GNSS interference detection for aviation in China

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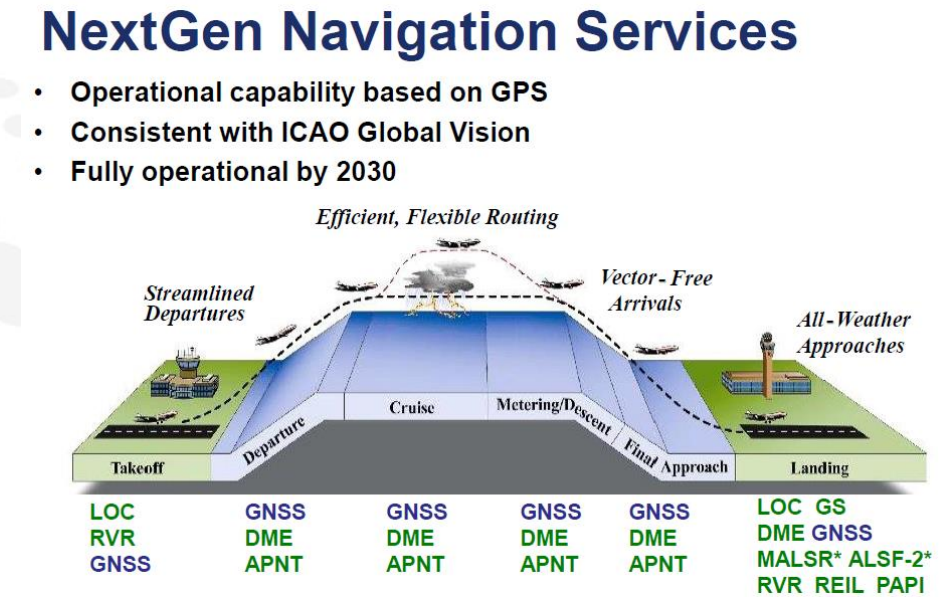
Application of GNSS in aviation

- **Satellite navigation in civil aviation (mainly used in navigation and timing): important .**
- **GNSS can meet accuracy requirements of aviation.**



(from FAA)

Accuracy requirements of aviation

	Accuracy	
	Horizontal (95%)	Vertical (95%)
Airway (ocean)	3.7km	N/A
Airway (land)	3.7km	N/A
Terminal	0.74km	N/A
NPA	220m	N/A
APV I	16m	20m
APV II	16m	8m
CAT I	16m	6~4m
Aviation timing	Us level	

GNSS interference affects safety of aviation

- **GNSS signal is weak (-160dBW on the ground), and vulnerable to interference.**
- **Safety of aviation will be seriously affected when GNSS was interfered.**

Typical GNSS interference cases in airports

- **Many GNSS interference cases in airport have been reported.**

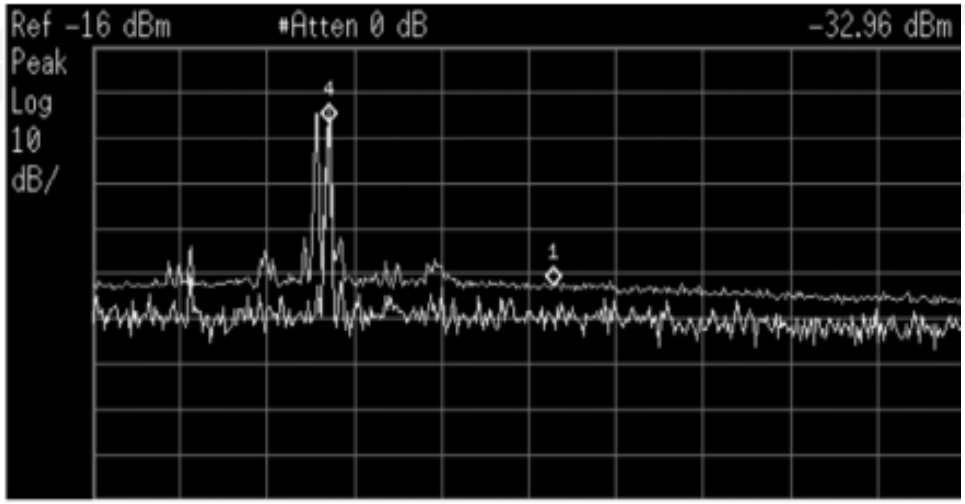
Time	Location	Description	RFI source	RFI source belongs to
1997	Lucano airport, Switzerland	GPS L1, L2 were interfered at civil/military airport	Permanent transmitter	Italian military
2002	Frankfurt airport Germany	Received signal at L1 band was interfered around the airport with coverage of 150km	unclear	Unclear
2009~2011	Newark, USA	GBAS system anomaly often	GPS private jammer	personal

