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SUSTAINABLE FUTURE.

GNSS RFI Monitoring Activity and Information Sharing in JAPAN

Makoto FUKUDA (Mr.)
Special Assistant to the Director
CNS Planning Office, Air Navigation Service Engineering Division
Air Navigation Service Department, Civil Aviation Bureau (JCAB)
fukuda-m09h7@mlit.go.jp

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GNSS RFI Cases in Japan

RFI cases occurring in Japan
(2020 and 2021)

NPAC Activities when RFIs occur

NPAC activities will guide future GNSS
RFI response

Current Activities

A more effective vision for the future

NPAC ‘s Role

Organizations essential to GNSS operations

Information Sharing by NOTAM

Delivering reliable information to flight
users

Other Issues

Matters requiring further consideration

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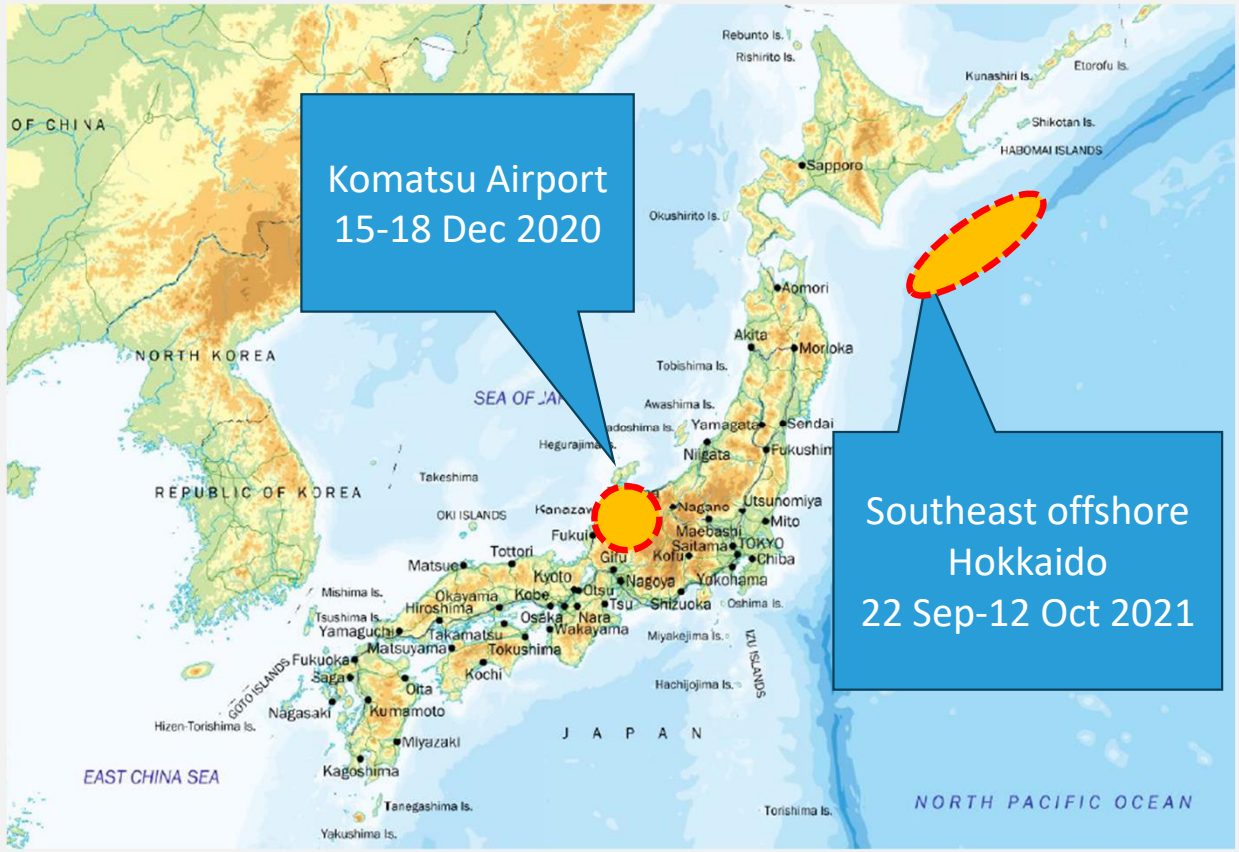
GNSS RFI Cases in Japan

RFI cases occurred in Japan

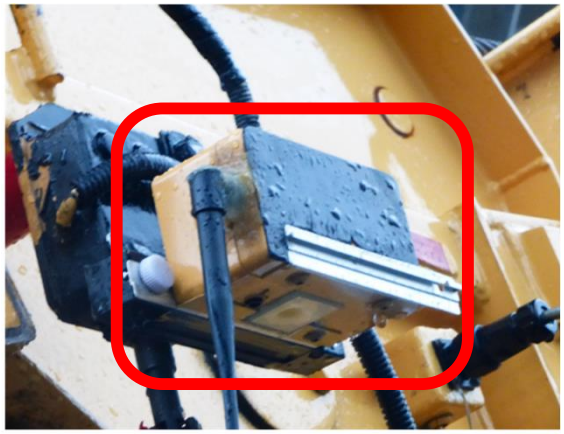
(2020 and 2021)



