Development of TIS-B system for situation awareness enhancement

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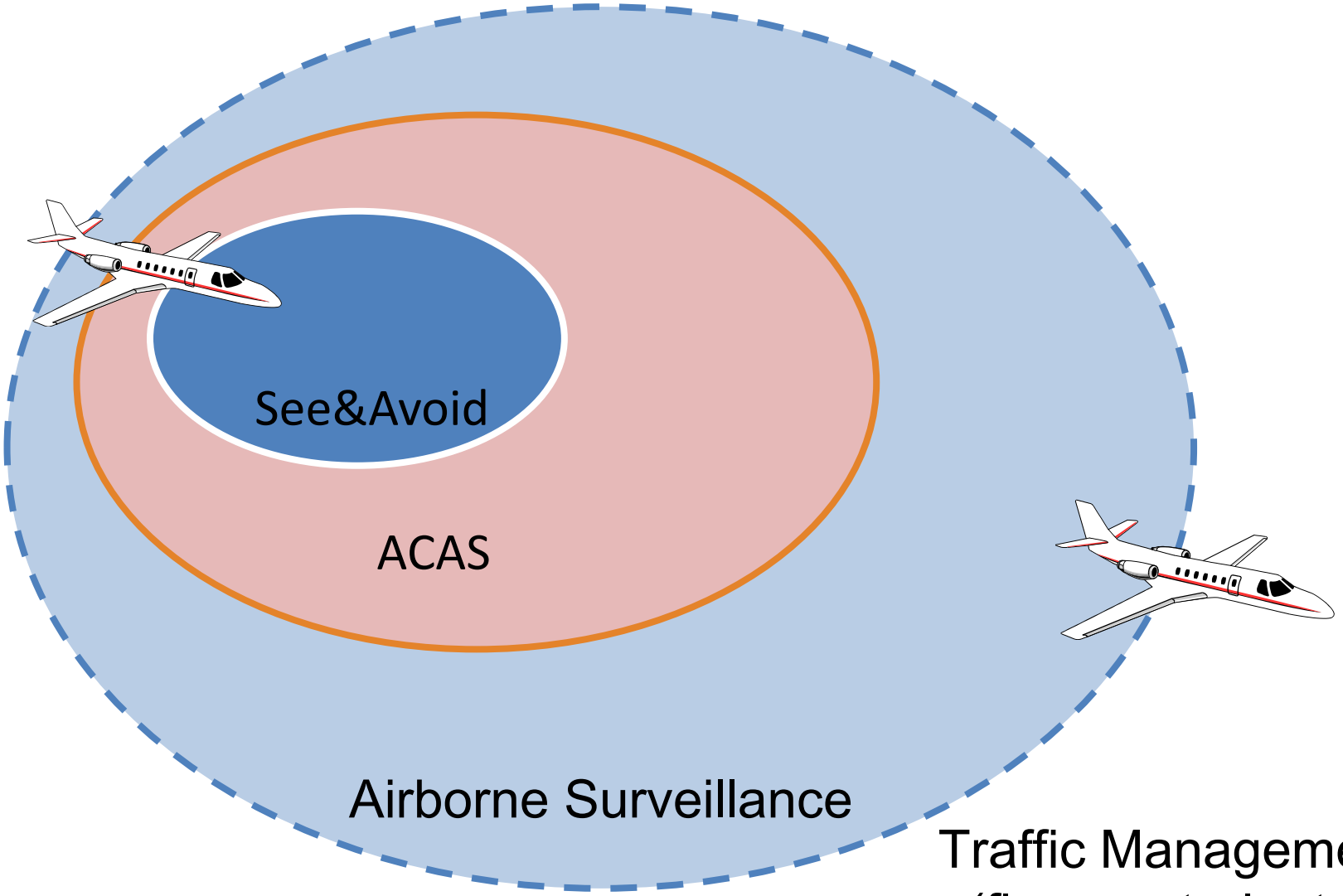
Abstract

Air traffic situational awareness is an essential factor for flight safety and efficiency. Today, pilots have only two methods for situational awareness with, through visual acquisition or with traffic information via voice messages from Air Traffic Controllers. These methods have limitations in reducing aircraft separation because of their delay in acquiring traffic. To improve the acquisition of traffic information, airborne surveillance with a ADS-B/TIS-B has been proposed. This paper reports on the prototype TIS-B system developed by ENRI and on the results of evaluations with flight testing.

