The technology summary of reports from past IDM workshops

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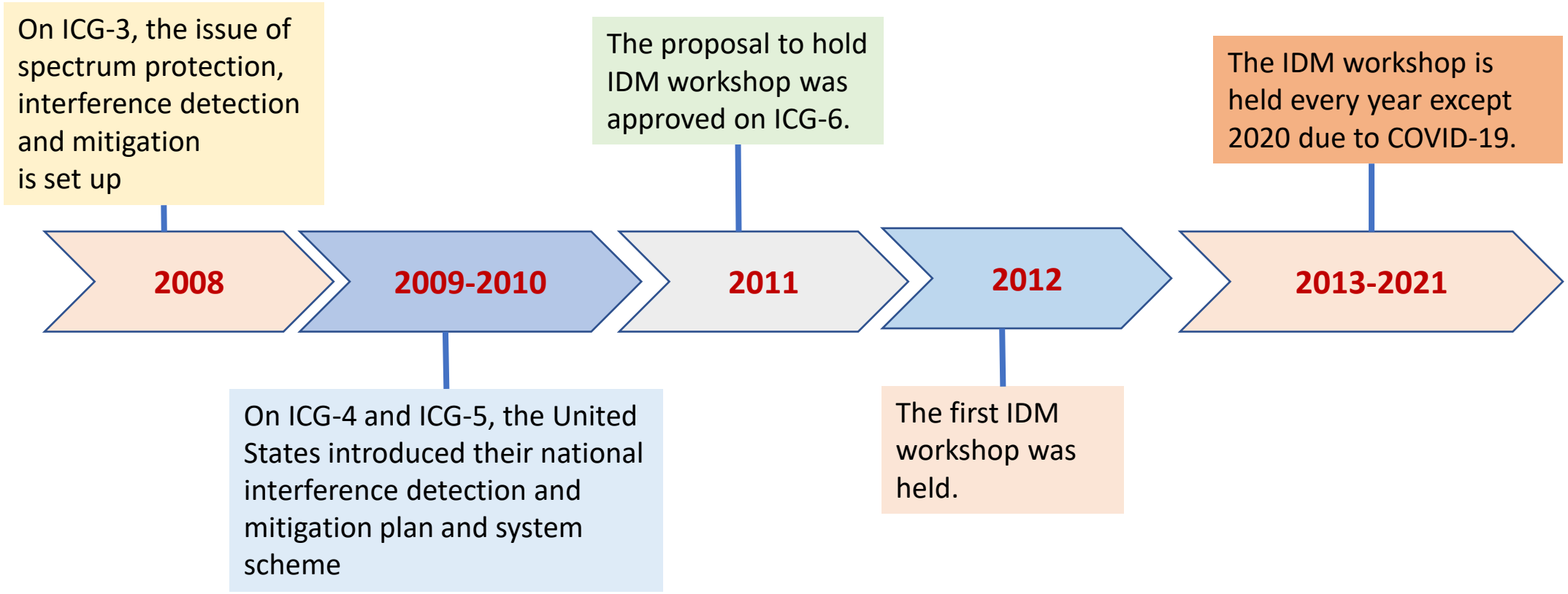
01