GNSS RFI Cases in Japan

Komatsu Airport, 15-18 Dec 2020

1. GPS reception failures occurred in the vicinity of Komatsu Airport. 16 scheduled flights were affected:
   -1 flight was delayed , -1 flight was canceled,
   -1 flight had to go around due to an EGPWS malfunction; and
   -2 flights switched to radar vectors for PAR approach/departure without using GNSS
2. Network Performance Assessment Center (NPAC) analyzed the incident and determined that the cause was external interference.
3. It was found the RFI was caused by a wireless camera mounted on a crane at a construction site, a few kilometers from the airport (a transmitter did not comply with technical standards).
4. Telecommunications Bureau of Ministry of Internal Affairs and Communications, which regulates radio waves, instructed the installer to stop using the wireless camera. The GNSS RFI has been resolved.



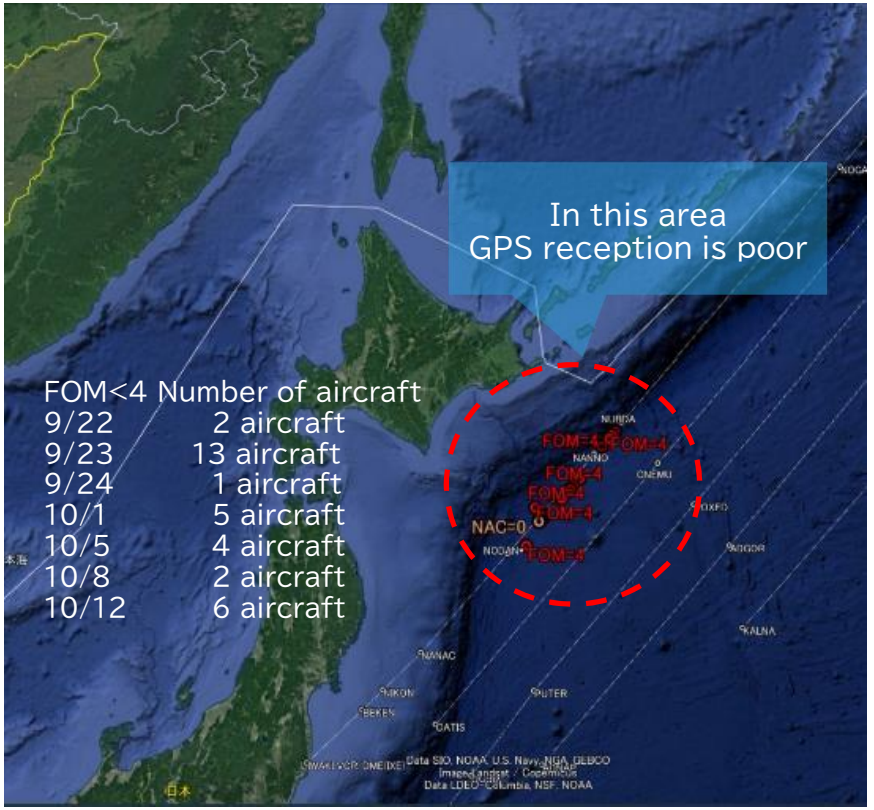
Wireless Camera

Wireless camera at the top of the crane

GNSS RFI Cases in Japan

Southeast offshore Hokkaido, 22 Sep-12 Oct 2021

1. The FOM (Figure of Merit) of multiple aircraft degraded off the southeast coast of Hokkaido, and an oceanic controller of ATMC (Air Traffic Management Center) reported they received pilot reports that indicated ADS-B was unavailable.
2. As a result of investigation by NPAC, 33 aircraft were found to have FOM<4 in ADS-C.
3. A NOTAM was issued in anticipation of GNSS RFI in the area southeast of Hokkaido , taking into consideration the impact on air navigation.
4. Even after RFIs disappeared, due to the possibility of RFI, NOTAM continued until its deadline (30 Nov).



[9/23 ADS-C (FOM) < 4 plots >

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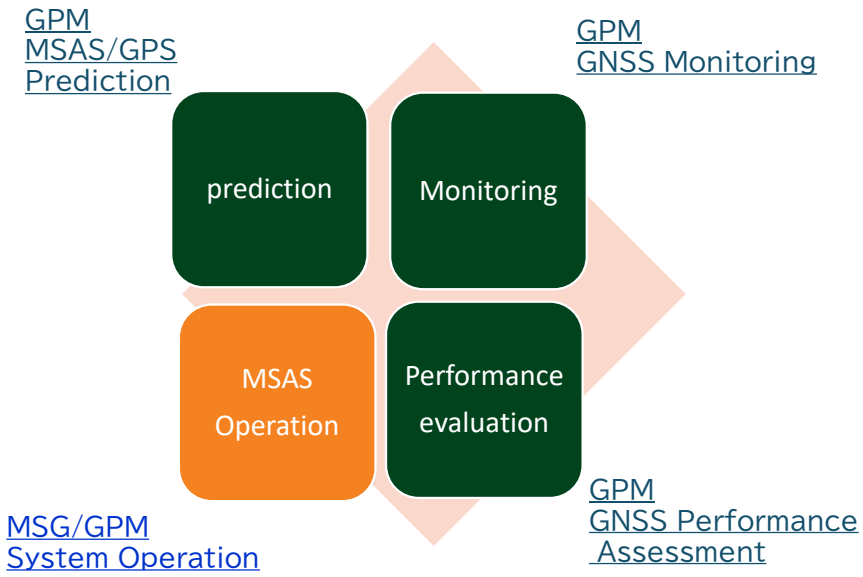
NPAC ‘s Role

