Innovate UK**  
**GAARDIAN** – 2008 - Technology to detect Jamming  
**SENTINEL** – 2011 - Technology to geolocate Jamming  
**AJR** – 2013 – Technology to photograph vehicle with Jammer

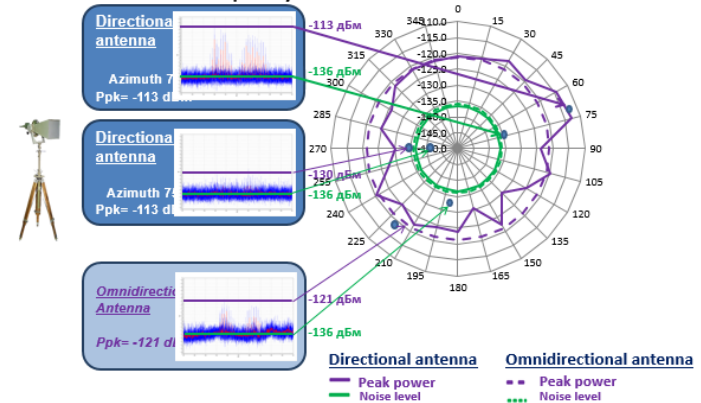
Chronos GPS jamming detection technology used in the **Harris Signal Sentry™ 1000** System for geolocation



Recommendations for estimation of electromagnetic environment and Interference environment in GNSS frequency Bands. Content suggestions

### Section 8. Total estimation of electromagnetic and interference environment

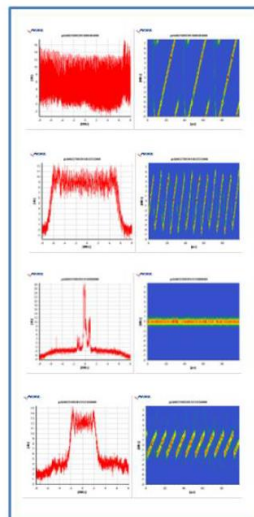
The basis of the methodological approach - the construction and analysis of special diagrams of the spatial distribution of energy emission in the GNSS frequency bands



## DETECTOR Characterisation

Characterisation and parameterisation of incoming signals

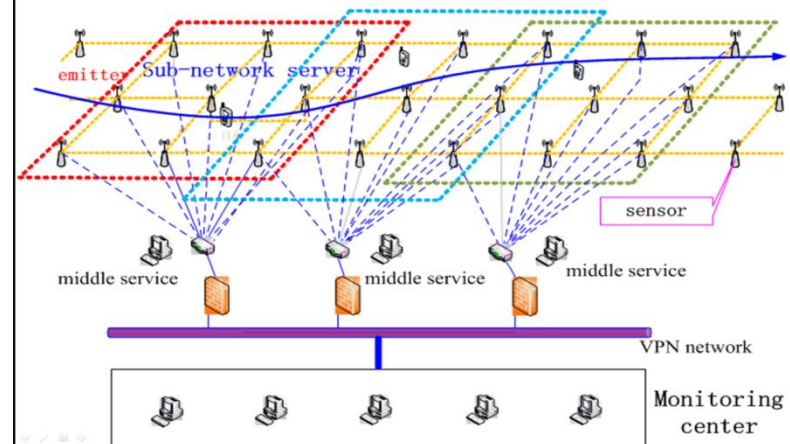
1. Determine likely **impact** on users
2. Differentiate **unintentional** interference from **jamming**
3. **Differentiate** between jammer types
4. Identify **multiple detections** of the same interference versus one-offs
5. Identify **trends** in the evolving threat
6. Develop **countermeasures**
7. **Catalogue** the threats



DETECTOR captures and characterises the threat



## Grid Radio Monitoring Network in Shanghai



# Crowd Sourcing



Every cell phone can be a GPS jamming detector.  
Requires a Public/Private Partnership.



# Your Role

- We encourage you to go back to your national regulators and find out how they are protecting GNSS from interferers.
- Do they realize the vulnerability of GNSS reception?
- Do they appreciate the economic impact of GNSS loss?
- Are they doing enough to protect GNSS spectrum from interference?