Interference cases in China airports

Example1: GPS interference in Foshan airport

- **In Sep. 2009, During the flight inspection, GPS receiver was found to be interfered.**
- **Result: positioning unavailable.**
- **RFI source: Yagi directional antenna on top of a building of community policeman team (with direction to the airfield runaway).**

Spectrum of interference signal

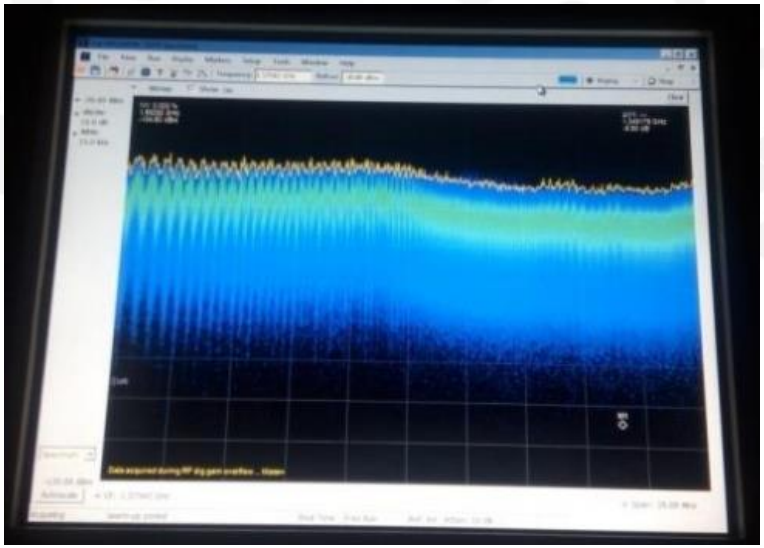


Transmitter

Interference cases in China airports

Example 2: GPS interference in Chengdu Shuangliu airport

- **In Nov. 8th, 2015, during the flight inspection of the west runway of Chengdu Shuangliu airport.**
- **The flight inspection crew reported that there was GPS signal interference near the runway, causing the onboard flight inspection system failure.**
- **RFI Source: illegal transmitter installed in a automobile repair plant.**



Spectrum of interference signal

Transmitter

Interference cases in China airports

Example3: GPS interference in Shijiazhuang airport

- **During 14-19 Oct. 2015, in Shijiazhuang airport. GPS navigation signal was not available, the flight inspection can not be finished.**
- **Result: can not positioning in the northwest runway, may cause potential safety risk during aircraft take-off and landing phase.**
- **RFI source: illegal used transmitter in a village, can shield 2G, 3G, 4G and GPS signals**

Transmitter

- **At present, still no special-purpose device and system for GNSS interference detection in aviation. General spectrum detection device from Radio management administration is used.**
- **The general spectrum detection device is not enough for GNSS interference detection in aviation.**
  - **Can not detect weak GNSS interference signal**
  - **Can not detect spoofing.**
- **special-purpose device and system is necessary.**

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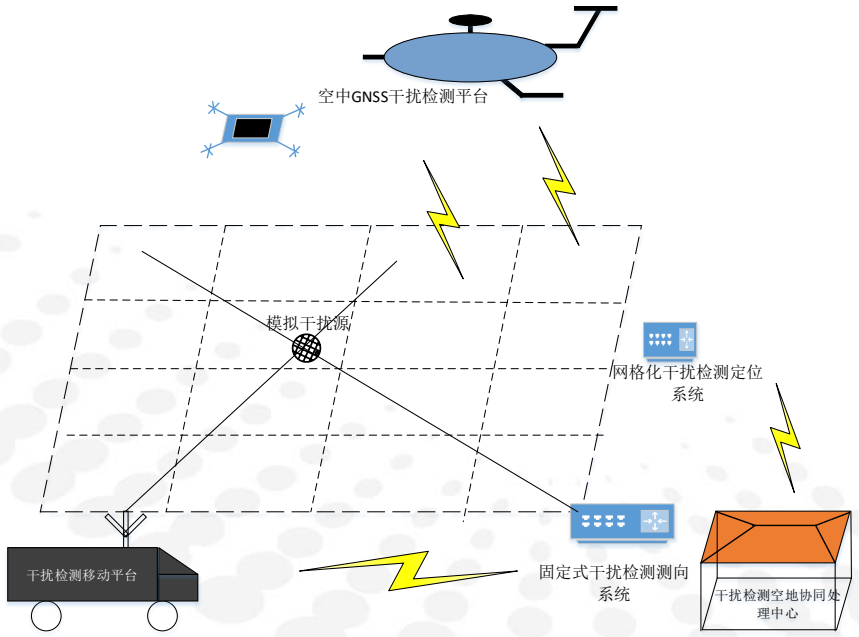
In view of the serious GNSS interference problem in civil aviation, special-purpose device and system have been developed in China.