Organizations essential to GNSS operations



MSAS (Michibiki Satellite-based Augmentation System)
MSG (MSAS Signal Generation and operation equipment)
GPM (GNSS Prediction and Monitoring equipment)

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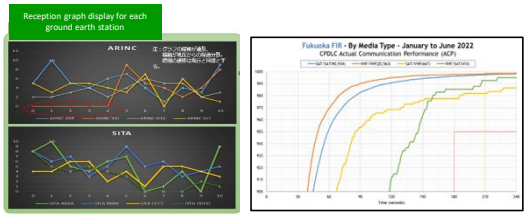
NPAC 's Role

NPAC (Network Performance Assessment Center) in Hitachi-Ota, Ibaraki

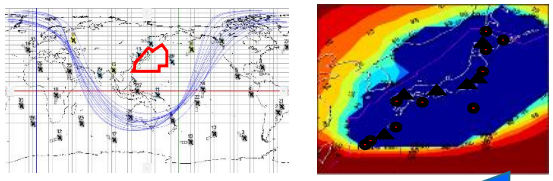
Communication

- Relay data communication messages related to control instructions and information necessary for safe aircraft operation.
- Measure and analyze data communication transmission delay time and message reachability.



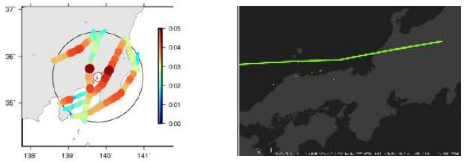
Navigation

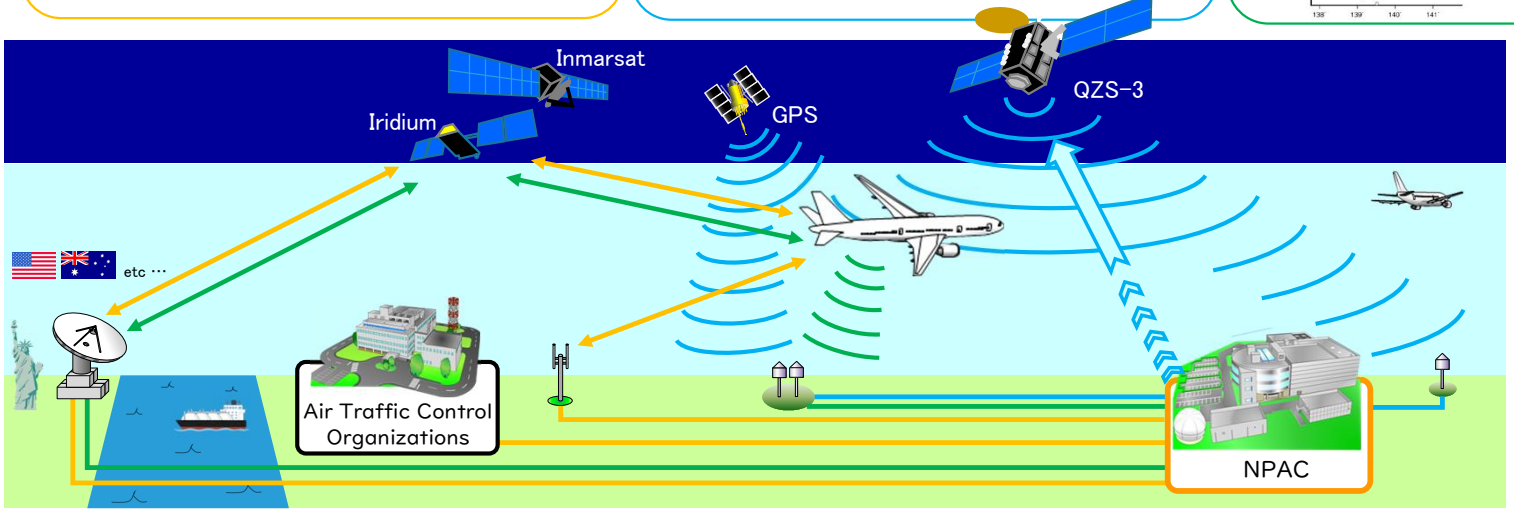
- Generation and monitoring of augmentation signals (SBAS signals) necessary to use GPS for aircraft operations.
- Prediction of GPS availability for aircraft
- Monitoring of GPS signal degradation, interference.



Surveillance

- Monitoring of radio wave environment of surveillance frequencies.
- Accuracy monitoring of aircraft position in use of GPS.(navigation related)
- Transmission delay monitoring of aircraft position information using satellite data links.(communication related)





NPAC

Hitachiota City, Ibaraki Pref.