6<sup>TH</sup> IDM WORKSHOP  
BASKA, CROATIA  
09 MAY, 2017



International Committee on  
Global Navigation Satellite Systems

PRESENTATION: "RFI Source Localization using Flight Track Data"

*Gerhard Berz, Focal Point Navigation Infrastructure, EUROCONTROL*

PRESENTATION: "Adjacent Band Compatibility Assessment Testing from U.S."

*David Turner, U.S. Department of State*

PRESENTATION: "RED Discussion Status from EU" *European Commission*

PRESENTATION: "Resilient PNT through Interference Detection, Mitigation and GNSS Augmentation" *John Fischer, VP Advanced R&D, Orolia-Spectracom*

PRESENTATION: "3GPP Process and How GNSS Interests Can Be Further Integrated With Their Work" *Michel Monnerat, Navigation Domain France, Thales Alenia Space*

PRESENTATION: "Standardization of GNSS Threat Reporting and Receiver Testing (STRIKE3 Project)" *Mark Dumville, General Manager, NSL*

PRESENTATION: "Detection Techniques of GNSS Spoofing and Ionospheric Scintillation"  
*Ruimin JIN (Senior Engineer) and Weimin ZHEN (Senior Researcher)*  
*China Research Institute of Radiowave Propagation (CRIRP)*

# **GNSS RFI Source Localization using Flight Track Data**

Gerhard BERZ

Focal Point Navigation Infrastructure

ATM Directorate, Research & SESAR Division, NAV & CNS Unit

[gerhard.berz@eurocontrol.int](mailto:gerhard.berz@eurocontrol.int)

UN ICG Interference Detection and Mitigation (IDM) Workshop

Baska, Croatia, 9 May 2017

# **GNSS RFI Source Localization using Flight Track Data**

A representative from Eurocontrol reported on efforts to set up interfaces for mitigation of GNSS RFI in States, supported by sector-specific Regional Organizations (Aviation in Europe in the case of Eurocontrol). Information / process presented:

## **Detecting GNSS Outages**

From passive threat monitoring to active intervention during relevant events

- Eurocontrol is collecting GPS Outage Reports by pilots through standard aviation safety processes and is encouraging other regions / sectors to do the same

## **Determination of Probable Cause**

Elimination of Non-RFI Causes (Constellation issues, space weather, etc.)

## **Localization and Elimination of RFI Source**

Supporting the chain of detection (Operator / ANSP) to confirmation, characterization and localization (radio regulator) to elimination (law enforcement)

- Eurocontrol is actively investigating the use of aircraft ADS-B position reports to support localization of RFI sources

# Requests to UN ICG IDM Workshop

The representative had some specific requests for the workshop attendees:

- Support information exchange for aviation with GNSS system operators
  - For both threat monitoring and significant event mitigation
  - Help to identify non-RFI causes (space weather, receiver issues if aware)
- Forward aviation relevant reports to relevant entities (States, Regional Organizations)
  - Eurocontrol has active projects and services to support European States, in line with guidance from ICAO (GNSS Manual)
  - Eurocontrol encourages other regions to set up similar processes

It is recommended that ICG members determine the entities involved and process used to forward reports of Aviation RFI within their countries and discuss findings at the next WG-S Compatibility Subgroup meeting.



# 3GPP Process and How GNSS Interests Can Be Further Integrated With Their Work

Michel Monnerat

**ThalesAlenia**  
*a Thales / Leonardo company* **Space**

# 3GPP Process and GNSS Interests

- September 2018 is a key milestone in the process of establishing 5G standards
- The four step process is:
  1. Discussion Paper
  2. Study Item – with the endorsement of 4 companies/members
  3. Technical Report
  4. Work Item – to modify specifications



# DRAFT RECOMMENDATION

- All System Providers have governmental and/or industrial members of the 3rd Generation Partnership Project (3GPP) that participate through one or more of the 7 telecom standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC)
- Therefore, System Provider delegations to the ICG [in a step-by-step manner should]:
  1. Seek the views of their 3GPP members on the establishment of specifications for device-based GNSS interference detection - immediately following ICG-12
  2. Use the Providers Forum to reach consensus on whether or not to formally endorse a device-based detection standard through a communication to the 3GPP Technical Specifications Group (TSG) – February or June 2018
  3. Consider how data from device-based detection will be integrated into [national/governmental] mitigation efforts –



# Resilient PNT through Interference Detection, Mitigation and GNSS Augmentation

***John Fischer***  
***VP Advanced R&D***

The Global Leader in Resilient PNT

Providing the world's most critical applications real-time, accurate,  
reliable positioning, navigation, and timing data.