- **Development of device for GNSS interference detection**
- **Development of demonstration system for GNSS interference detection**
- **……**

Demonstration system in Dongying Shengli airport

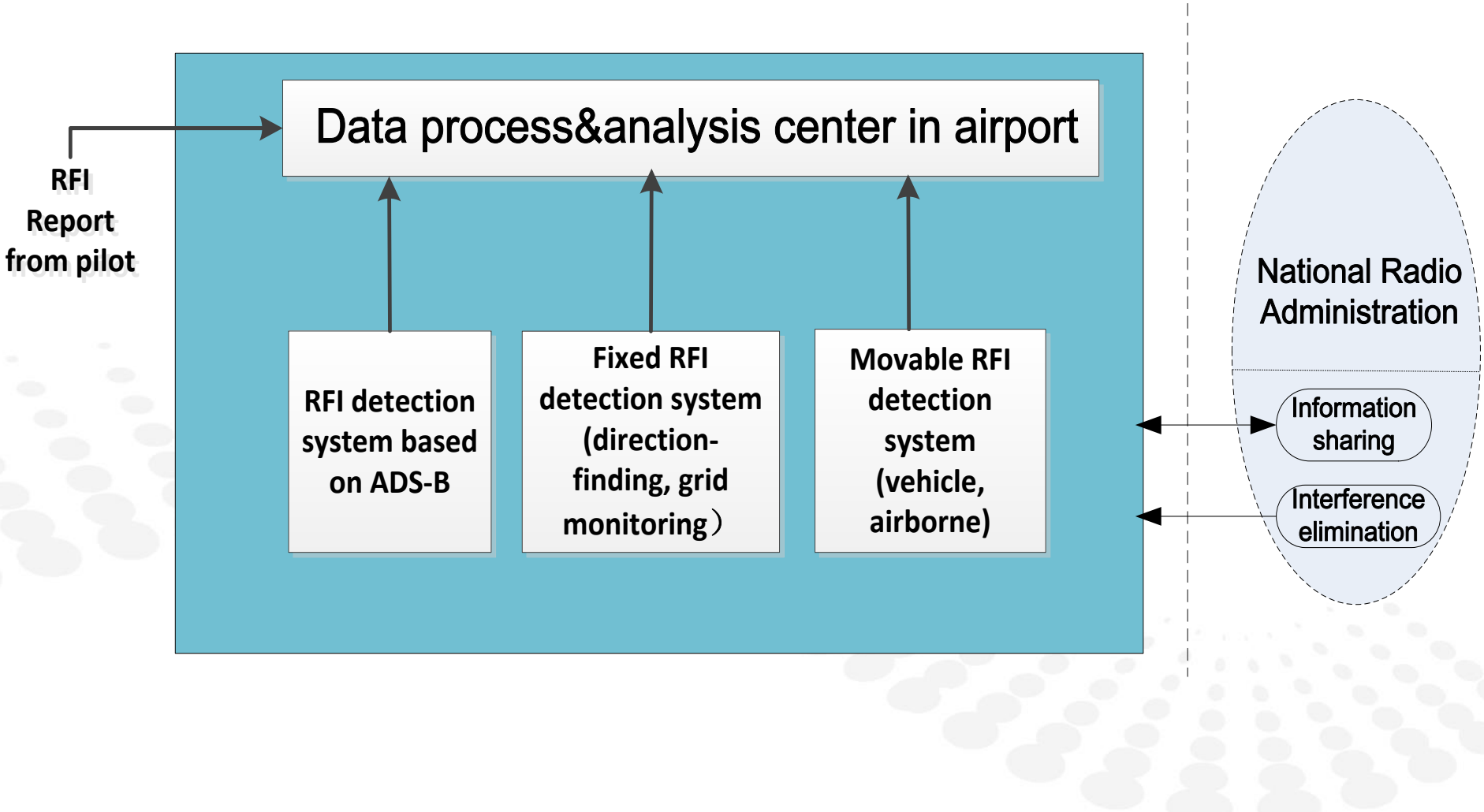
A project on demonstration system of GNSS interference detection in *Dongying Shengli* airport has been initiated.