Surveillance Area

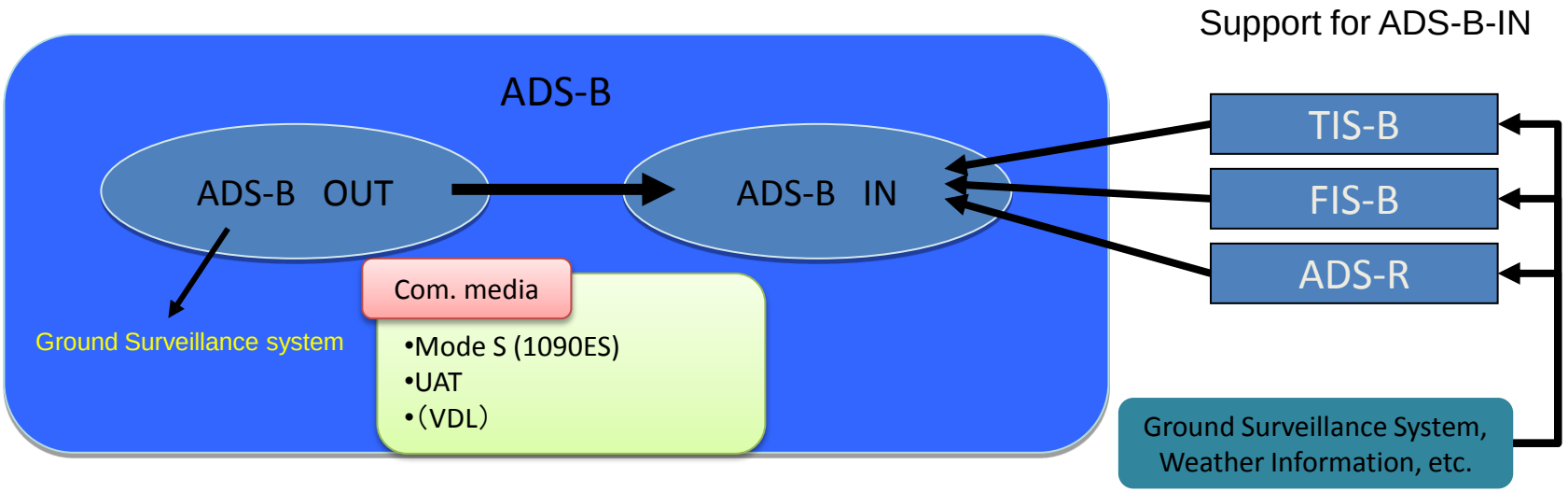


Traffic Management
(flow control, etc.)