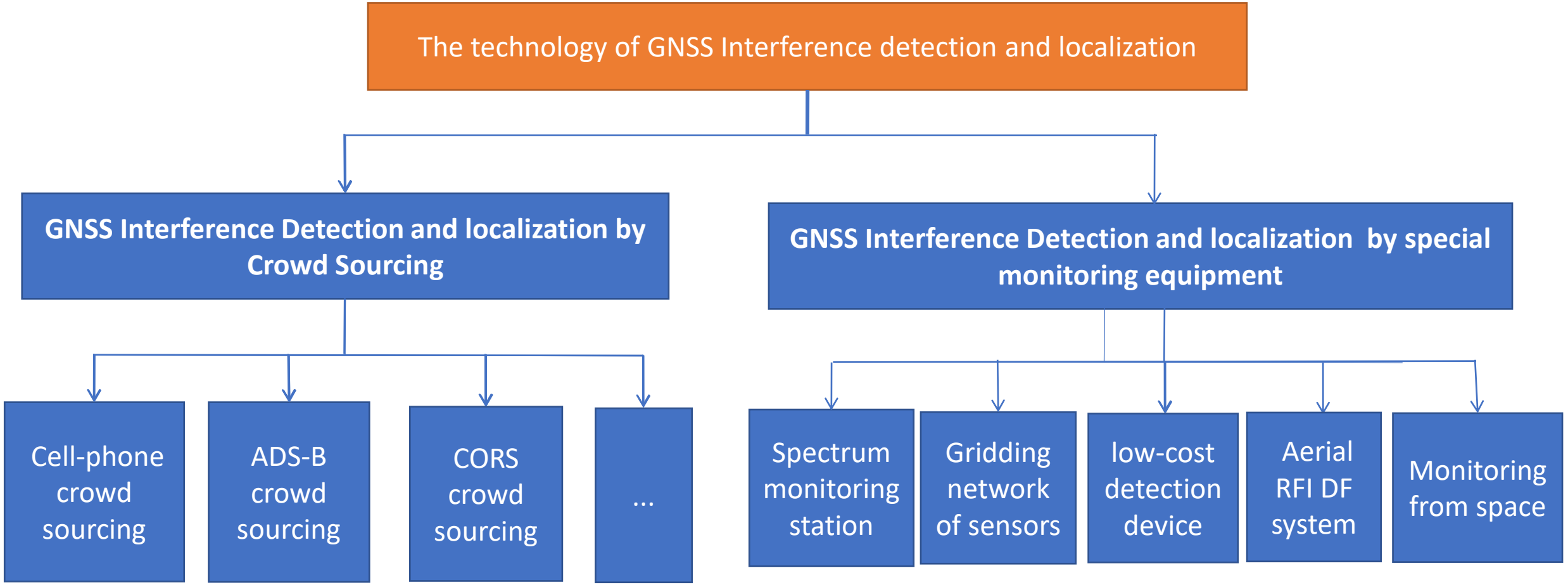
Brief introduction

IDM workshops



9 IDM workshops have been conducted to date.

IDM Technologies of past IDM workshops



All the technologies in this report come from previous IDM workshops.

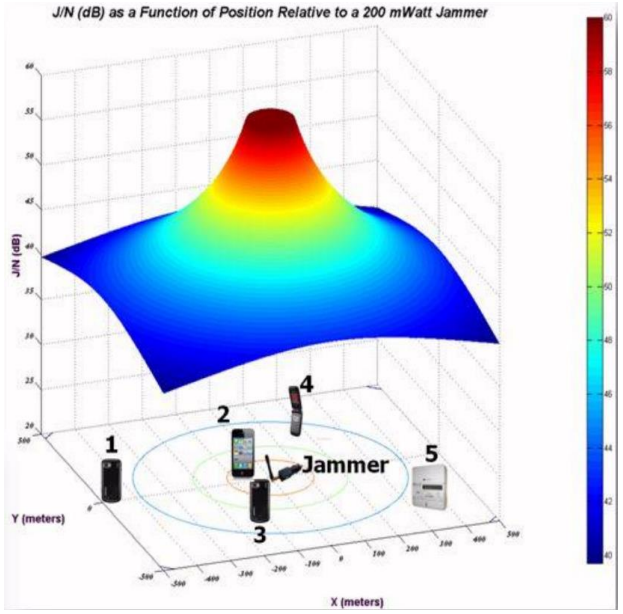
02

GNSS Interference Detection and localization by Crowd Sourcing

(1) Jammer detection and location using cell-phone crowd-sourcings

It was first introduced by Logan Scott. Tom Stansell Made an extended introduction on the 4th of IDM workshop in 2014.

This technology makes use of GNSS information in a large number of distributed mobile phones to realize GNSS interference detection.



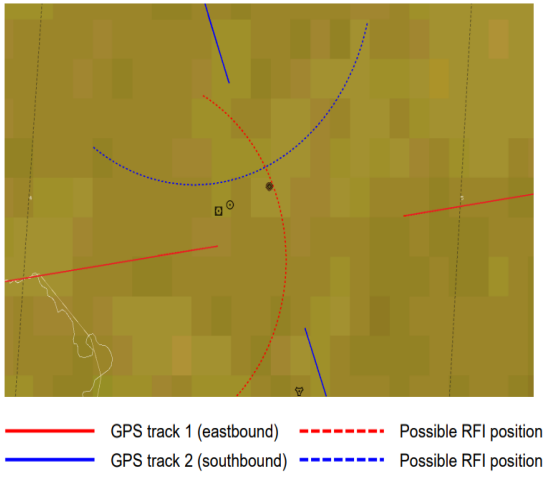
- The aggregate of phones, each reporting J/N and own position, provides a basis for locating the jammer.
- Phones located closer to the jamming source will see higher J/N than those further away.
- The data center can locate RFI according to info from cell phones.

