The 10th meeting of ICG

Review of GNSS IDM Technology

ZHEN Weimin[1], Shen Jiemin[2]
1.China Research Institute of Radiowave Propagation
2.Beijing Satellite Navigation Center
02.Nov. 2015, Boulder, U.S.

As is known to all, GNSS is vulnerable to interference and this has been confirmed in many areas all over the world. Since the application of GNSS has become wider and wider, it is necessary for us to know about GNSS interference!

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1. *Review of the GNSS interference in ICG*

2. *Introduction to the detection/localization techniques of RFI in ICG*

3. *Discussion on crowd sourcing method in ICG*

4. *Recommendation of next IDM workshop and suggested topics*

1. Review of the GNSS interference in ICG

➢ **Classification of GNSS interference**

➢ **Threshold of Unintentional Interference**

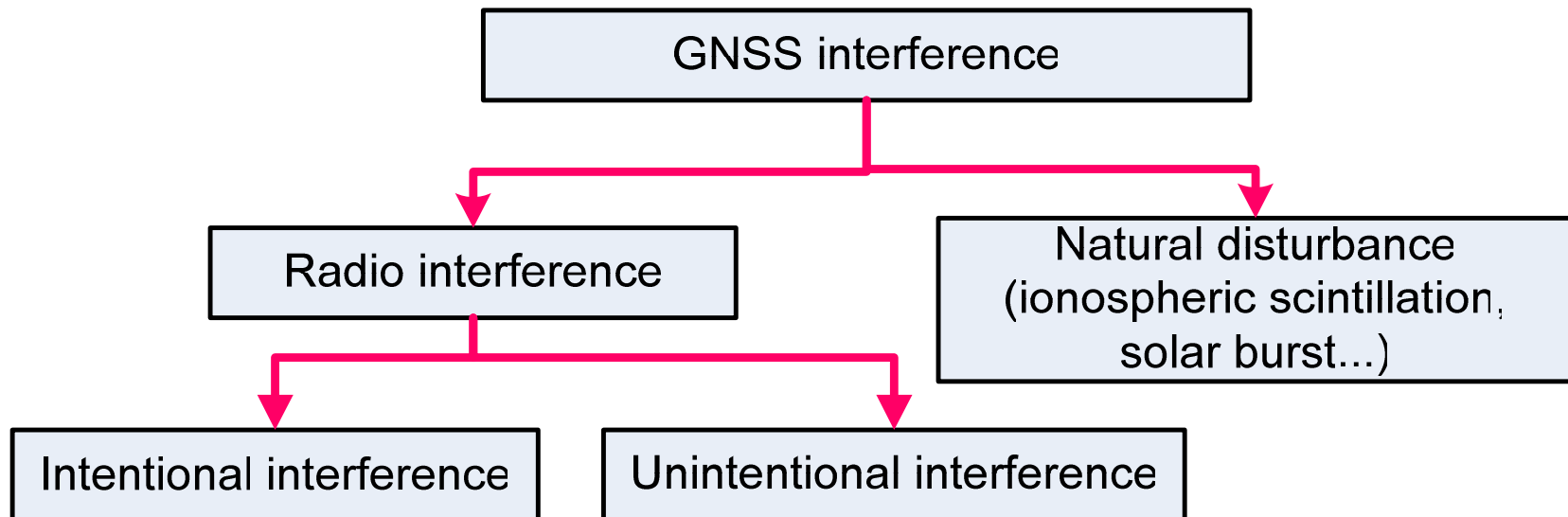➢ **Spatial distribution of emission in the frequency bands of GNSS**