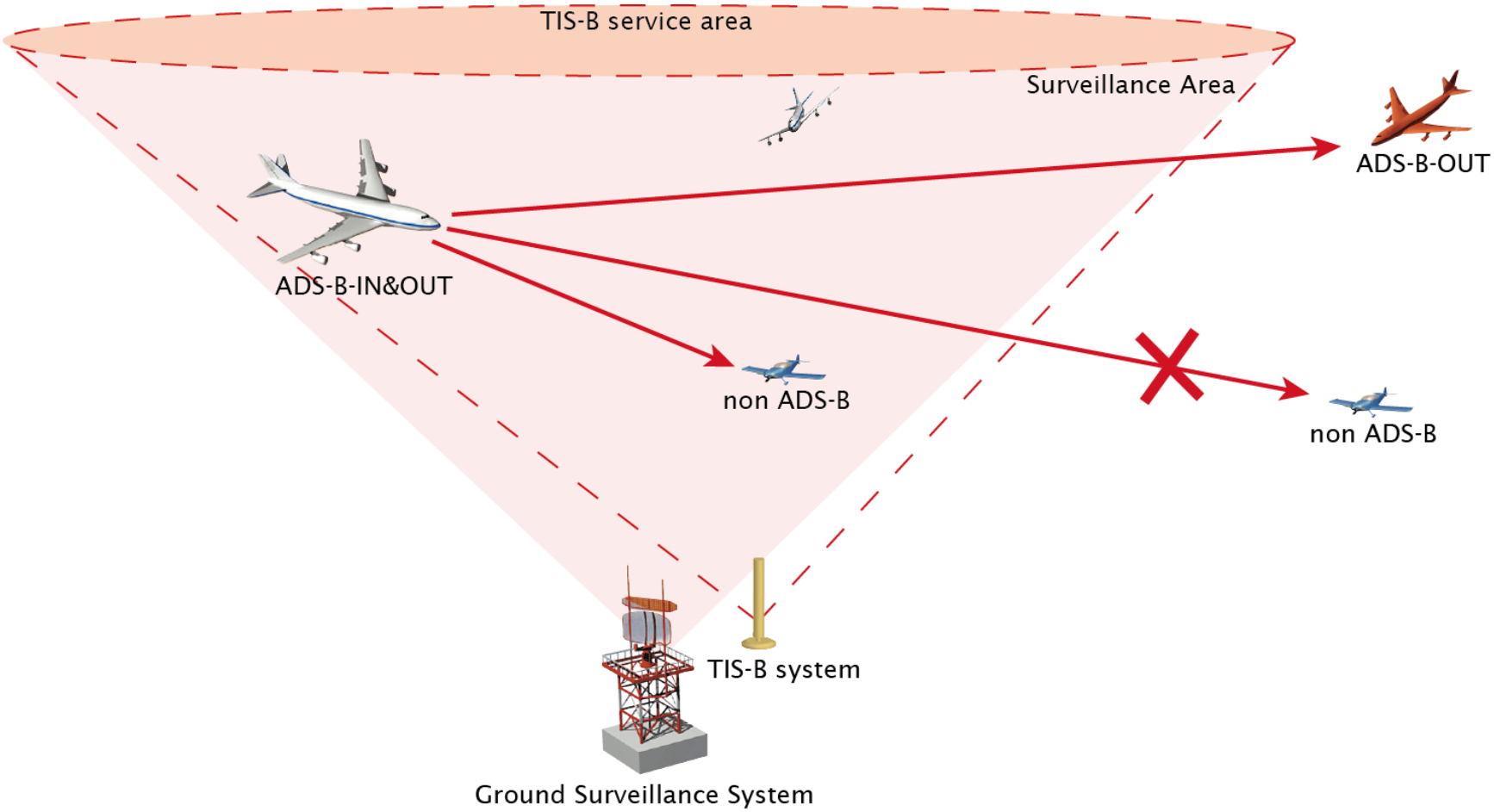
What is TIS-B ?

