GNSS Interference Detection

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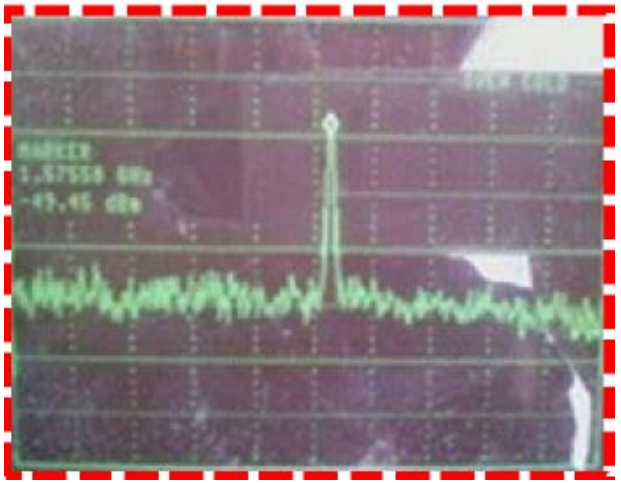
Recent Interference events in Korea

☐ 24 June ~ 4 July, 2010

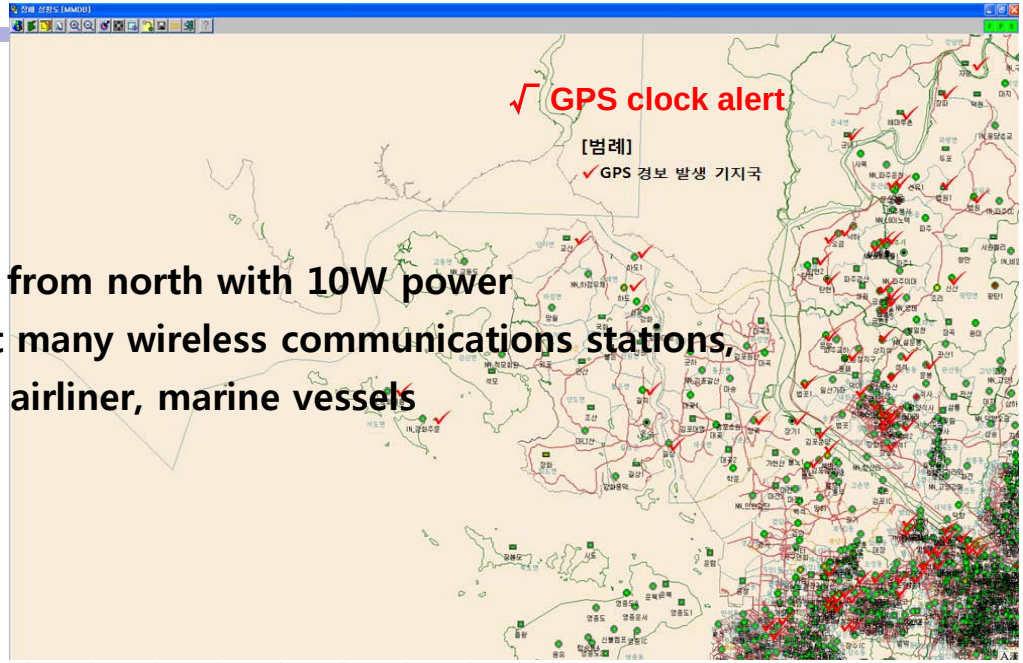
- Eastern area of Seoul
- Continually, 10~20 minutes
- single tone jamming (약 - 49dBm) at 1.5755 GHz
- Source : unknown, but emitted from Namsan area
- Report : Holdover of GPS clock at several wireless communications stations