Airborne view of Dongying Shengli airport



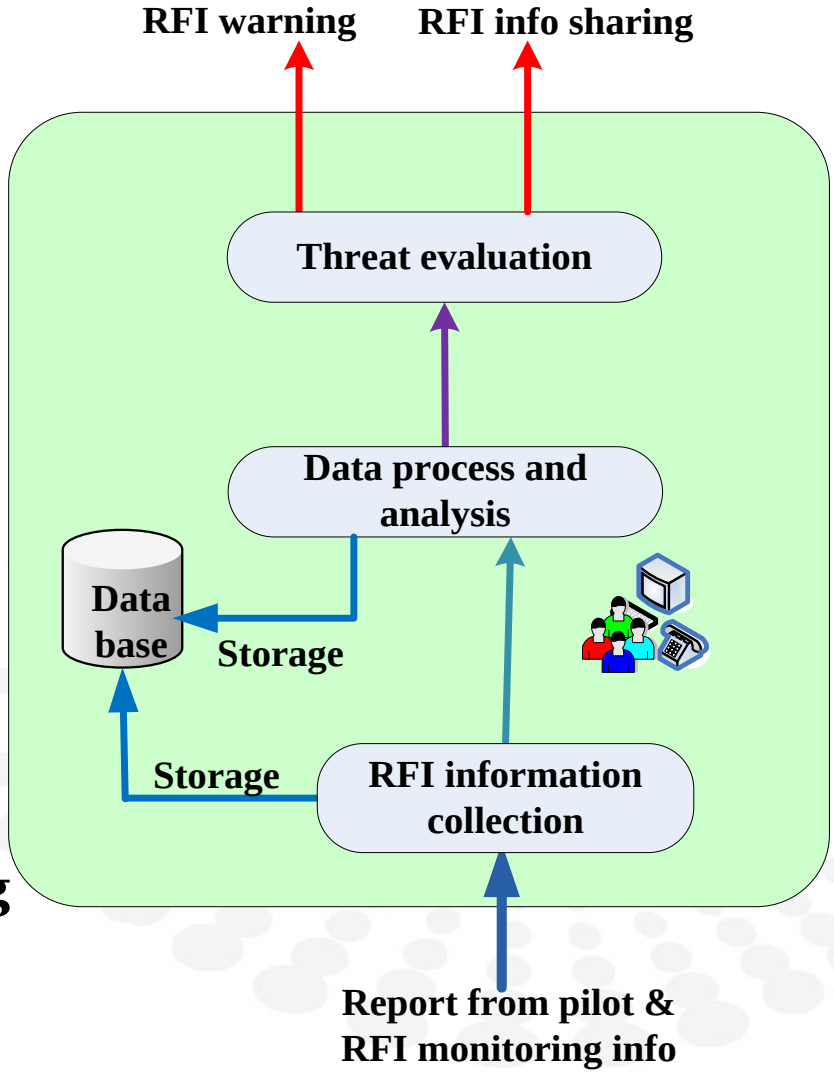
Demonstration system

Scheme of GNSS interference detection system for airport



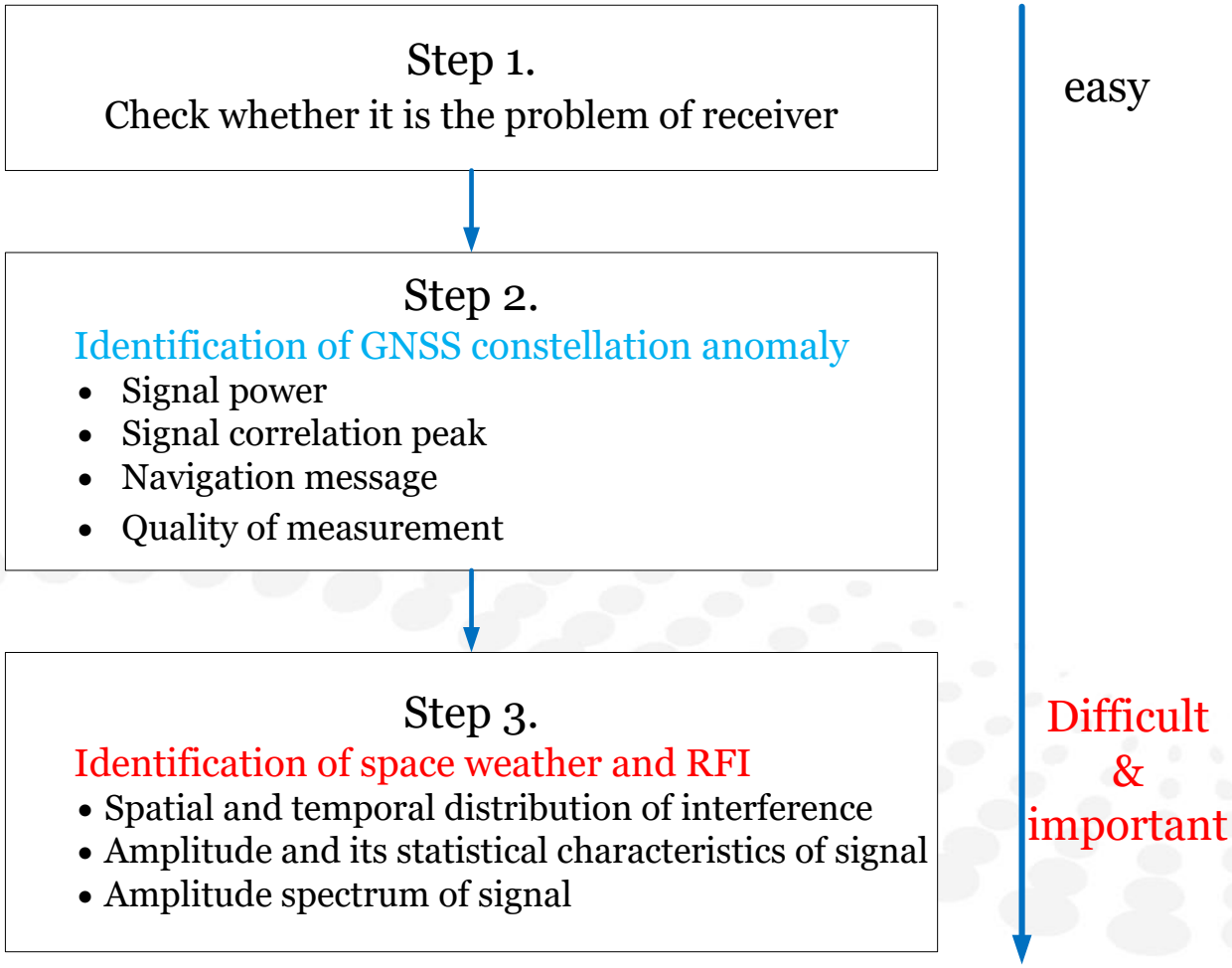
Function of data process & analysis center