a) Classification of GNSS interference

GNSS Interference---- classified in ICG-7

- **Radio interference (Interference from radio systems)**
  - *Intentional interference*
  - *Unintentional interference*
- **Natural Disturbance (mainly ionospheric scintillation and solar burst)**
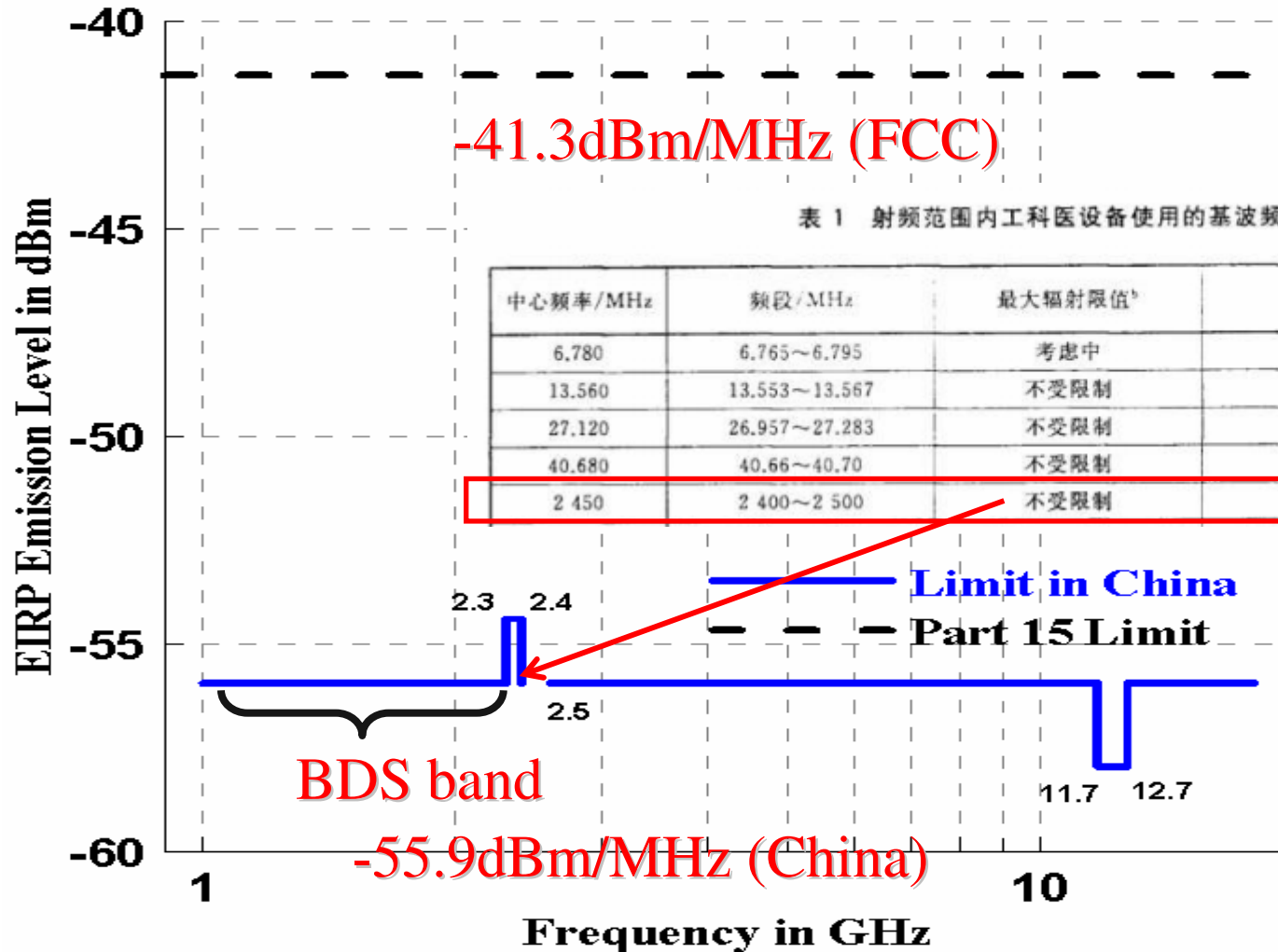
b) Threshold of Unintentional Interference

➢Unintentional emission limits in RNSS bands in different countries have been discussed in IDM workshop and Task Force meeting.

➢Unintentional interference is generally emitted by those devices of bad design, aging or experimental tests.