Traffic Information Service – Broadcast

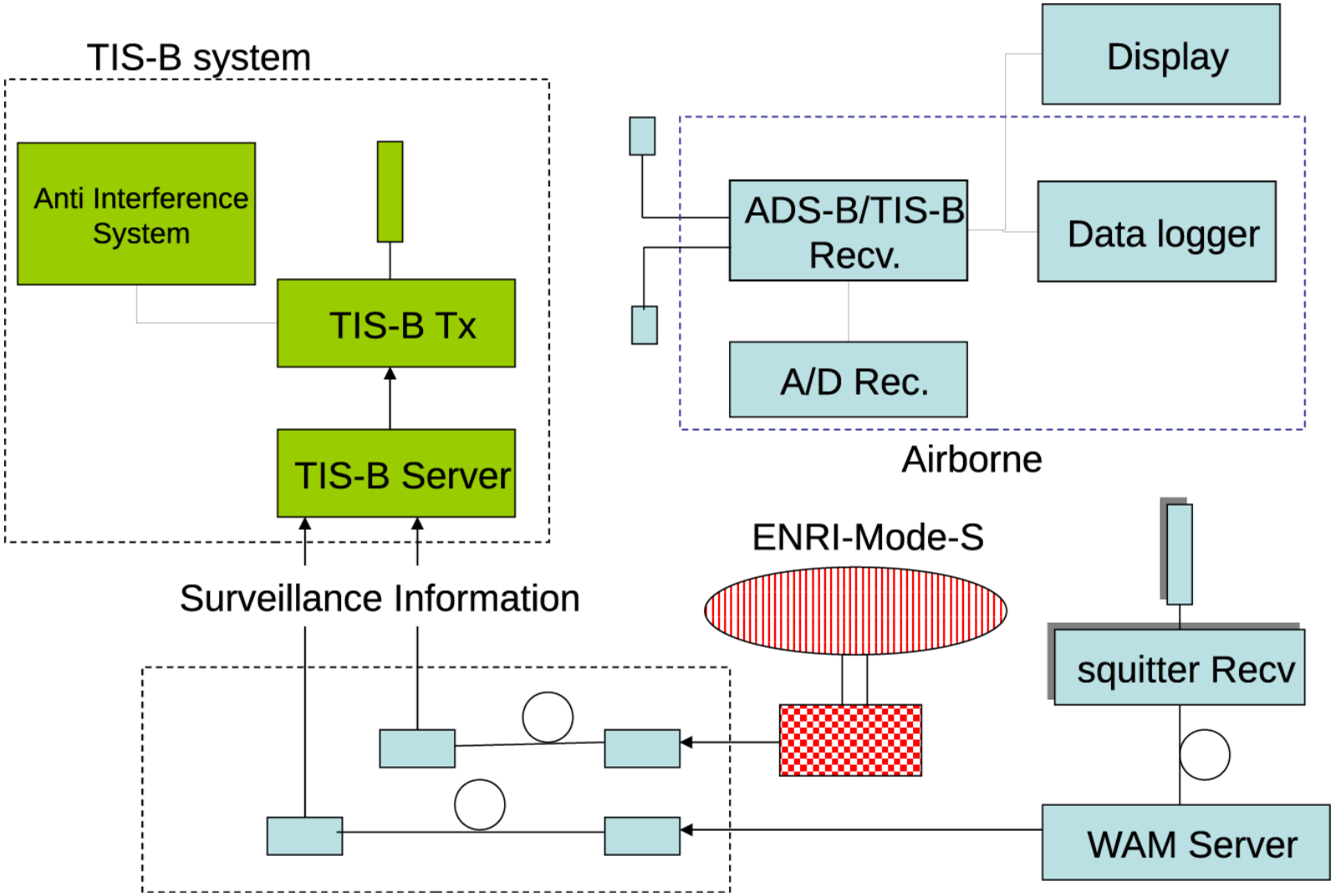
TIS-B is a function in which transmitters on the ground provide aircraft with information about nearby aircraft. The TIS-B information is likely to come from ground-based surveillance sensors such as air traffic control radars or multilateration systems.