- **Collection of RFI information (from pilot report and RFI monitoring info)**
- **Data process and analysis (including interference identification)**
- **Information storage**
- **Threat evaluation**
- **Warning and information sharing**



Interference identification

First, receiver problem, constellation anomaly and space weather should be excluded



Workflow of GNSS interference identification

RFI identification

Then, RFI can be identified in detail.

Type of interference:

- **continuous wave interference,**
- **frequency modulated interference,**
- **white nose interference,**
- **deceptive interference etc.**

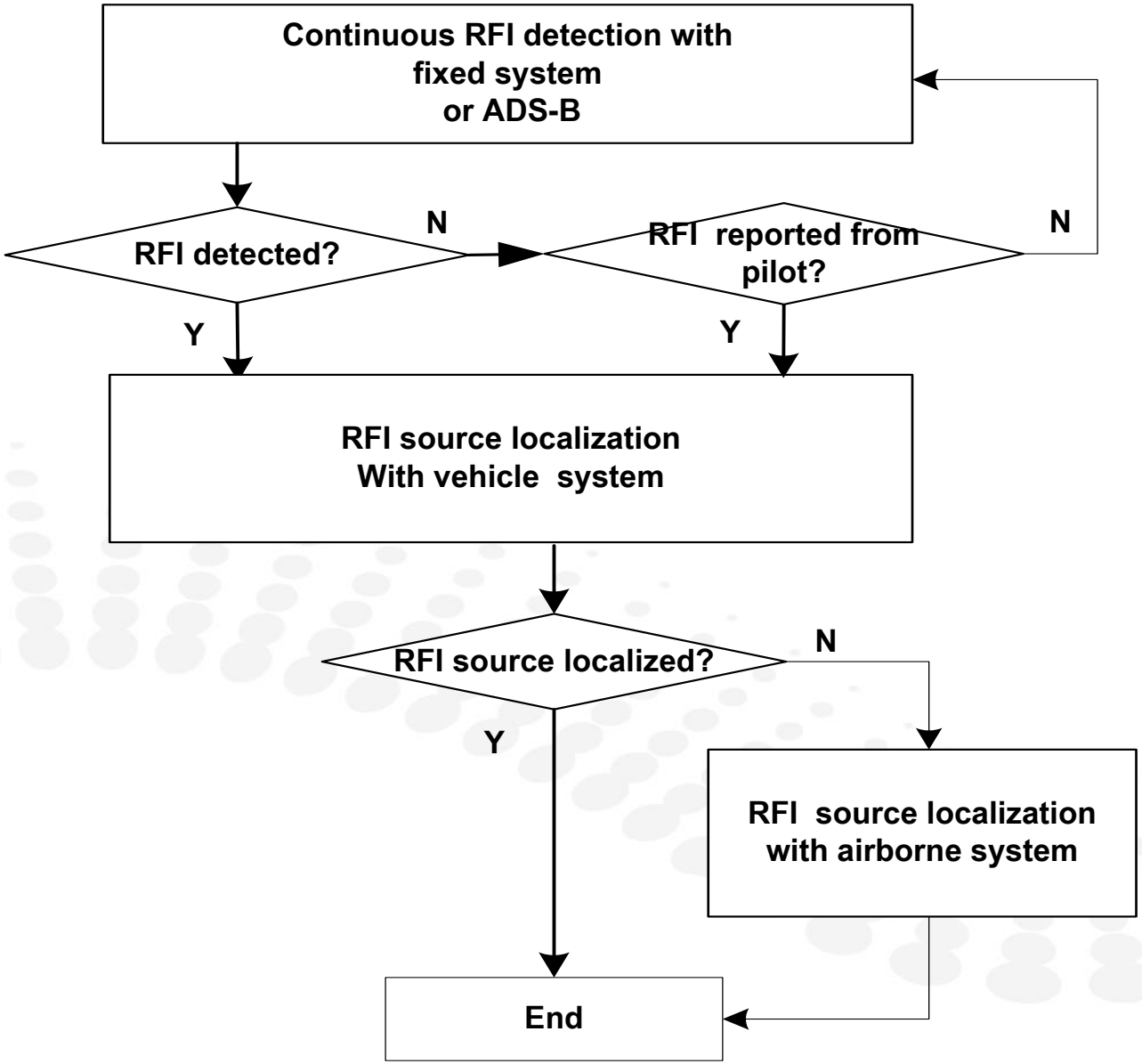
Parameters for interference evaluation:

- **effective carrier noise ratio,**
- **acquiring performance,**
- **tracking performance,**
- **timing performance etc.**

Results:

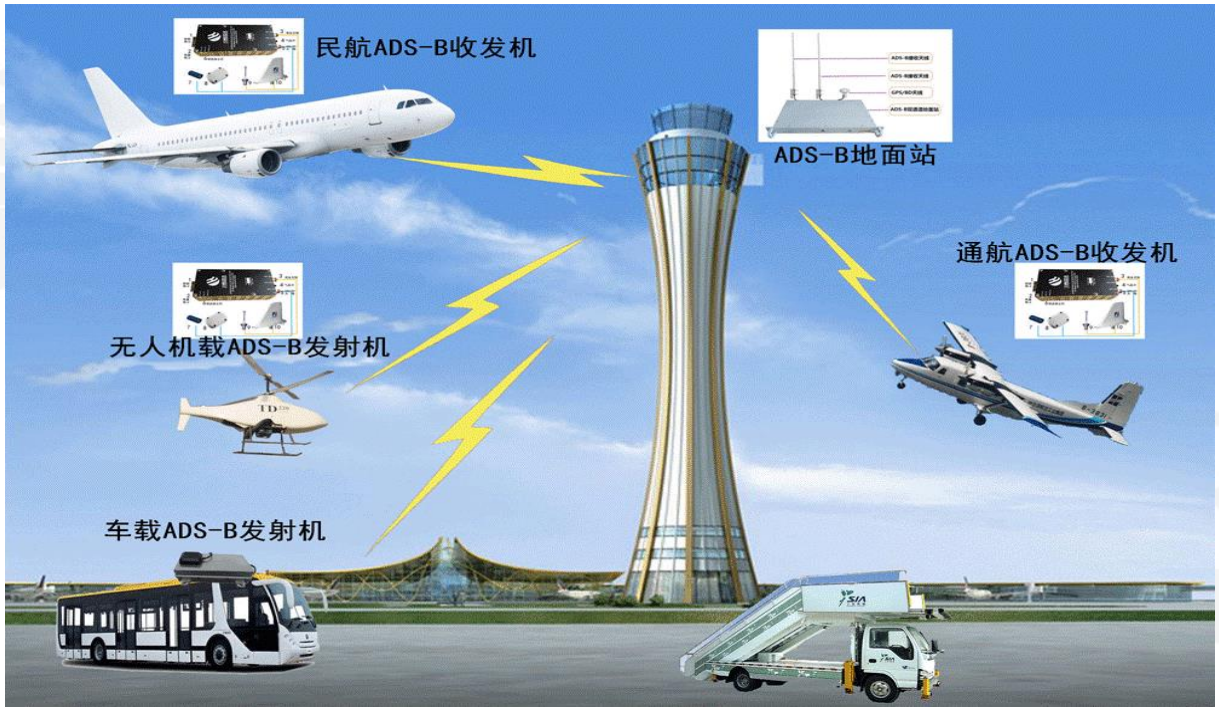
- **decrease of carrier and noise ratio of visible satellites,**
- **wrong acquiring of receiver,**
- **decrease of number of acquired satellite,**
- **increase of searching and acquiring time,**
- **distortion of code correlator and carrier phase tracker,**
- **result from discriminator tracking loop,**
- **decrease of timing performance.**