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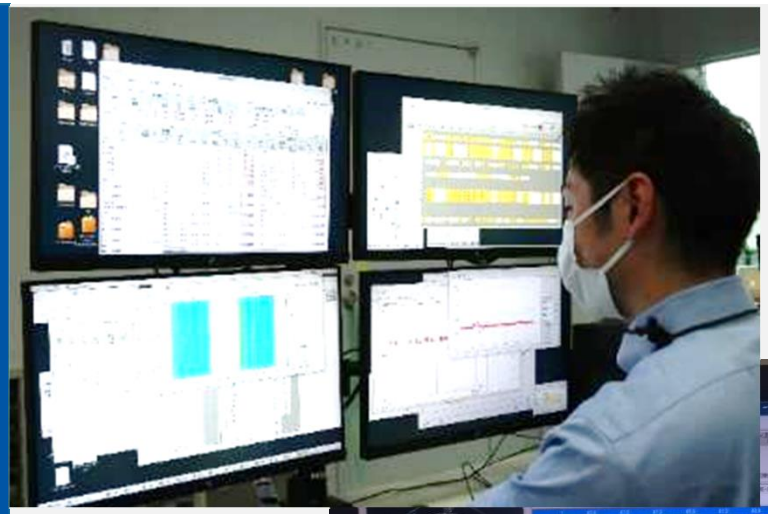
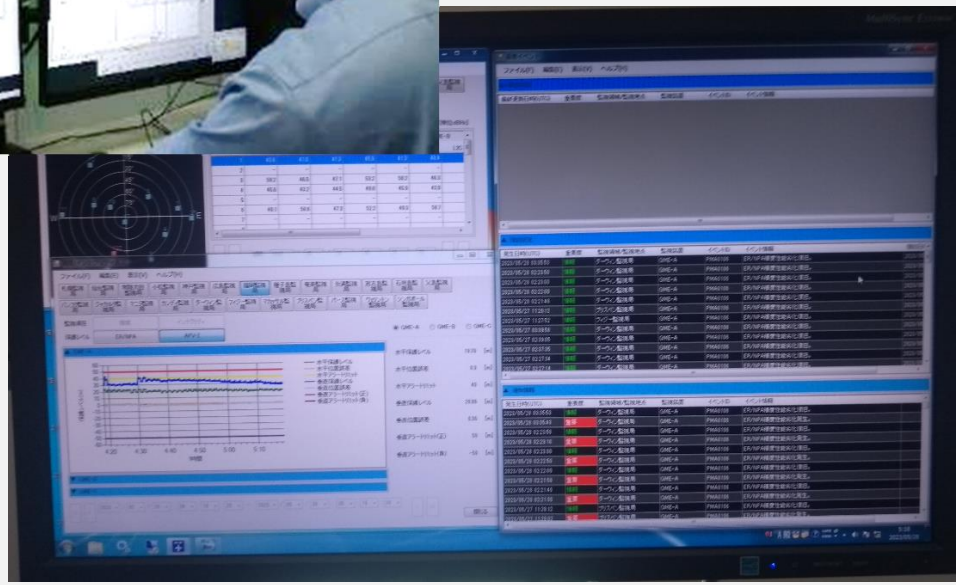
NPAC activities when RFIs occur

NPAC activities will guide future GNSS RFI response



Staff analyzing RFI

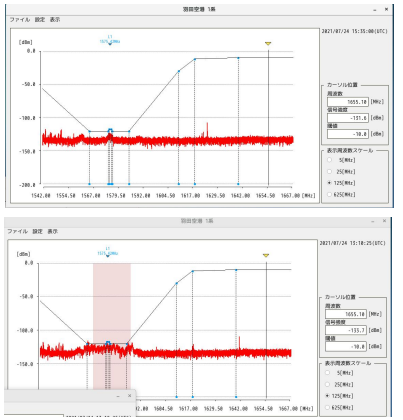
Checking the status of each satellite



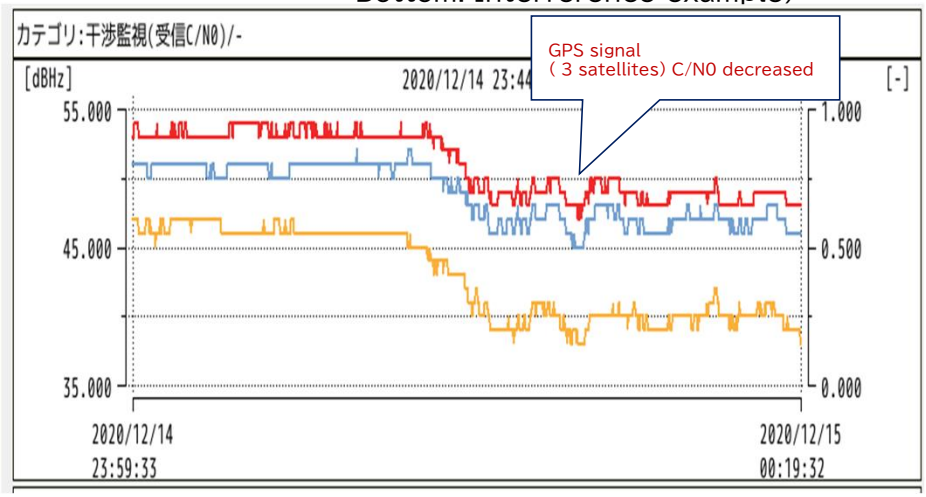
NPAC activities when RFIs occur

Komatsu Airport: Checking the C/N0 change of GPS signals

1. NPAC was informed by Komatsu Airport for the GNSS reception failures.
2. NPAC analyzed the recorded data of MSAS monitoring station at Komatsu Airport, and identified the C/N0 (Carrier to Noise density ratio) change of the GPS signal.
3. It was determined that the RFI was caused by external interference other than GPS.
4. NPAC collaborated with the Regional Telecommunications Bureau to identify the source of the RFI.
5. The cause was an impact of radio waves emitted from a wireless camera mounted on the top of the crane.