Country	E.I.R.P.
U.S	-41.25dBm/MHz
Japan	-58~-55dBm/MHz
China	-56~-54dBm/MHz
IEC CISPR Publication 11	-58~-55dBm/MHz

b) Threshold of Unintentional Interference

-41.3dBm/MHz (FCC)

表 1 射频范围内工科医设备使用的基波频率*

中心频率/MHz	频段/MHz	最大辐射限值ᵇ	对ITU无线电规则的指配 频率表作出的脚注编号
6.780	6.765~6.795	考虑中	5.138
13.560	13.553~13.567	不受限制	5.150
27.120	26.957~27.283	不受限制	5.150
40.680	40.66~40.70	不受限制	5.150
2 450	2 400~2 500	不受限制	5.150

Limit in China

Part 15 Limit

BDS band

-55.9dBm/MHz (China)

Emission limits of ISM equipment in each band

b) Threshold of Unintentional Interference

*Results :*

➢ *FCC Part 15 limits are less stringent than IEC CISPR Publication 11 limits.*

➢ *Attendees reached consensus that a strict regulatory threshold is suggested in case of unintentional interference to GNSS.*

c) Spatial distribution of emission in the frequency bands of GNSS

- *Spatial distribution of emissions in the frequency bands of GNSS are measured and analyzed by Russian experts.*

- *Results can be used for research of interference to GNSS.*
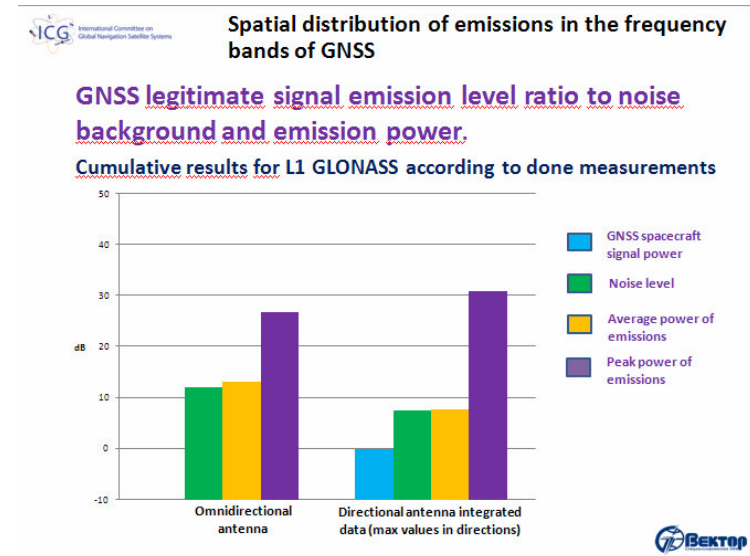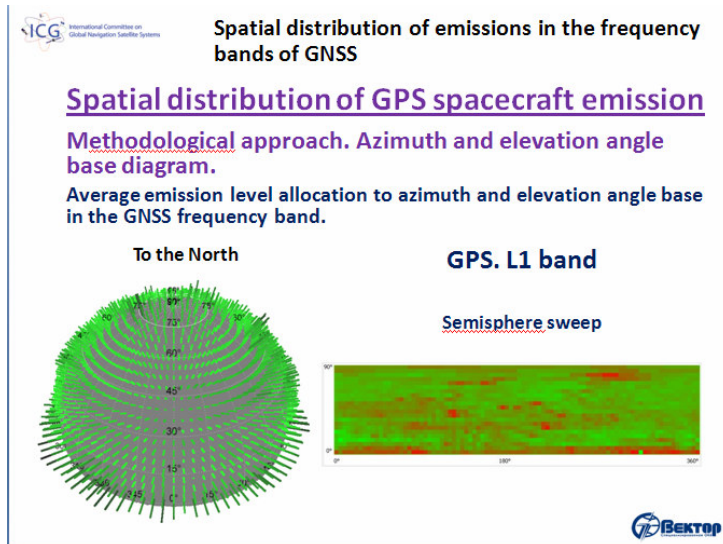
2. Introduction to the detection/ localization techniques of RFI

In this part, we will review the IDM techniques as well as IDM systems examples discussed in previous ICG meetings and workshops.