Working flow of GNSS interference detection system



RFI detection system based on ADS-B

- **ADS-B in aircraft or vehicle can broadcast its own No. location and velocity, and receive info from ADS-B in other aircraft or vehicle.**
- **Approximate position of interference source can be derived from interrupted latitude, longitude, height and time info of ADS-B.**



Fixed interference detection system

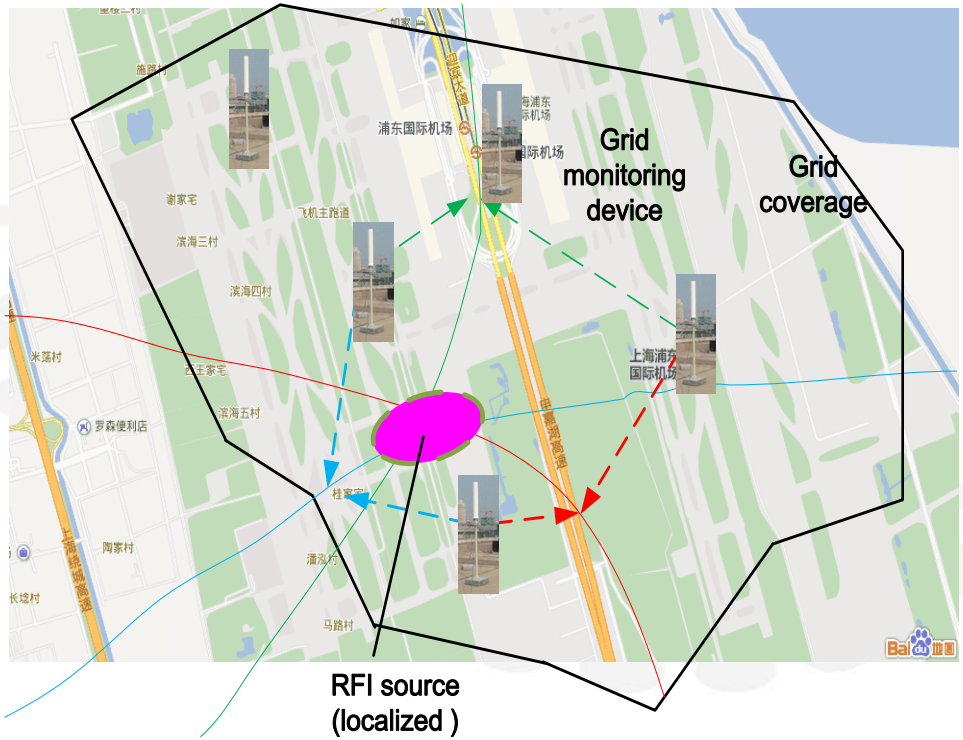
1）Ground RFI DF(direction finding) system

DF system can be used to detect interference and find direction of RFI source.

2）Ground RFI grid detection system

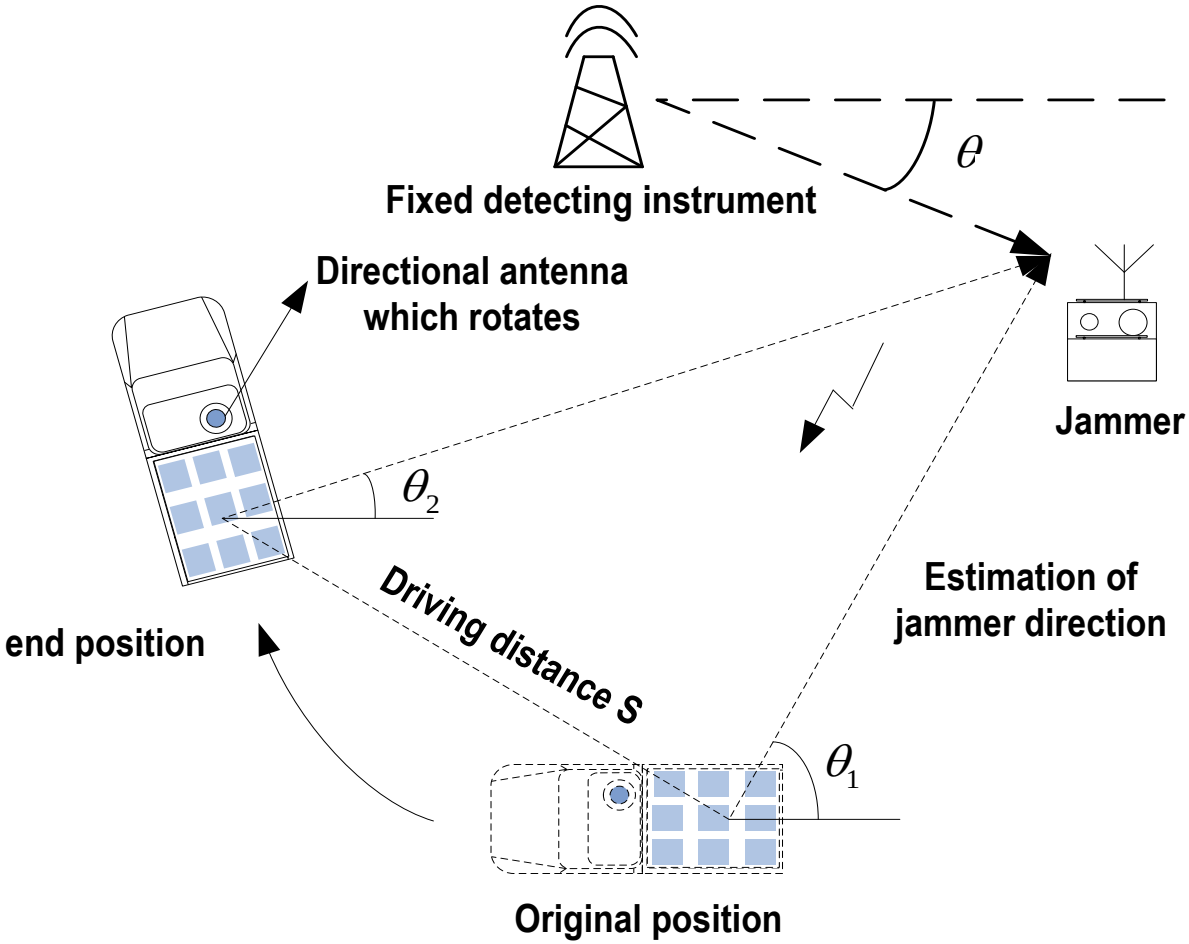
Grid system can be used to detect interference and localize RFI source by TDOA method.