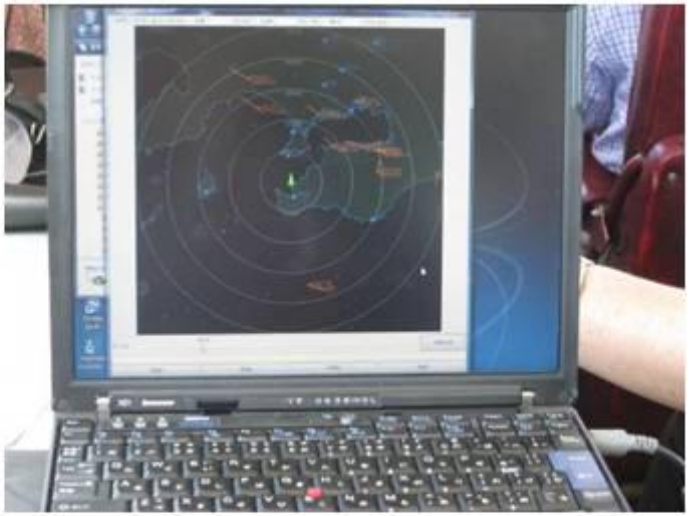
ADS-B and TIS-B system



ENRI prototype TIS-B system

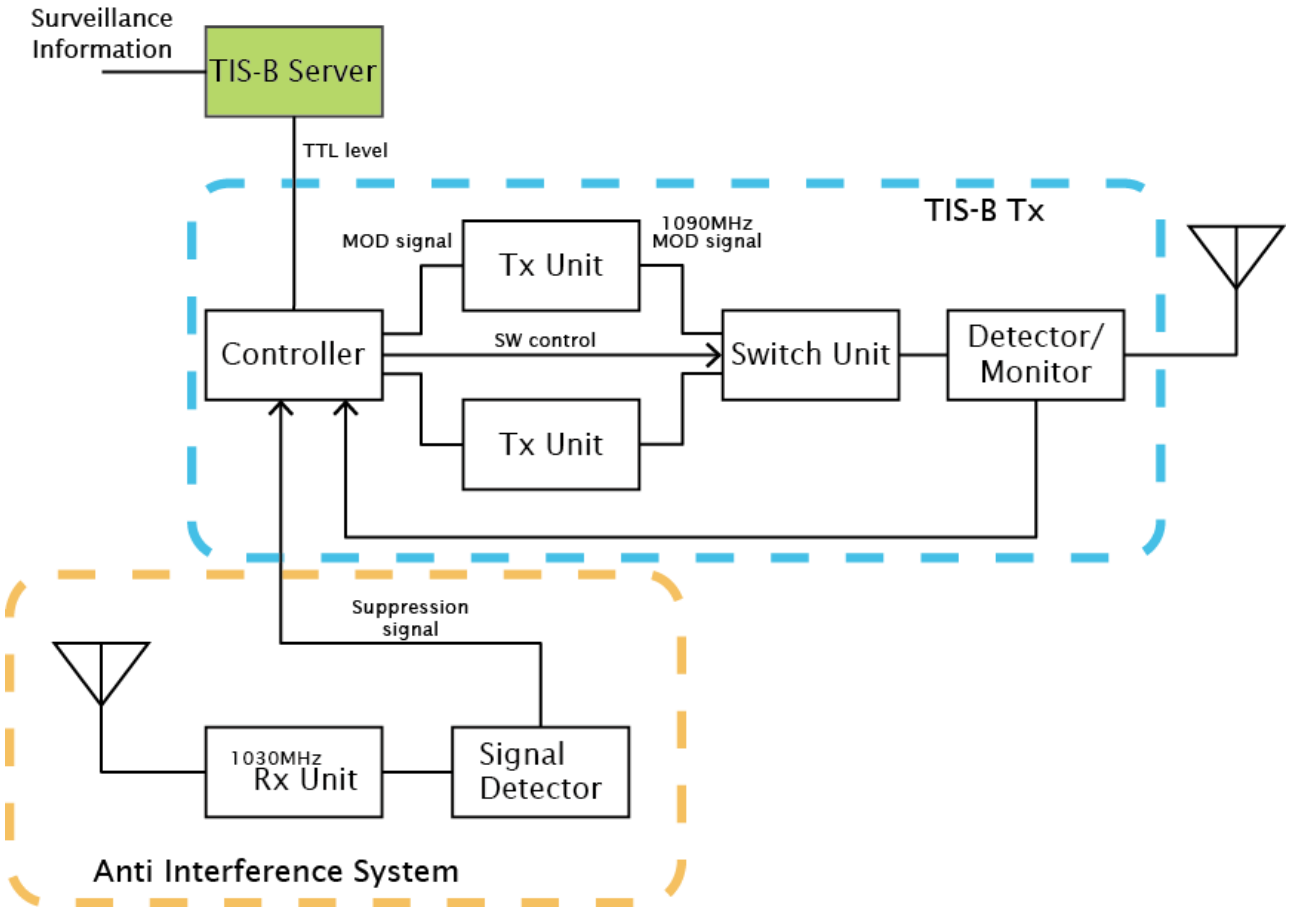


ENRI Prototype TIS-B system



The left is the ground station, the center is the ADS-B/TIS-B receier on the aircraft, and the right is the PC-based data display.