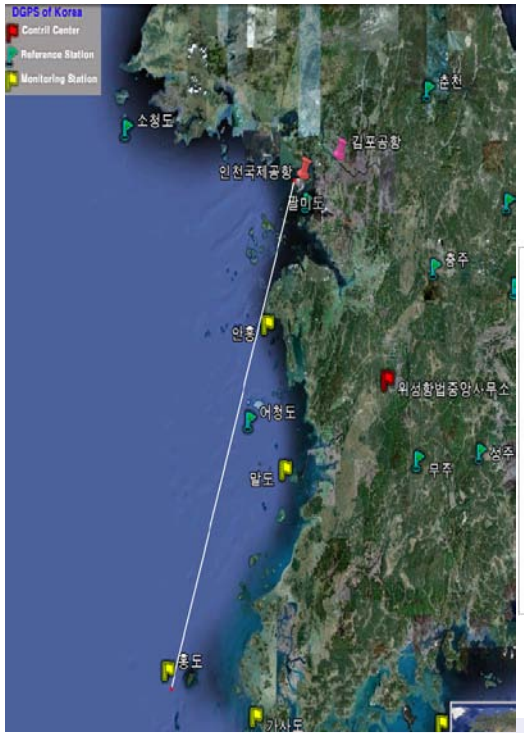
```
165> 2010/06/24 00:45:45 Holdover [52 53 0 0]
166> 2010/06/24 00:46:23 Locked to GPS - Primary
167> 2010/06/24 00:47:59 Recovery Offset [0 ns]
168> 2010/06/24 00:48:34 Holdover [52 53 0 0]
169> 2010/06/24 00:52:11 Locked to GPS - Primary
170> 2010/06/24 00:57:58 Recovery Offset [0 ns]
171> 2010/06/24 00:59:09 Holdover [52 54 0 0]
172> 2010/06/24 00:59:53 Locked to GPS - Primary
173> 2010/06/24 01:00:40 Holdover [52 54 0 0]
174> 2010/06/24 01:01:53 Locked to GPS - Primary
175> 2010/06/24 01:03:01 Holdover [52 54 0 0]
176> 2010/06/24 01:03:41 Locked to GPS - Primary
177> 2010/06/24 01:04:15 Holdover [52 54 0 0]
178> 2010/06/24 01:05:35 Locked to GPS - Primary
179> 2010/06/24 01:07:32 Holdover [52 54 0 0]
180> 2010/06/24 01:08:49 GPS Receiver Restart [10] - Primary
181> 2010/06/24 01:08:49 GPS Receiver Restart [10] - Secondary
182> 2010/06/24 01:10:05 Locked to GPS - Primary
183> 2010/06/24 01:11:02 Holdover [52 54 0 0]
184> 2010/06/24 01:15:29 Locked to GPS - Primary
185> 2010/06/24 01:17:15 Holdover [53 54 0 0]
186> 2010/06/24 01:17:53 Locked to GPS - Primary
187> 2010/06/24 01:19:29 Recovery Offset [0 ns]
188> 2010/06/24 01:22:38 GPS Receiver Restart [11] - Secondary
189> 2010/06/24 01:22:39 GPS Receiver Restart [11] - Primary
190> 2010/06/24 01:23:11 Holdover [53 54 0 0]
191> 2010/06/24 01:45:17 Receiver - Secondary
192> 2010/06/24 01:45:17 Active - Secondary
193> 2010/06/24 01:45:27 Locked to GPS - Secondary
194> 2010/06/24 01:47:11 Standby - Primary
195> 2010/06/24 01:57:27 Recovery Offset [400 ns]
196> 2010/06/24 02:08:20 GPS Receiver frequency [4, -13E-11]
```

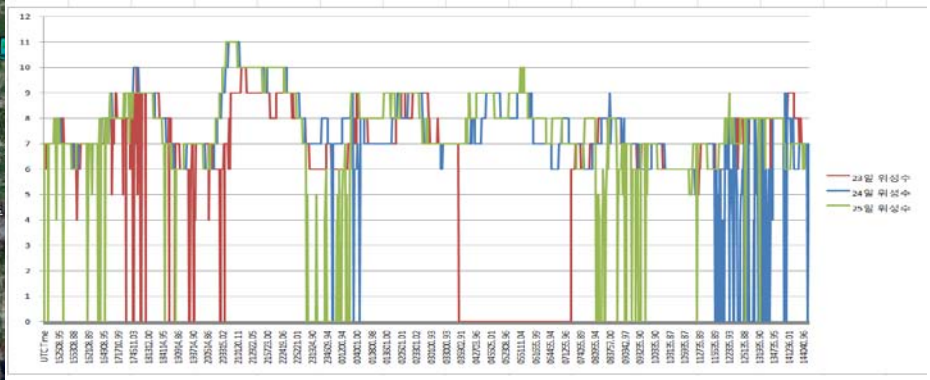


☐ 23 August ~ 27 August, 2010

- West-northern area
- single tone jamming at 1.575 GHz
- Source : estimated being emitted from north with 10W power
- Report : Holdover of GPS clock at many wireless communications stations, Maritime DGPS stations, airliner, marine vessels