1) RFI Detection Techniques

2) RFI Localization Techniques

3) Systems examples

1) RFI Detection Techniques

a) High sensitivity Spectrum detection

If the power of interference is large enough, spectrum detection technique will be useful.
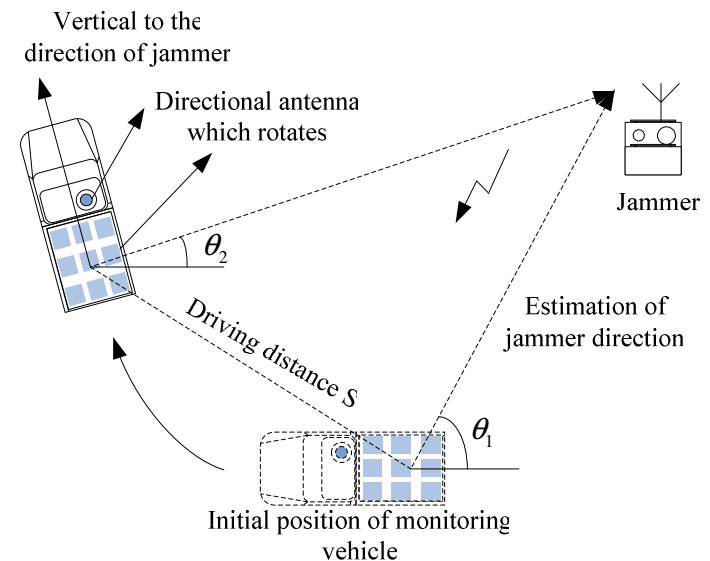
b) RFI detection from GNSS signal

This technique is based on the analysis of GNSS signal

➢ Weak RFI signal detection.

➢ monitor not only RFI signal but also ionospheric scintillation.
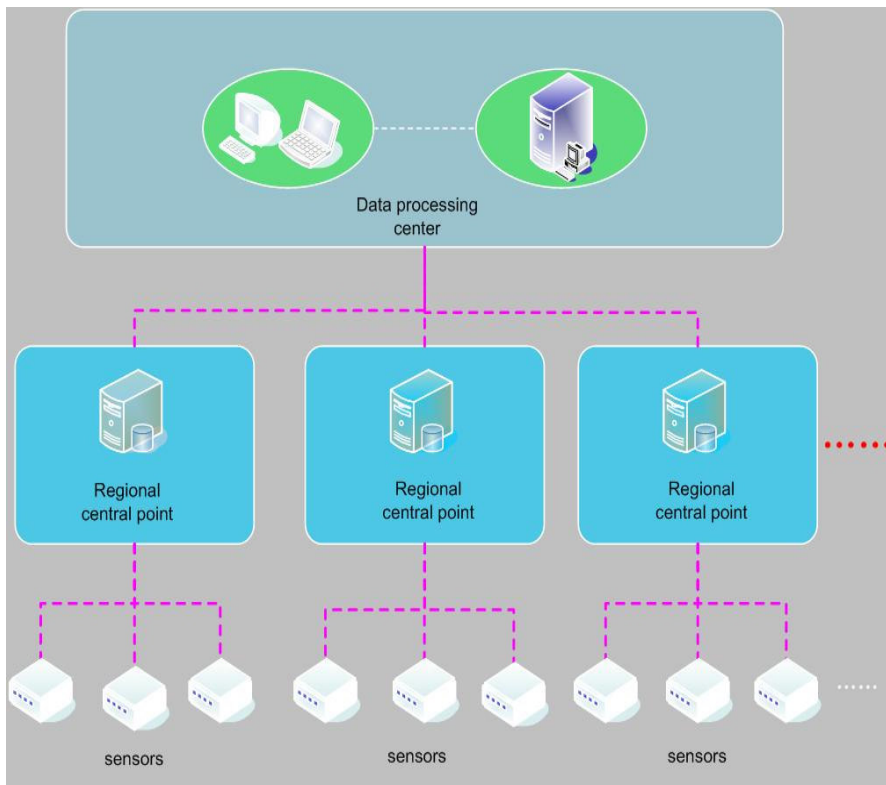
2) RFI Localization Techniques

a) Cross localization based on interference direction finding

Based on interference direction finding with single station, cross localization can be implemented with multiple stations(fixed-fixed stations, fixed-moveable stations and moveable-moveable stations).

Vertical to the direction of jammer

Directional antenna which rotates

θ_2

Jammer

Estimation of jammer direction

Driving distance S

θ_1

Initial position of monitoring vehicle

2) RFI Localization Techniques

b) Grid Localization based on spectrum sensors

Antenna

Sensor

Wide area coverage and continuous monitor

3) System examples

a) Signal sentry 1000----U.S

In the 4th IDM workshop, a real time interference detection system has been introduced.