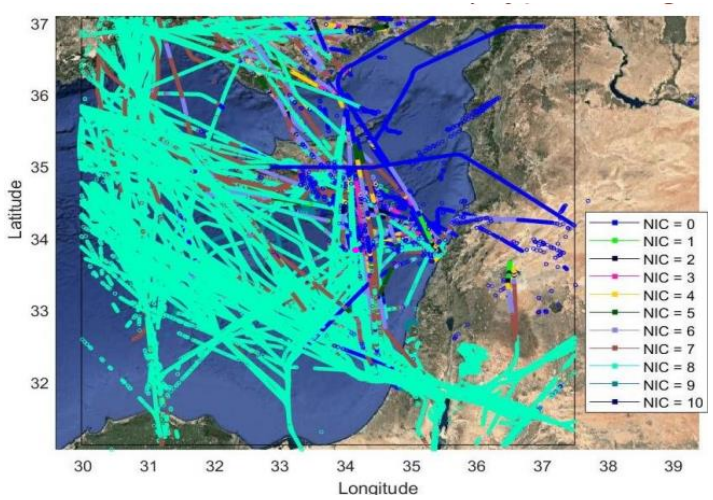
J/N output need to be built into chips in the New mobile phones.

(2) Jammer detection and location using ADS-B crowd-sourcings

Relevant reports on IDM workshops include:
(1)GNSS RFI Source Localization using Flight Track Data, Gerhard BERZ , 6th IDM workshops in 2017
(2) GNSS RFI Status Downlink by Gerhard BERZ, 8th IDM workshops in 2019
(3) Air ground coordinated RFI detection system in airport, Zhenweimin, 9th IDM workshops in 2021
(4) Characterization of ADS-B Performance under GNSS Interference, TODD WALTER, Zixi liu etc, 9th IDM workshops in 2021

This technology utilizes ADS-B data from multiple aircraft to realize GNSS interference detection.





- Realized by the loss of tracking and reacquisition information of the GNSS in ADS-B system.
- NIC information of ADS-B data can also be combined to detect and locate the interference.

(3) Jammer detection and location using CORS crowd-sourcings

Report on IDM workshops :
Crowd-sourced platform for GNSS anomaly identification, isolation and attribution analysis , Mark Dumville , 7th IDM workshops in 2018.

- Make use of the Continuously Operating Reference Stations(CORS)data from Global, regional, national, local CORS networks.
- CORS receivers are typically multi-GNSS, multi-frequency.
- Real-time, offline.

03

GNSS Interference Detection and localization by special monitoring device

Relevant reports on IDM workshops include:

(1) European activities on Jammers, Repeaters, Pseudolites and Interference Detection, Dominic Hayes, **1st** IDM workshop in 2012. This report iintroduces the DETECTOR Project introduction which include the a low cost GNSS interference detection and characterization solution for road transport.

(2)Interference Detection and Mitigation Workshop, Dr. T.D. Powell,Dr. M.A. Jeffris,Rick Hamilton， Hayes, **1st** IDM workshop in 2012. This report includes the introduction of C/N0 Sensor.

(3) Experimental Grid Radio Monitoring Network for Low power Interference Monitoring, Liu Zhijian, 3th IDM workshop in 2014. This report introduces gridding network of sensors.

(4) Update of GNSS IDM in China, ZHEN Weimin, Xiong Wen,4th IDM workshop in 2015. This report includes introduction of gridding network of sensors, Interference monitoring by navigation receiver.

(5) GNSS Jamming Detection and Mitigation in the EPCIP Framework, Daniele Borio, 4th IDM workshop in 2015, This report includes introduction of low cost jamming detectors based on COTS components.