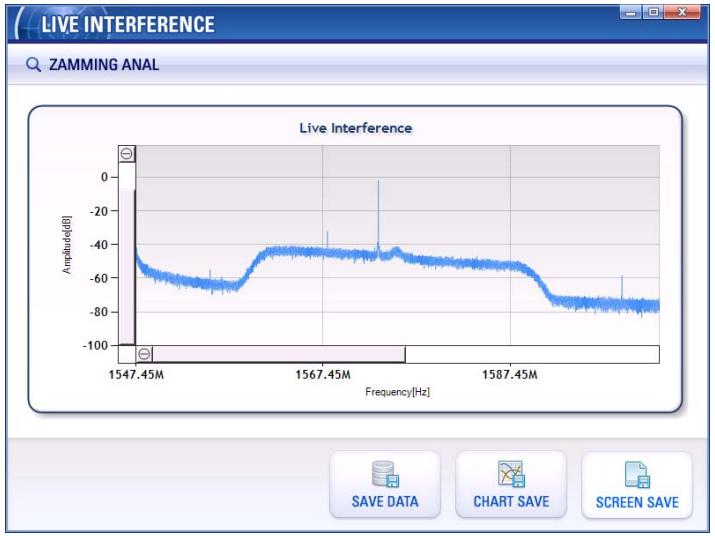




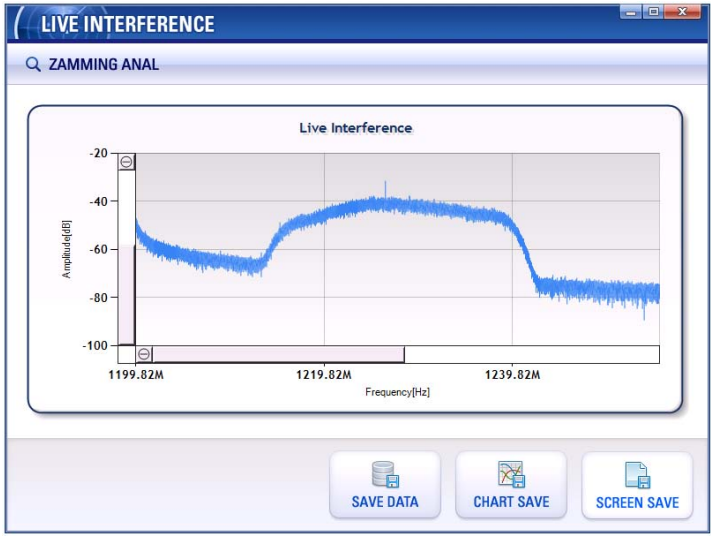
MDGPS station at HongDo (23rd ~ 25th August 2010)

☐ Several days from 5 March, 2011

- West border (Near to Seoul) & East border (Geum Gang Mt. Area)
- L1(CW) & L2(Sweep), Variable power
- Report : Holdover of GPS clock at several wireless communications stations