- Detect weak GNSS interference signal
- Detect spoofing.



Vehicle-system

Cross localization can be used with vehicle-system to accurately localize RFI source.

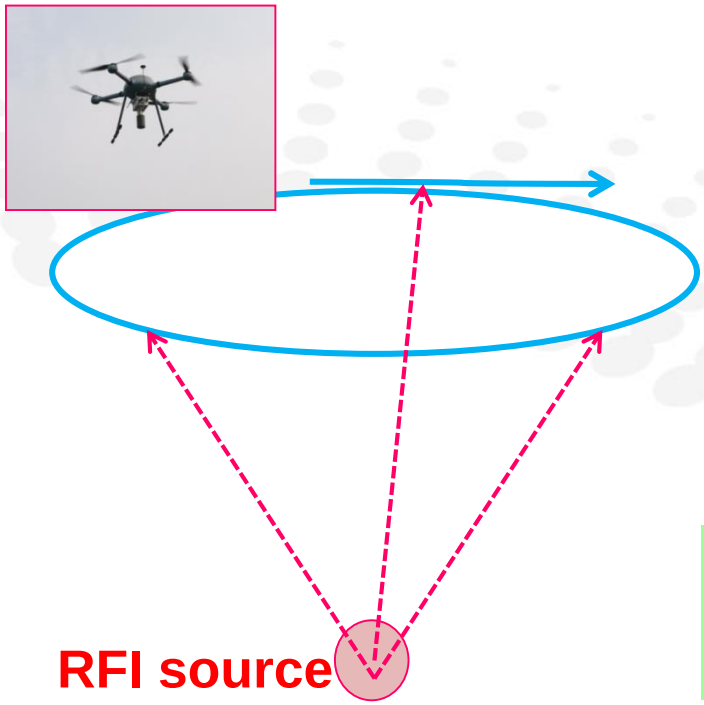


Airborne-system

- **When interference can not be detected with ground system, airborne-system will be used for detection.**

Step 1: Use airborne-system to measure the direction of interference at different points and approximately localize RFI source by cross localization;

Step 2: Use ground movable instruments to accurately localize RFI source.



Airborne platform can be airplane or UAV etc.

Title: Recommendation on GNSS interference detection in civil aviation

Background/Brief Description of the Issue:

Interference has became serious threat to GNSS application in aviation.

Discussion/analysis

In order to keep GNSS safer operation of civil aviation, ICG should investigate GNSS interference detection status of each member states in detail, and provide scheme for GNSS interference detection system together with ICAO.

Recommendation

It is recommended that ICG should

- invite member states to report on present status and efforts of GNSS interference detection in civil aviation. Based on this further info sharing action can then be considered.
- consider inviting ICAO participants/experts to discuss scheme for GNSS interference detection system.

Proposed ICG-13 WG-S Action

- WG-S will invite member states and experts to the ICG-13 meeting to report on present status and efforts of GNSS interference detection in civil aviation, including the utilization of ADS-B
- Based on this further information sharing, subsequent action can be considered

(from WG S intersessional meeting)

Thank you!

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