- Function:
  --Detects and locates sources of GPS
      signal interference
  --Provides location of interference
- Application in:
  --Shipping Ports
  --Law Enforcement
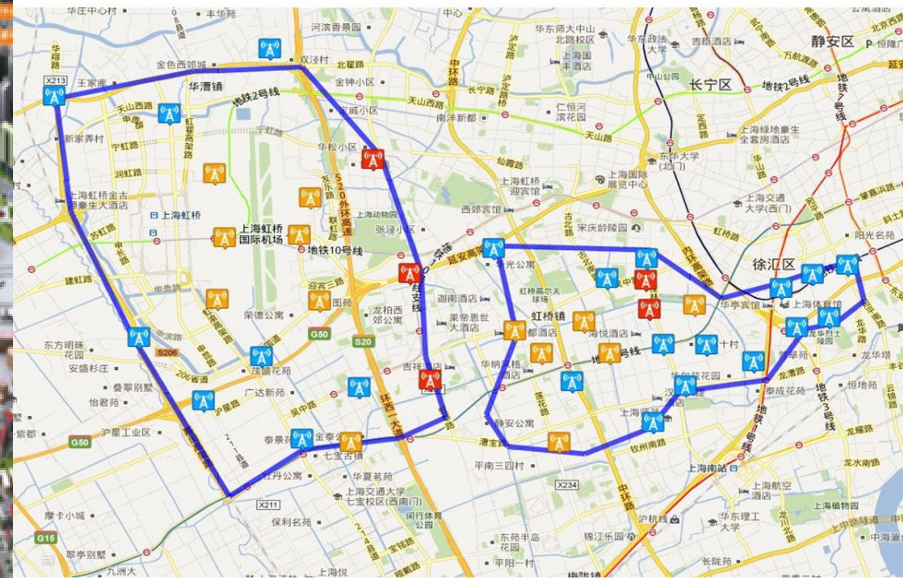 --Airports
  --Security

3) System examples

b) Grid RFI monitoring system ----China

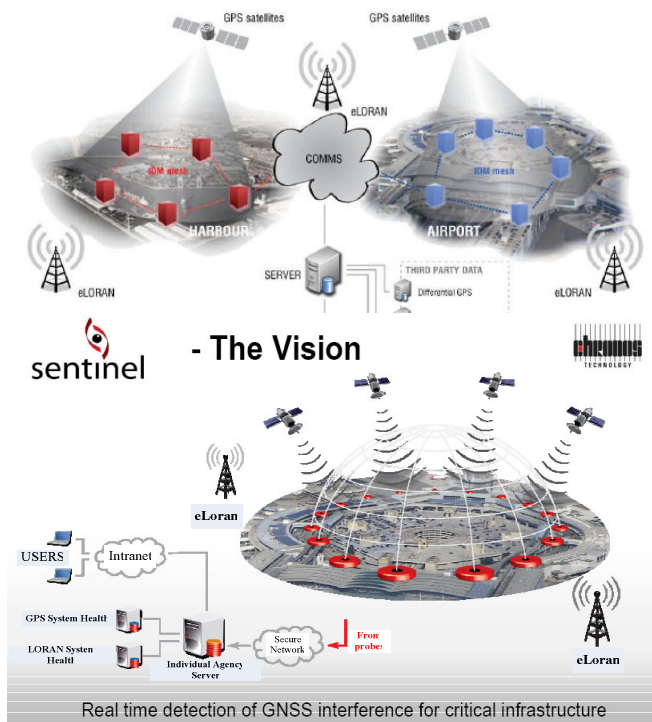**Grid Radio Monitoring Network in Shanghai**

◆Network deployment—sensors

ICG-9   *3rd IDM workshop*
The grid of monitoring system for Qingdao Olympic center and Shanghai
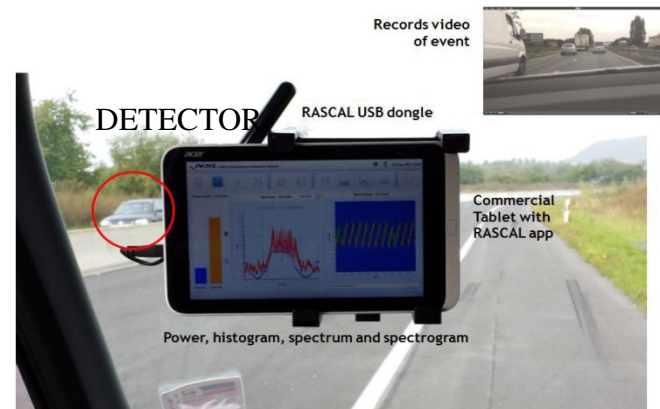
3) System examples

c) GAARDIAN and SENTINEL system----E.U.