Ground System



TIS-B system Tx Power

- TIS-B Service Assumption
  - TIS-B Service Area → 50NM (propagatoin loss -133dBm)
    - Target Application: ATSA-AIRB, ATSA-VSA
  - Receiver MTL (minimum trigger level) → -84dBm
  - Antenna Gain
    - Ground → 8dBi
    - airborne → 0dBi
  - Line loss → 3dB
  - Link margin → 6dB

Tx power → 53dBm (200W)

Transmission Rate

Aircraft ADS-B message

3.1 Hz

The maximum ADS-B Message transmission rate of non-transponder ADS-B Transmitter implementations shall not exceed 6.2 transmitted messages per second.

Aircrafts within service volume

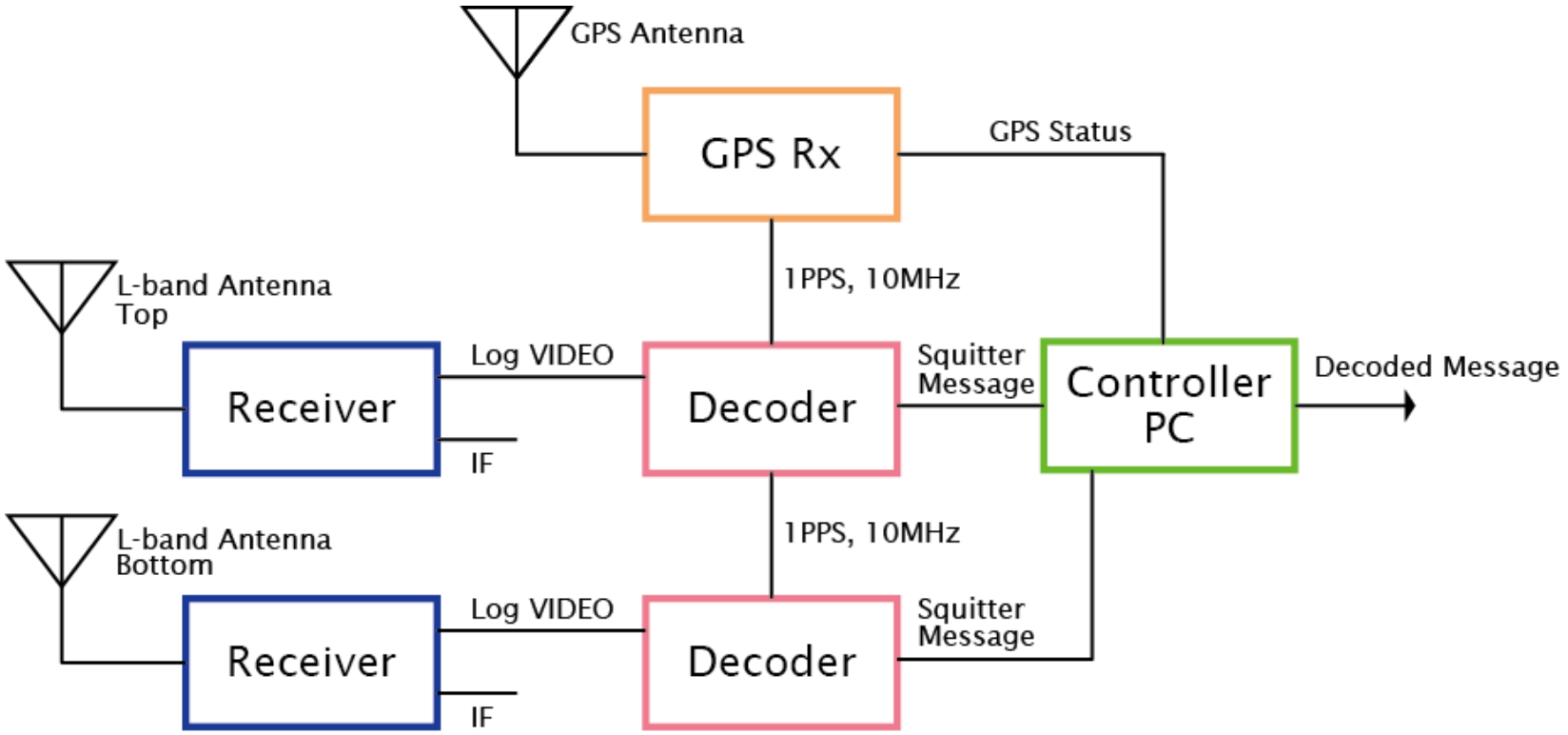
250

The SSR mode S which uses one of our surveillance data sources can process 250 aircraft per second.