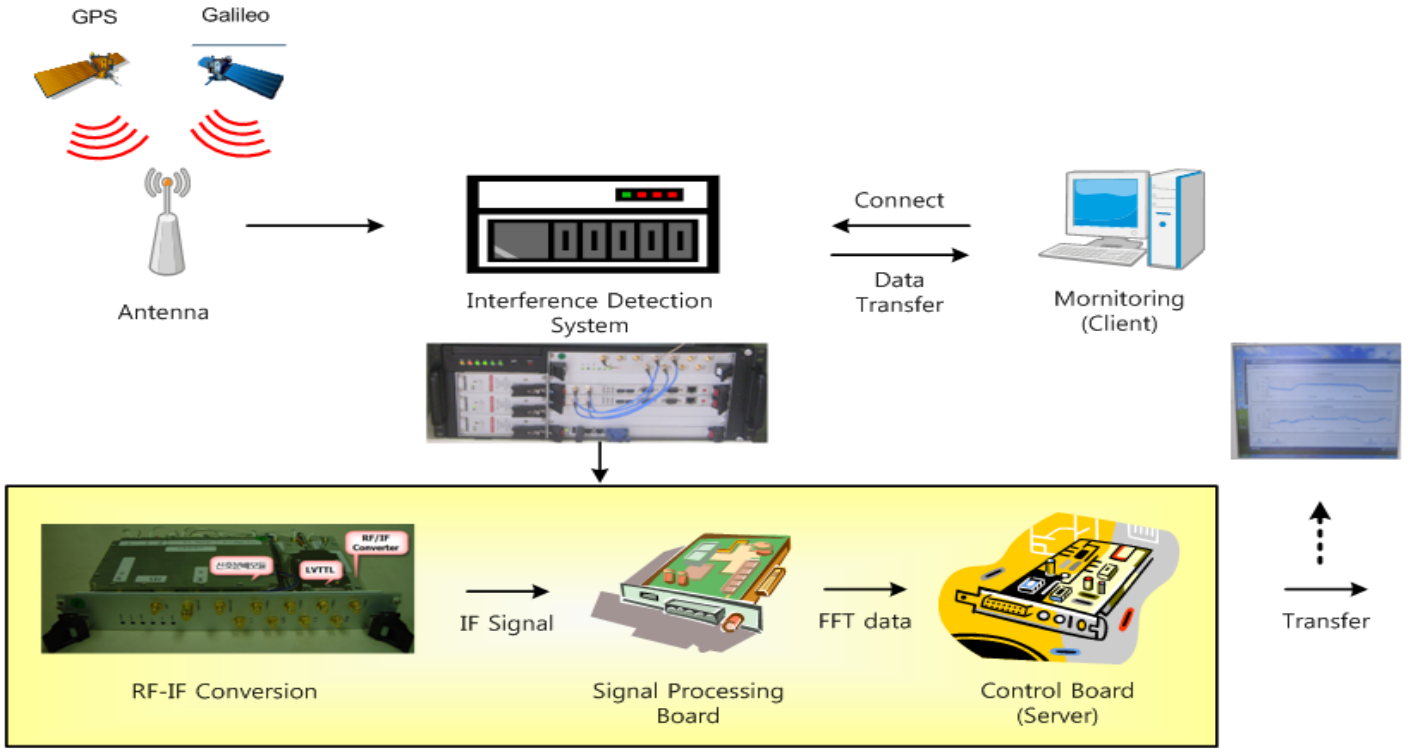
40dB + noise floor (L1, CW)



10 dB + noise floor (L2, sweep)

Interference detection & mitigation plans

- **For the wireless communications network**
  - **Implement GPS Interference Detection Sensors**
  - **Add Warning Mechanism according to several threat levels**
  - **SMS messaging to specified personnel by warning levels**