➢Monitoring GNSS frequency;

➢Real time detection of GNSS interference for critical infrastructure;

➢Assured PNT, accuracy, availability, Integrity and continuity.

The E.U. has also developed some GNSS interference detection systems such as DETECTOR for highway in the 3rd IDM workshop.
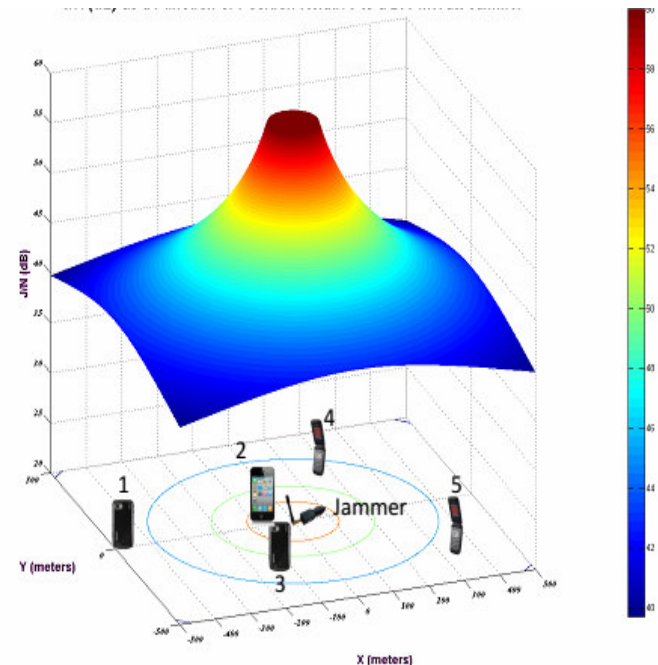
3. Discussion on cell phone crowdsourcing and cell tower RFI localization method

1) **Cell-Phone Crowdsourcing Method**
2) **Cell-Tower RFI localization Method**

1) Cell-Phone Crowdsourcing Method

In the 3rd IDM workshop, American expert made an presentation of

<Interference Detection by Crowd Sourcing> which may provide best

performance at lowest cost in interference localization.

- **The aggregate of phones, each reports J/N and its own position, provides a basis for locating the jammer.**

- **The data center can located RFI according to info from cell phones.**

1) Cell-Phone Crowdsourcing Method

- ## Advantages:
  - ◆ *Wide area coverage*
  - ◆ *Weak interference signal detection with large number of cell-phones*

- ## Disadvantages:
  - ▫ **Location Information Uploading**
    - ◆ *Threat to cell-phone users' privacy*
    - ◆ *Who will pay for the cell-phone users' data uploading cost?*
 - ▫ **Challenge to data capacity and data process**
  - ▫ **Standards and Patents**
    - ◆ *Technical standards need coordination with industry such as mobile phone producers and chip providers.*
    - ◆ *Detailed investigations on government & market.*

# 2) Cell-Tower RFI localization method(*The 4th IDM workshop*)

We suggested that it might be better to begin with cell-towers RFI localization method. This method:

➢ *Not only provide RFI information to wide area coverage GNSS users*

➢ *But also provide RFI information to mobile communication GNSS Timing service in cell-tower;*
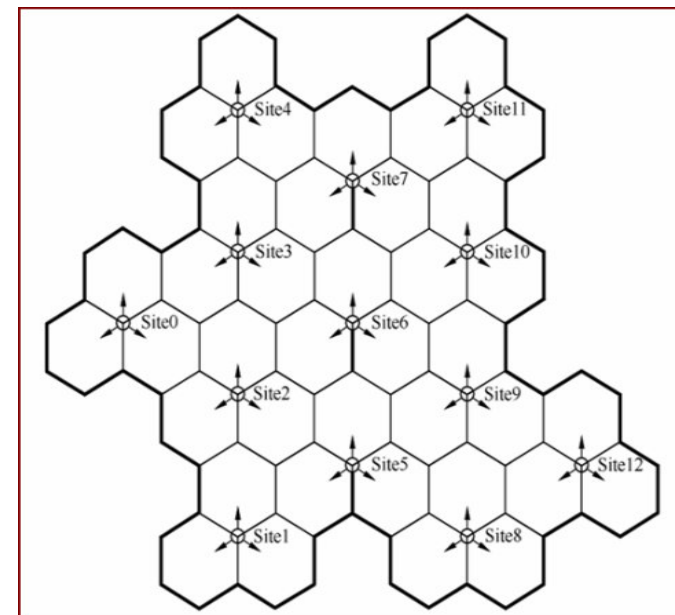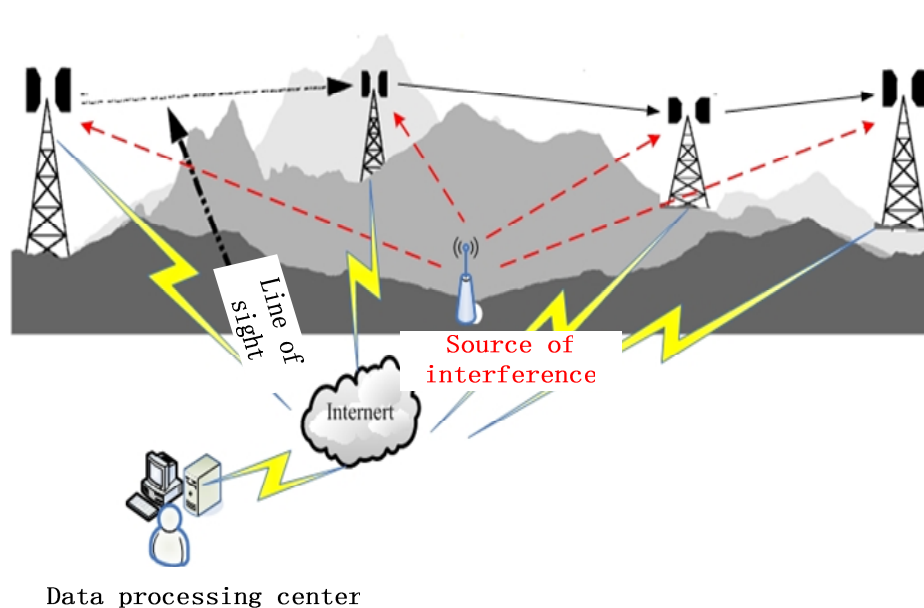
Monitoring network topology based on cell-towers