Spectrum analyzer status
(Top: Normal,
Bottom: Interference example)

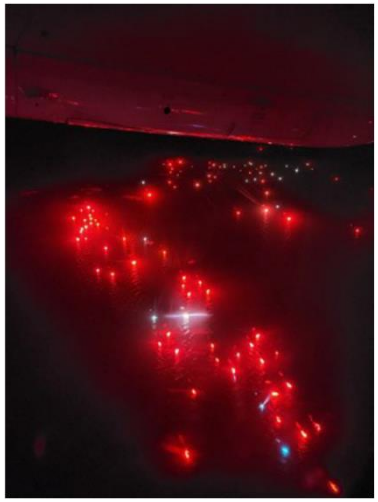


GPS signal C/N0 fluctuations
(Carrier power to noise power ratio)

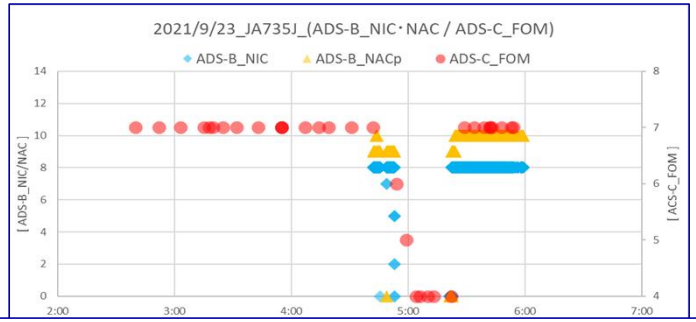
NPAC activities when RFIs occur

Southeast offshore Hokkaido:

Check ADS-B (NIC/NAC value) and ADS-C (FOM value)

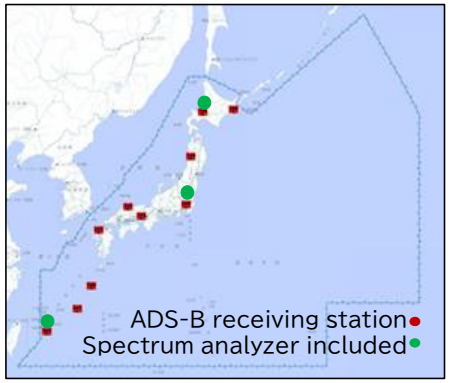


1. A pilot report was received from an operator who had detected ADS-B unavailable in the cockpit. It was discovered that the same case occurred on multiple aircraft over southeast offshore area.
2. NPAC investigated various sources and found that the aircraft's NIC (Navigational Integrity Category) /NAC (Navigational Accuracy Category) as well as FOM (Figure of Merit) had been degraded.
3. It was assumed that GNSS RFI had been occurring in the area. In consideration of the impact on operations, a NOTAM was issued to inform operators that GPS reception level might be reduced .
4. Even after the effects of the RFI had been disappeared, NOTAM continued until its deadline (30 Nov).
5. The source of the GNSS RFI is unknown.



NIC : Navigation Integrity Category : A number between
NAC : Navigation Accuracy Category (Accuracy): A number between

[ADS-B at the incident （ NIC/NAC value ）and ADS-C （FOM value ）



Location of receiving station

04

Information Sharing by NOTAM

Delivering reliable information to flight users

NOTAM
(6366/21 NOTAMN
Q)RJJJ/QGWXX/IV/NBO/E/000/999/4155N14652E100
A)RJJJ B)2110141000 C)2110241459
E)GPS POSITION ACCURACY MAY BE REDUCED WITHIN A 100NM RADIUS CENTERED ON NANNO ON THE FUKUOKA FIR.)