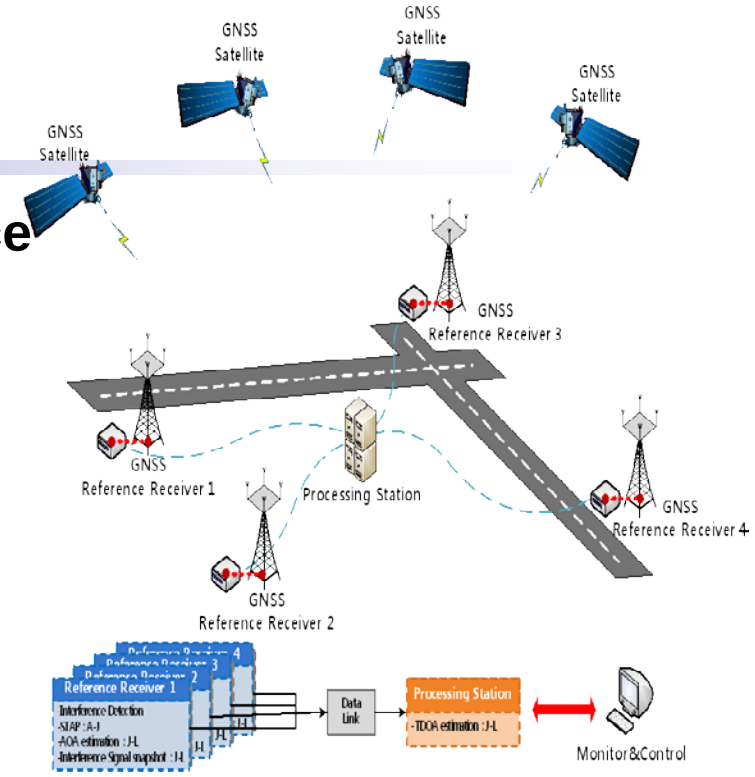
For Air Traffic Control in Aviation

- Deploy GNSS interference monitoring network and link to NOTAM

R&D for locating the interference source

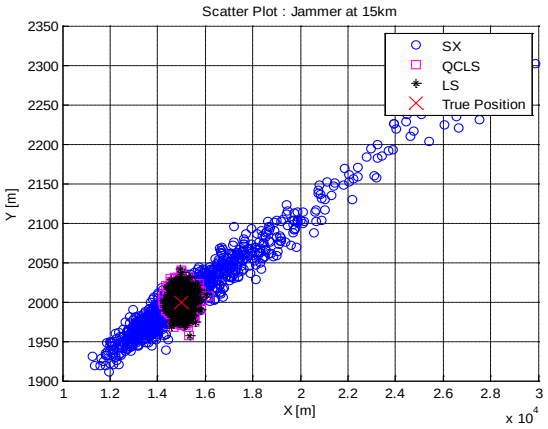
- NAP (national Agenda Program)

Simulation for Incheon Int'l Airport



jammer localization for GBAS

Method	5 km		10 km		15 km	
	x [m]	y [m]	x [m]	y [m]	x [m]	y [m]
LS	35.16	4.31	112.43	7.80	251.81	11.55
QCLS	36.59	4.41	122.62	7.85	260.54	11.64
SX	85.03	6.12	664.16	22.35	3068.74	68.17



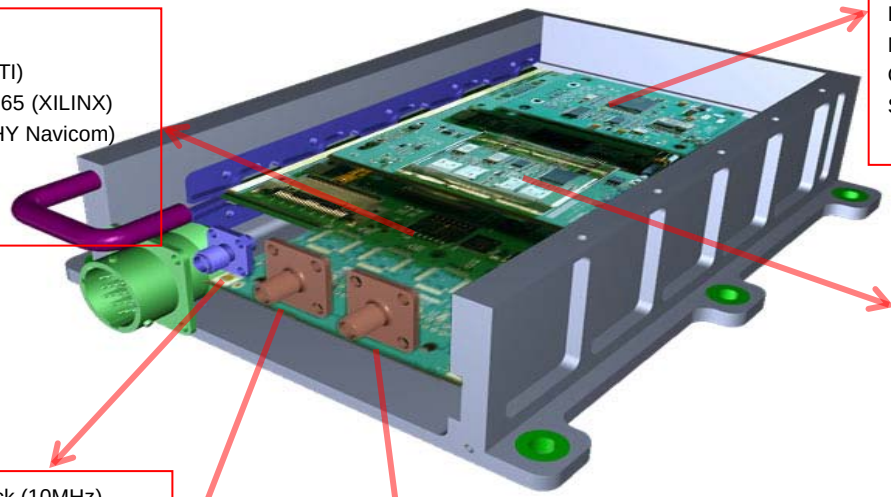
R&D for locating the interference source

Prototype for detecting & locating interference

- **WLAN B/D**
  Freq.: 2.4GHz
  Channel : 13Ch
  Distance : 1km (LOS)
  Baud rate : 250kbps
  Modulation : OFDM
  Output Power : 20dBm
  Spec.: IEEE802.11b/g Compliant

- **Digital B/D**
  DSP : TMS320C6416T (TI)
  FPGA : XC5VSX50TFF665 (XILINX)
  Correlator : LCORE-M (HY Navicom)
  Channel : 36 Channel
  Output rate : 1Hz

- **RF/IF B/D**
  Input : GPS L1 C/A
  Bandwidth : 2MHz
  Quantization : 1.5bit
  AGC Range : 50 dB
  Total Gain : 100dB(approx.)
  Clock : 22MHz