b. Cell-Tower RFI localization method

中国移动中心

省中心

地市中心

基站
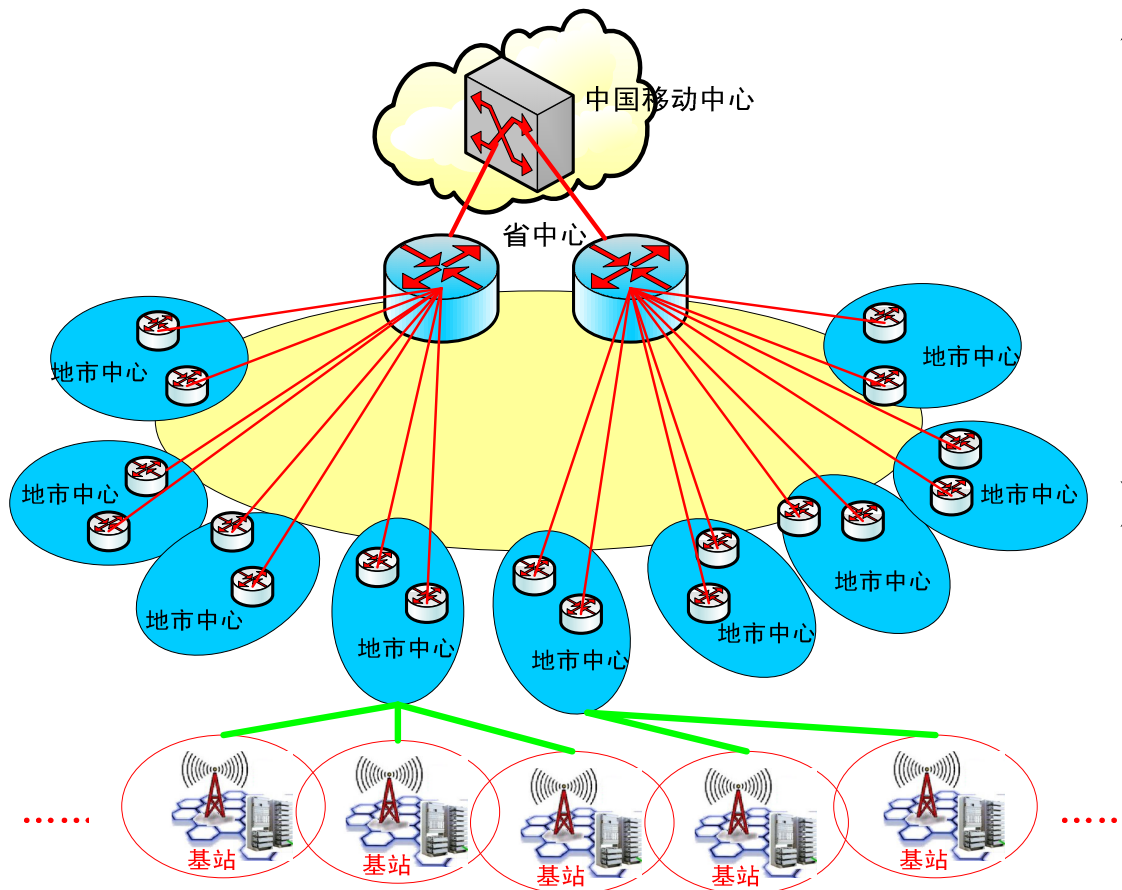
➢ *Existing communication network and cell-tower resources can be utilized by this method to detect RFI.*

➢ *Avoid majority of disadvantages of cell-phone crowdsourcing method.*

This method meets the need of wide-area monitoring network. It is easy to implement.

4. Recommendation of next IDM workshop and suggested topics

Next Proposed Workshop – May 2016

- **China expressed interest in hosting the 5th IDM Workshop during the 4th IDM workshop in Vienna Austria in June 2015.**

    - *It is recommended that the 5th IDM workshop to be held in conjunction with the 2016 China Satellite Navigation Conference (CSNC) during 18-20 May in Changsha.*
    - *Ideas and topics for discussion are welcomed.*

Suggested topics

- *Update from current Providers' IDM status*

- *Information on UN Experts Workshop*

- *Interference Detection and Geo-Location techniques*

- *Cell-Phone Crowdsourcing Method*

- *Cell-Tower RFI localization Method*
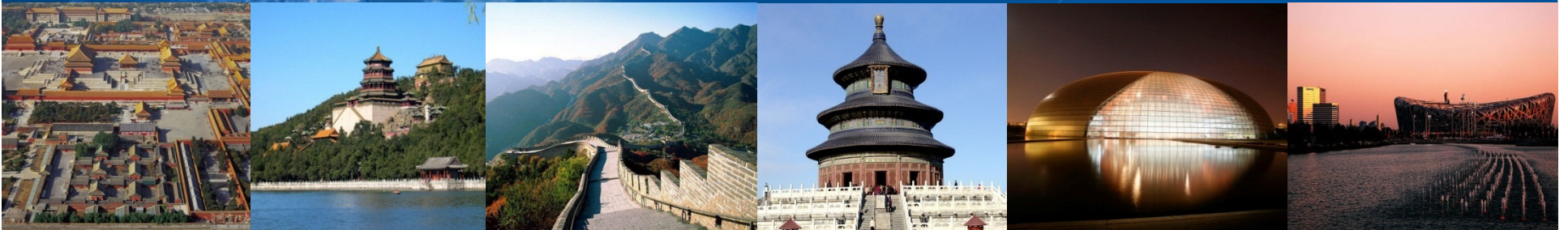
- *Spoofing detection*

Thank you!

beidouint@beidou.gov.cn

www.beidou.gov.cn

www.compass.gov.cn