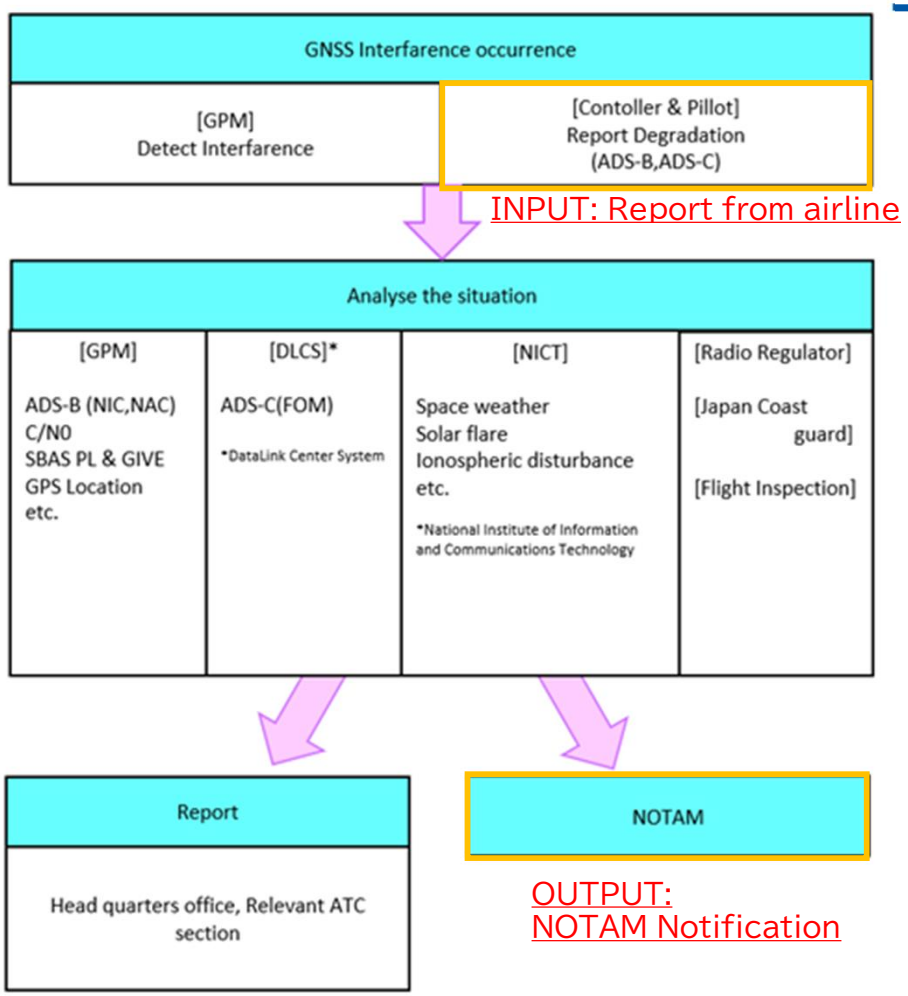
NOTAM
(6586/21 NOTAMR 6366/21
Q)RJJJ/QGWXX/IV/NBO/E/000/999/4155N14652E100
A)RJJJ B)2110221257 C)2111301459EST
E)GPS POSITION ACCURACY MAY BE REDUCED WITHIN A 100NM RADIUS CENTERED ON 415457.90N 1465133.04E NANNO ON THE FUKUOKA FIR.)

Contents of NOTAM issued by GNSS RFI off the southeast coast of Hokkaido

Information Sharing by NOTAM

Delivering reliable information to flight users

1. NPAC has established response procedures in the event that the degradation of GNSS navigation accuracy is confirmed, and communication procedure for coordination with related agencies.
2. NPAC centrally manages RFI information and understands impacts on GNSS navigation. It also has a framework in place to quickly notify users of ongoing interference using NOTAM .



GNSS interference response flow

Information Sharing by NOTAM

Delivering reliable information to flight users

Contents of NOTAM issued when GNSS RFI occurs

" GPS position accuracy may be reduced within a 100 NM radius centered on NANNO on the Fukuoka FIR ."