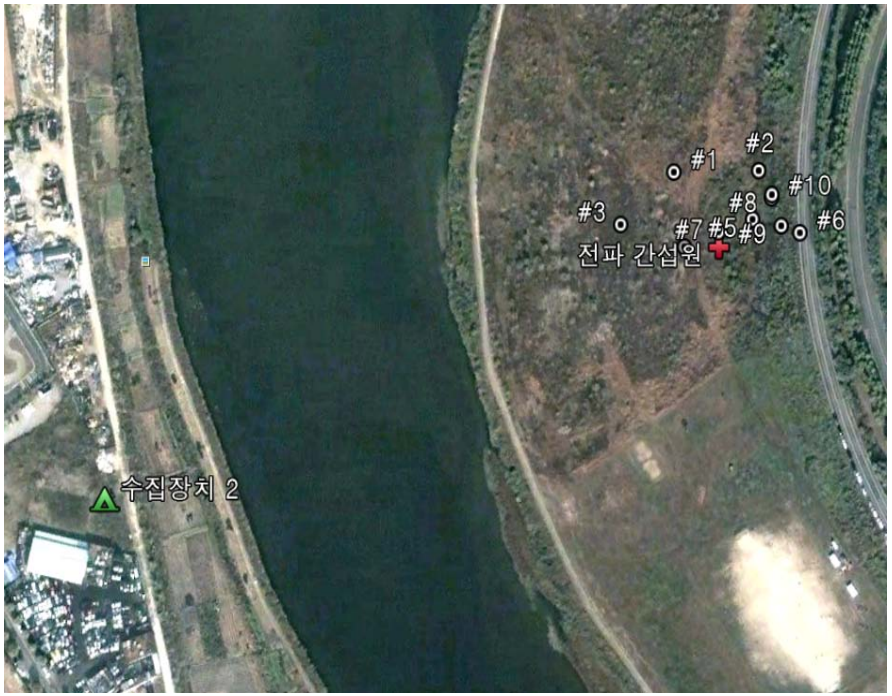
Ext clock (10MHz)

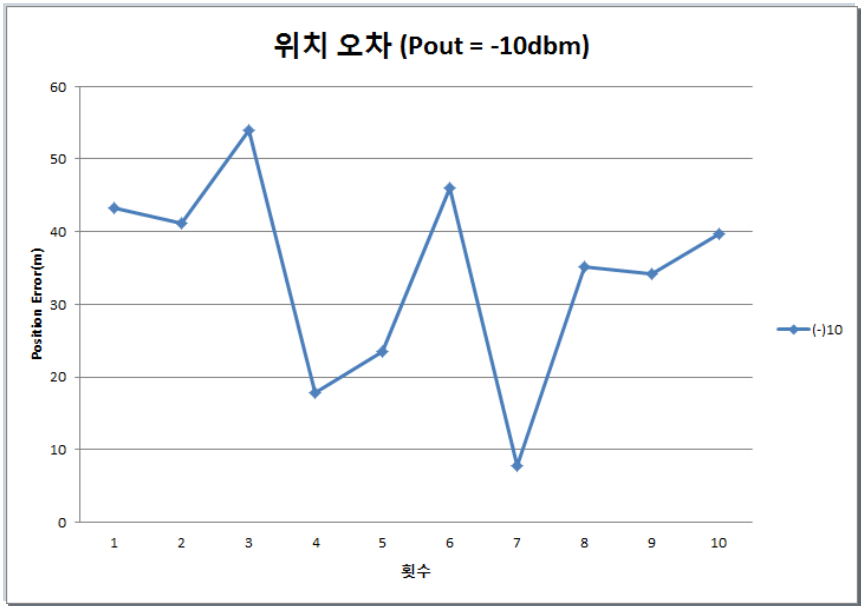
GNSS Antenna

WLAN Antenna

Test result (TDOA)

- Interference
  - AWGN, 4MHz BW, fc = 1575.42MHz
  - -10dBm power





Average of positioning error 34.2m

Concluding Remarks

- **GNSS dependencies in critical infrastructures**
  - Transportation systems
  - Communications systems
  - Banking systems
  - Power grid systems
- **Well recognize threats & preparing actions**
  - Interference detection, dissemination of interference report information
  - Not yet interagency plans
- **Expect interagency plans including civil and military as well**