(6) GNSS interference evaluation and mitigation for aviation, Zhenweimin,Hanchao,7th IDM workshop in 2018.This report introduces GNSS interference detection system for aviation that includes Ground RFI
Direction finding system, Ground RFI Grid detection system and Aerial RFIdirection finding system.

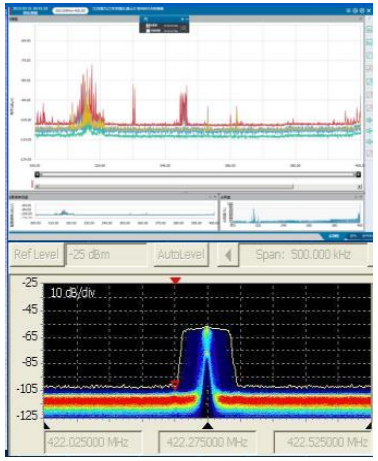
(7) Development and Operation of a GPS Jammer Localization System at the Airport, Deok Won Lim,8th IDM workshop in 2019.The system includes 4 Receiver Stations, a Central Processing Station, a Monitoring Station.

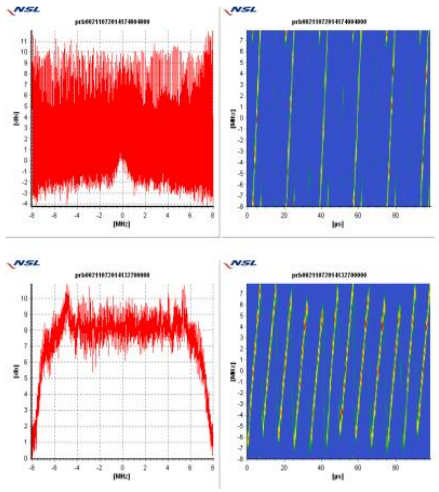
(8) Development of the European GNSS Interference Protection Network: EGIPRON, Joaquín REYES GONZALEZ,9th IDM workshop in 2021.

(9) GNSS Interference Monitoring from Space, Francisco Amarillo Fernandez, 9th IDM workshop in 2021.

Special GNSS interference monitoring device reported at IDM workshops mainly include Spectrum direction finding device，gridding network of sensors， low-cost detection device， aerial RFI DF device and space monitoring device.

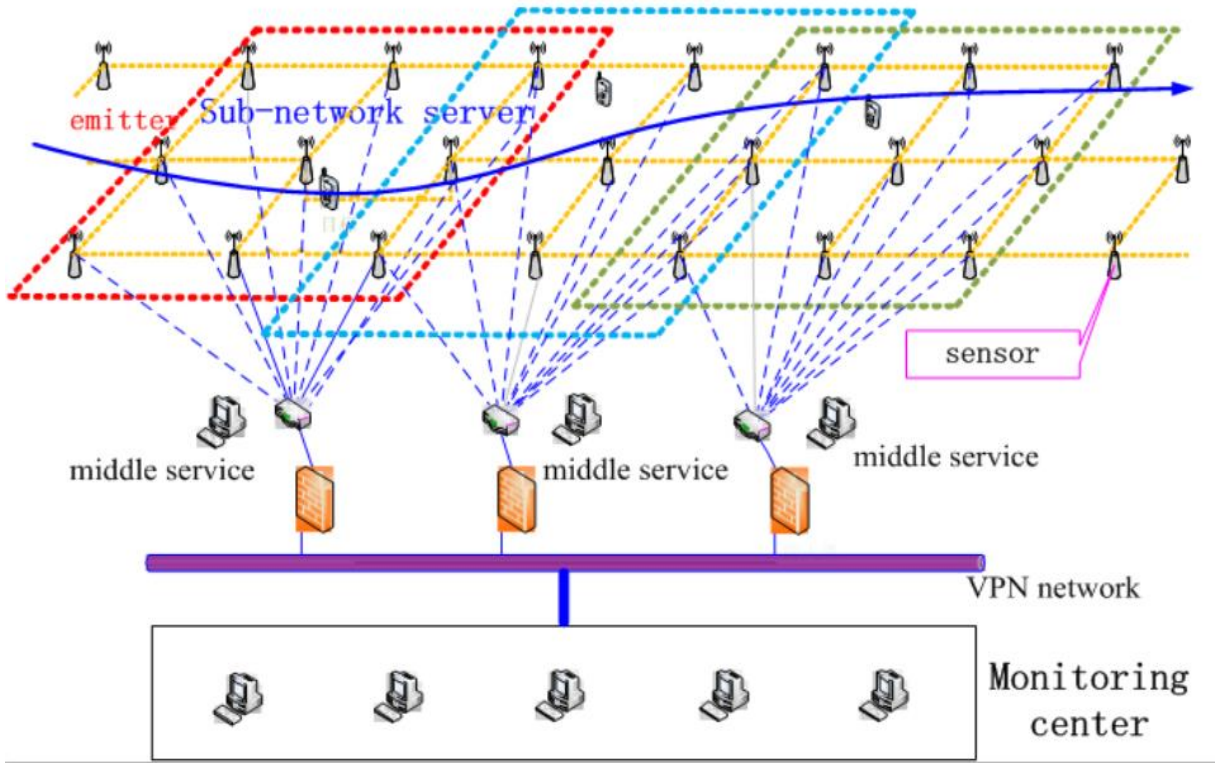
(1) Jammer detection and location using Spectrum direction finding device