775 Hz

We decided to allow 1000 messages per second system margin

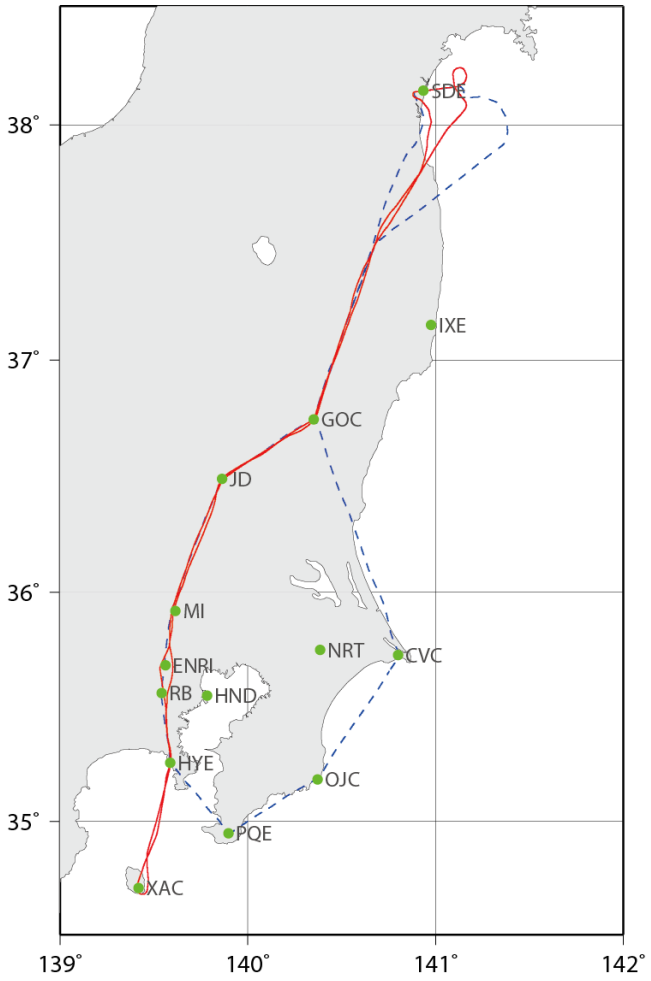
On-board Receiver system



Feasibility flight test

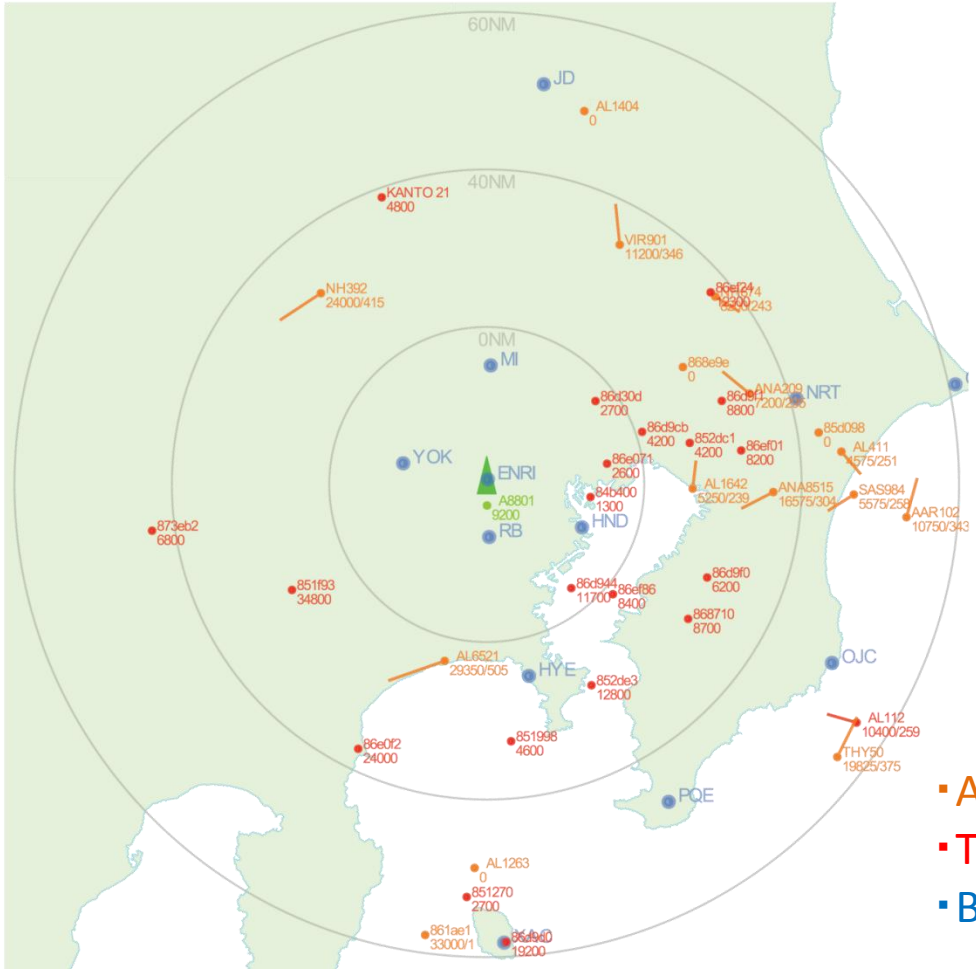
- Installed a receiver and display system on ENRI B99
- Flight route
  - SDE-GOC-JD-MI-RB-YXE-XAC
  - SDE-GOC-CVC-OJC-PQE-YAE -RB-MI-JD-GOC-SDE
- Surveillance data: ENRI-SSR (at Chofu)
- on-board receiver MTL = -79dBm
  - receiver noise level is -96dBm

Flight route



The flight route and beacon stations. Solid line indicates round trip route between Sendai(SDE) and Oshima(XAC). Dashed line indicate Kanto route.

Data Plot



Simplified data plot from received ADS-B/TIS-B messages while airborne. The green triangle at the center indicates the airborne position measured by GPS. Red points indicate TIS-B aircraft, orange points with bar indicate ADS-B transmitting aircraft.

Results of flight test

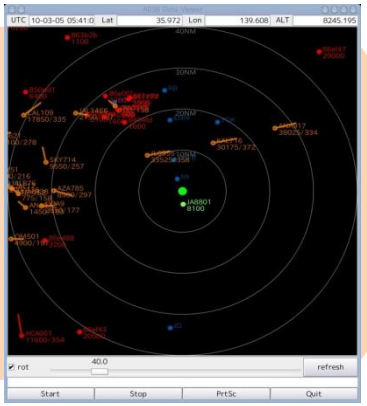
Transmitter Coverage: about 40NM

Signal reception rate: 10% (40Nm)
80% (around transmitter)

Before error correction

Easy to find aircraft

Display: Direction
Altitude
Callsign



We have determined the ability of the prototype TIS-B system. It is clear that our system has an enough ability as a TIS-B transfer system for simple applications such as aiding visual acquisition.

Summary and Conclusion

In this paper, we described our prototype TIS-B system using an 1090MHz extended squitter, and the results of evaluation through flight tests. From the results of the flight testing, we have determined the ability of the prototype TIS-B system. It is clear that our system has an enough ability as a TIS-B transfer system for simple applications such as aiding visual acquisition. We are currently developing a new TIS-B server which generates free text type squitter messages instead of RTCA standard. Using the new server, we will try to transmit more useful messages for flight safety with an extended squitter.

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