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NOTAM
 (6366/21 NOTAMN
  Q)RJJJ/QGWXX/IV/NBO/E/000/999/4155N14652E100
  A)RJJJ B)2110141000 C)2110241459
  E)GPS POSITION ACCURACY MAY BE REDUCED WITHIN A 100NM
     RADIUS CENTERED ON NANNO ON THE FUKUOKA FIR.)
```

GW : Items related to GNSS wide area operations. XX : Other. IV : I is IFR , V is VFR , if IV it's both.
NBO : Handling classification. N is something that requires immediate attention. B is pre-flight information bulletin, O is operational. E is en-route, A is airport. If AE it's both. There is also W (NAV Warning).
000/999 : Upper and lower flight levels.

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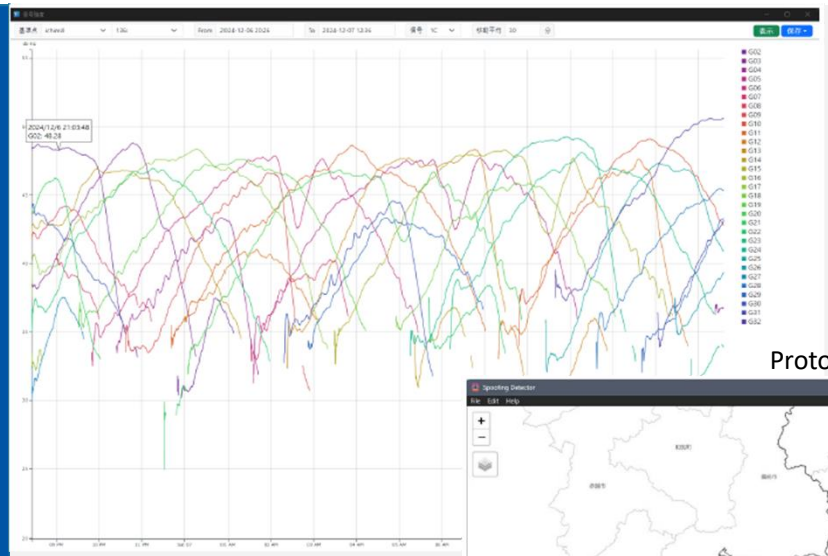
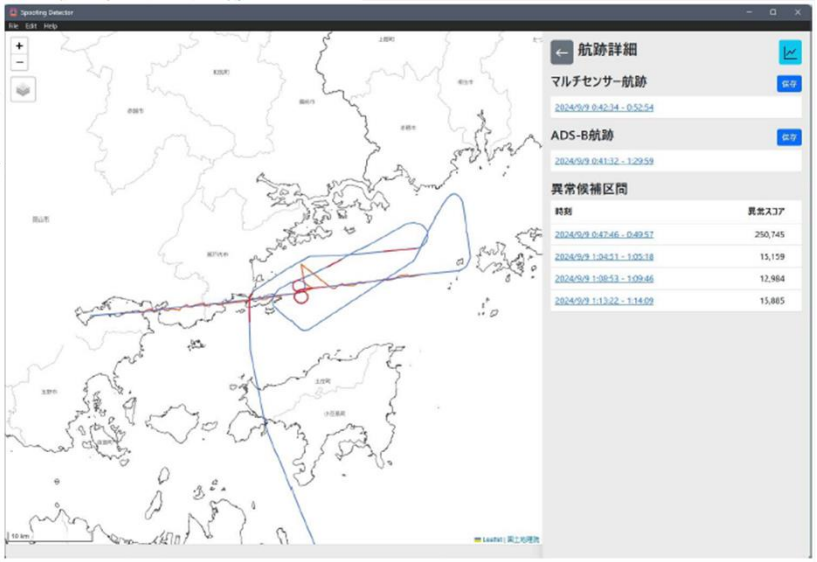
Current Activities

A more effective vision for the future



Prototype of GNSS jamming detection tool

Prototype of GNSS spoofing detection tool



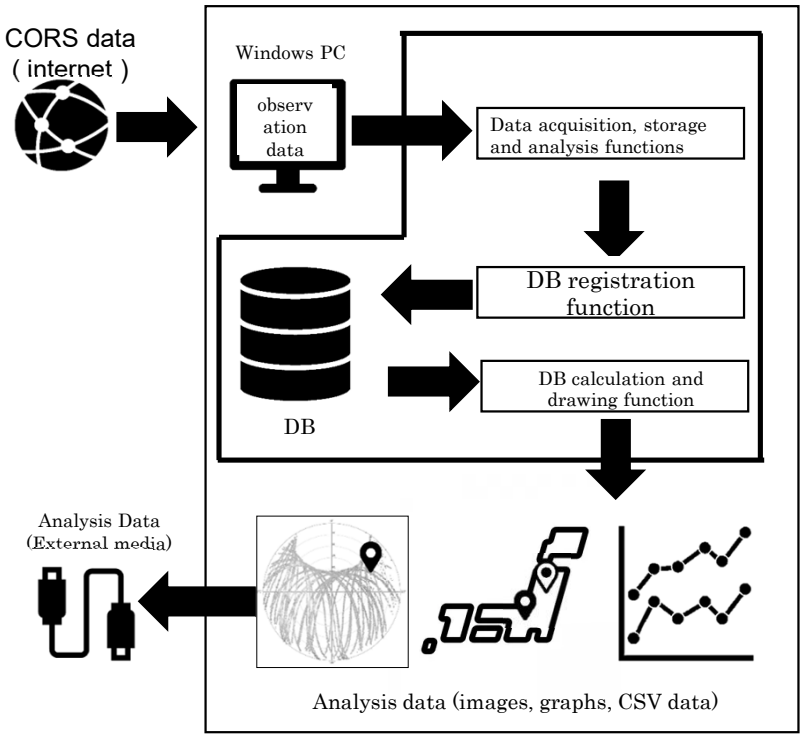
Current Activities

A more effective vision for the future

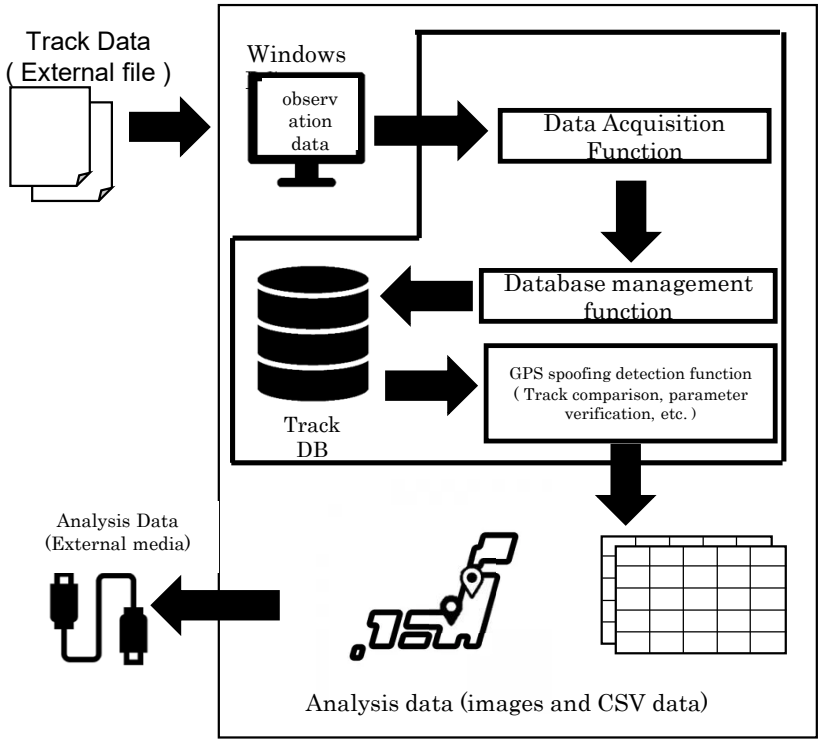
1. In Japan, CARATS (Collaborated Actions for Renovation of Air Traffic Systems: a long-term vision for the future air traffic system) considers specific measures for new "GNSS RFI monitoring" measures from 2025 and formulates the details.
2. NPAC is responsible for monitoring aircraft's positioning statuses using ADS-B with GPM .