- Monitor GNSS spectrum with high sensitivity, Measurements of frequency, power level, bandwidth, code rate etc.
- Differentiate unintentional interference from jamming.
- Differentiate between jammer types.
- Direction finding of RFI source： spatial spectrum that can Identify multiple interference at same time.

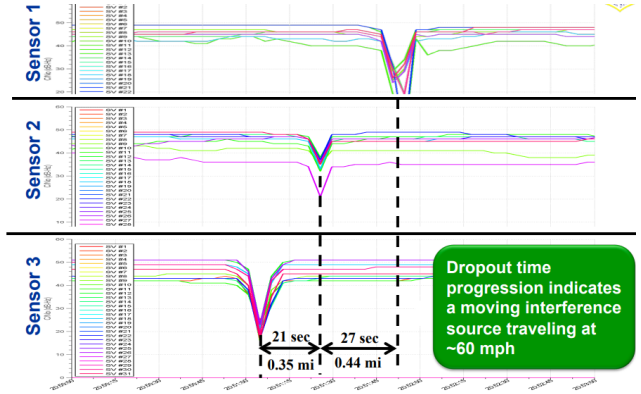
(2) Jammer detection and location using gridding network of sensors



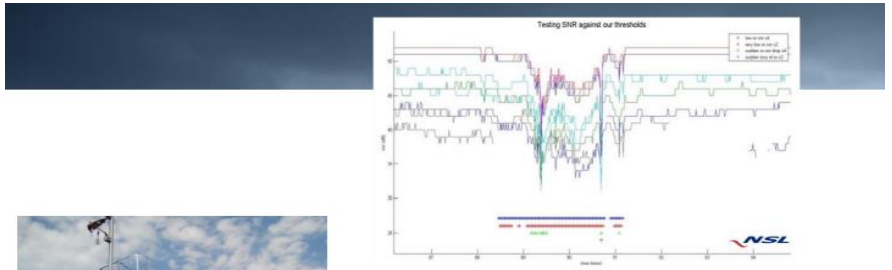
- measurements of frequency, power level, bandwidth, code rate etc.
- fast wideband spectrum scanning and spectrum occupancy.
- measuring of multi stations, TDOA location
- sensor : small size, light weight, unattended operation.

(3) Jammer detection and location using low-cost detection device

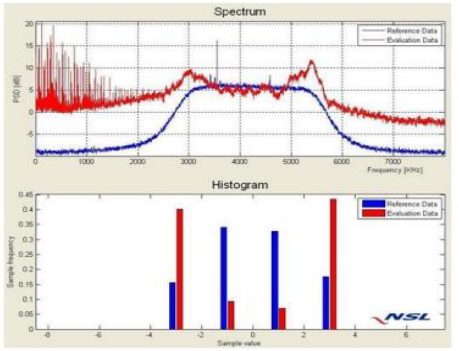
C/N0 Sensor.



a low cost GNSS interference detection and characterization solution for road transport