Safety, Security and Reliability



# Resilient PNT through Interference Detection, Mitigation and GNSS Augmentation

- *Orolia-Spectracom*, having significant expertise in the equipment, provided briefing on their IDM capability which weighs different nav messages with a score to detect interference and attenuates satellites at the horizon where most interference will come from. Their recommendation to providers is to augment GNSS timing with Iridium STL for backup being 30 dB stronger than GPS and encrypted. Additionally, Orolia supports the idea that every GPS receiver can report loss of GPS through Crowdsourcing.

# STRIKE3

What we now know about GNSS jammers

Mark Dumville

General Manager, NSL

11<sup>th</sup> Annual Baška GNSS Conference

7-9 May, Krk Island, Croatia

# Strike3

Strike3 Detector project funded by EU focused on standardization of threat reporting with a “minimum level of data.” Goal is to test receivers against what jammers are currently being distributed and final product to be offered to “super users” like governments, and equipment manufacturers. IDM Task force members should find out from IDM authorities what extra data values would be desired. Two draft documents available [www.gnss-strike3.eu](http://www.gnss-strike3.eu) Giving all due credit to the EU commission for initiating this project, WG-S members are encouraged to download and read these documents.

# Detection Techniques of GNSS Spoofing and Ionospheric Scintillation

Ruimin Jin *China Research Institute of Radiowave Propagation(CRIRP)*

Weimin Zhen *China Research Institute of Radiowave Propagation(CRIRP)*

# Detection Techniques of GNSS Spoofing and Ionospheric Scintillation

- Representatives from the China Research Institute of Radiowave Propagation(CRIRP) provided some details on their studies into spoofing and ionospheric scintillation and their affect on GNSS positioning and timing, both posing a serious threat to GNSS applications for critical infrastructures.
- Their study showed that an advantage of residual signal detection is that both spoofing signal and true signal can be detected from the received signal of receivers.
- Their study also showed that, through establishment of ionospheric irregularity modeling and signal propagation modeling, the parameters of ionospheric irregularities can be obtained based on measured data and used to provide better protection for GNSS applications.

# Detection Techniques of GNSS Spoofing and Ionospheric Scintillation

There was some question in the workshop whether ICG should treat space weather the same as IDM. WG-B is working in space weather and recommendation is to invite China to present this material to that group. However, the presenters question whether WG-B has a different focus on Space Weather (study of space weather using GNSS vs study of space weather to identify interference). Also, it is recommended that WG-S follow the progress of China's work on anti spoofing and ionospheric modeling and report the results to the ICG Provider's Forum.



# **EU Radio Equipment Directive (RED)**

Gerhard BERZ, Eurocontrol DATM  
Focal Point Navigation Infrastructure

Baska, 9 May 2017

# EU Radio Equipment Directive (RED)

- Given the abbreviated nature of the RED briefing in Baska, Co-Chairs will invite the EU to bring a more detailed briefing of the Radio Equipment Directive to the next meeting of WG-S in Paris 05-07 July, 2017



International Committee on  
Global Navigation Satellite Systems

# RECOMMENDATION

**Estimation of electromagnetic environment  
and interference environment in the point  
of territory of measurements in GNSS  
frequency bands**

*Development Result*

**Dr. Stanislav Kizima**

**ITU-expert, Deputy CEO R&D Centre for systems and  
tools of measurement “Vector”**

# Estimation of electromagnetic environment

- Co-Chairs will distribute Dr. Kizima's project paper and the IDM Task Force has resolved to review the paper and offer comments and suggestions by the end of September. This will allow for update and presentation of the project's revision to the ICG in Kyoto.

Both of these full presentations and all the presentations conducted at the IDM Workshop will be available at the ICG website.

Rick Hamilton: [Rick.Hamilton@uscg.mil](mailto:Rick.Hamilton@uscg.mil)

ZHEN Weimin: [crip\\_zwm@163.com](mailto:crip_zwm@163.com)