3. To detect GNSS jamming, JCAB has just developed a prototype GNSS jamming detection tool and will evaluate it by using real-time positioning data from approximately 80 out of 1,300 GPS-based Control Stations of the Geospatial Information Authority in Japan.
4. To detect GNSS spoofing, JCAB has just developed a prototype tool that can detect possible spoofing by comparing the ADS-B position date from each aircraft and fusion date with SSR and WAM of HARP (Hybrid Air-route suRveillance sensor Processing equipment), which is 2-second interval.
5. NPAC will verify the efficacy of the prototype tools described in 3.4 above and plan to implement them in operational monitoring equipment in the future.

Current Activities

A more effective vision for the future



Proposal for a tool to detect GNSS jamming

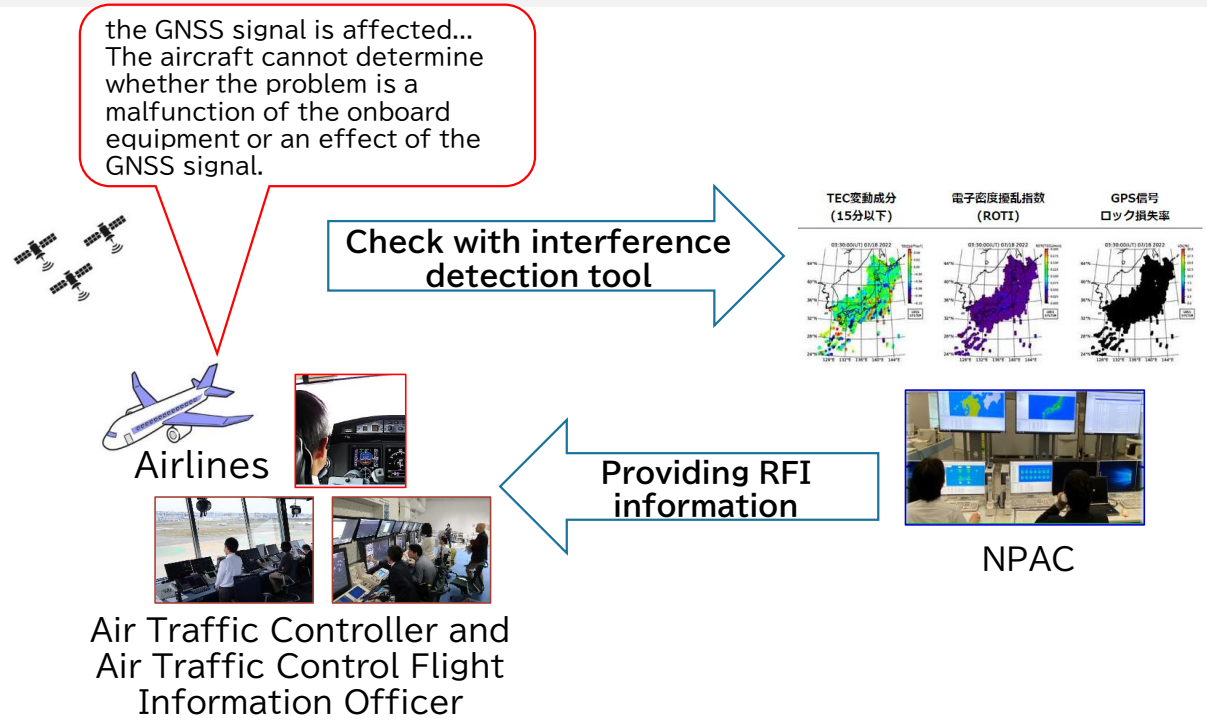


Proposed tool to detect GNSS spoofing

06

Other issues

Matters requiring further consideration



Other issues

Matters requiring further consideration

1. Establishment of new navigation technologies other than GNSS using APNT (Alternate Position, Navigation, and Timing) and MON (Minimum Operational Network) as a backup with conventional navigation
2. GNSS DFMC (Dual Frequency Multi Constellation) and Authentication to make GNSS itself RFI resilience
3. Offshore spoofing monitoring , etc.

Thank You

Dhanyavād, Xie Xie, Merci beacoup, Gracias, Shukran, Arigato

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