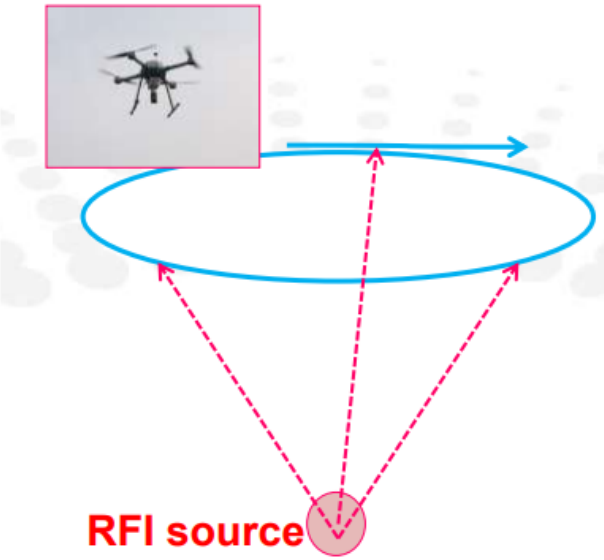
Drop in Signal/Noise of GNSS signals



Disturbed RF Power

- Integrated GPS receiver plus data logger.
- Interference can be monitored by the combination of PVT, C/N0,AGC, received power of receiver.

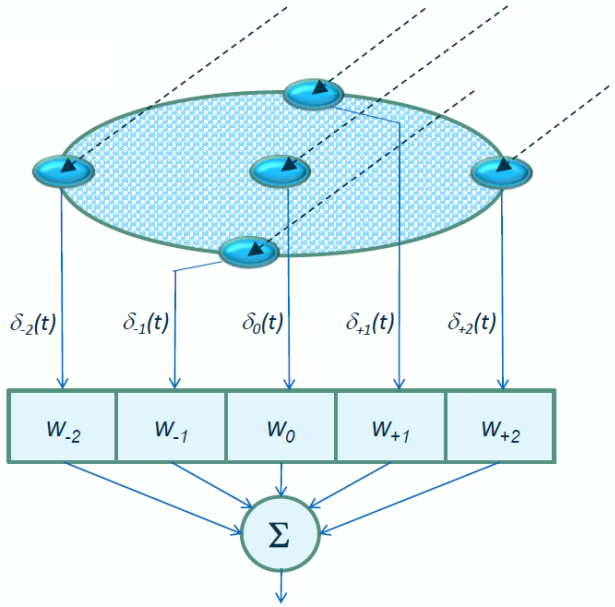
(4) Jammer detection and location using aerial RFI direction finding device



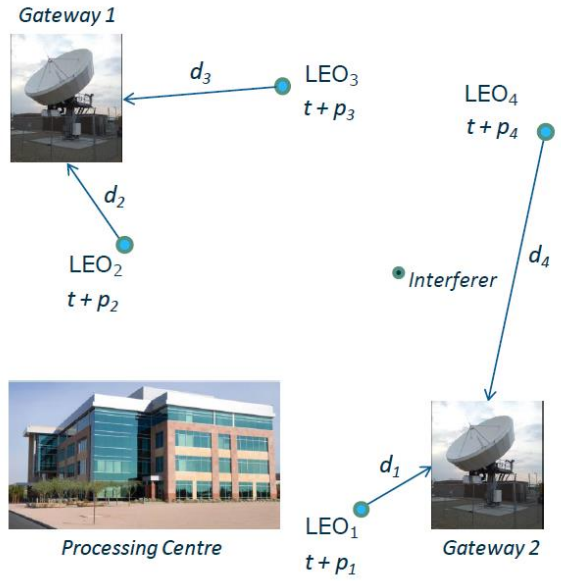
- Aerial platform can be UAV or airplane etc.
- Multi points measuring with single airborne RFI direction finding device.
- Multiple UAVs can realize the interference localization in real time.

(5) GNSS Interference Monitoring from Space

A GNSS spectrum monitoring-system, based on space-borne monitors at LEO satellites , enabling detection, characterization & localization of ground-based interferers over very wide areas.



Localization Techniques DOA.



Localization Techniques TDOA.

- Provides worldwide coverage, including oceans.
- Provides RFI localization by means of TDOA, TOA and DOA techniques
- Based on architecture in which the satellites are sensors, & the actual detection and localization is based on ground processing.

Thank you