Evaluation Results of
Airport Surface Multilateration

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• Introduction
  ➤ Background, Purposes

• Overview of Multilateration (MLAT)
  ➤ Advantages, How to get high performance

• Evaluation Tests
  ➤ Method, Evaluation system, Results

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What is the Multilateration?

Multilateration is a new surveillance system which detects signals of aircraft transponders and measures the aircraft positions by TDOA technique.

TDOA: Time Difference of Arrival
Back Ground
(Why do we introduce MLAT)

• Increasing aviation demands have brought expansions of major airports

• Layouts and operations in the airports have become more complex

• To ensure safe and smooth operation in this situation, an essential requirement is to provide accurate and highly reliable surveillance information to controllers

Need to Introduce MLAT!!
Purposes of Evaluation
(Why do we evaluate MLAT)

ENRI has conducted evaluation tests of MLAT by using an evaluation system at major airports. Main purposes are:

• To verify performance at each airport

• To propose optimal receiver antenna layout based on the test results
In This Presentation

• Evaluation results at Kansai international air port (A/P)
• Kansai A/P has specific restrictions for antenna layout
  ➔ Surrounded on all four sides by sea
  ➔ Not install antennas on the top of the terminal building
• To overcome above restrictions
  ➔ Provide our lessons learned from evaluations
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View from ATC tower
Conventional Surface Surveillance System  
(SMR: Surface Movement Radar)

- SMR has some **problems** such as:
  - No identification information on the controller screen
  - Performance degradation in the bad weather condition
  - Blind area blocked by large airport buildings
Advantages of MLAT

- Call sign display on a controller screen
- Good Performance in all weather conditions
- No blind area by adapting the antenna layout
- No additional avionics equipment to aircraft
Principle of Positioning

Hyperbolic lines: $a - b = \text{“Constant”}$
Principle of Positioning

Hyperbolic lines calculated by TDOA between Receiver A and Receiver B
Principle of Positioning

Hyperbolic lines calculated by TDOA between Receiver B and Receiver C
Principle of Positioning

The aircraft position is fixed as Intersection of two hyperbolic lines
How to Get High Performance

- **Positional relationship** between aircraft and receivers

![Diagram showing good and bad relations](image)

- **Good relation**
- **Small error**

- **Bad relation**
- **Large error**
How to Get High Performance

- To avoid signal interference by reflection of buildings

Direct signal →\text{Multipath signal} \rightarrow \text{Difficult to decode}

No detection
Not positioning
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Evaluation Method

- Evaluation items: Detection rate, Position Accuracy

- European standard: Performance requirement

<table>
<thead>
<tr>
<th></th>
<th>Detection Rate</th>
<th>Position Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runway/Taxiway</td>
<td>More than 99.9% (2s)</td>
<td>Less than 7.5m</td>
</tr>
<tr>
<td>Gate (Spot)</td>
<td>More than 99.9% (5s)</td>
<td>Less than 20m</td>
</tr>
</tbody>
</table>

- Evaluation by a Test vehicle equipped with a transponder

- To collect data efficiently to large evaluation areas

Transponder Antenna
Evaluation System

Receiver unit

Antenna

Target processor

1m

50cm
Antenna Layout
(Our Concept)

- Our experiences from past evaluations
  - Performance degradation: Signal interference
  - Big problem: Huge installation cost
  - Large number of RUs: Bring overload of the processor

- To avoid above problems
  - To locate antennas as high as possible
  - To install antennas in existing facilities as much as possible
  - To keep the number of RUs as low as possible
Antenna Layout
(Restricted Conditions)

- Surrounded on all four sides by sea
  - Difficult to install antennas widely around the airport
  - Antenna height is restricted by transition surface
  - Strong restriction for MLAT to get high performance at runway/taxiway area
Antenna Layout
(Restricted Conditions)

• Sophisticated terminal building in Kansa A/P
  ➤ To install antennas on the top of the terminal building is restricted due to a standpoint of the design
  ➤ Strong restriction for MLAT to get high performance at apron area
Layout of RU antennas

- ATC tower
- ILS Middle Marker
- ILS Glide Slope
- A/G tower
- Roof of cargo building
Layout of RU antennas

2 RUs were installed on top of ATC tower

Installation cost is cheaper than Haneda, Narita

Number of RUs: 18 units is smaller than Haneda, Narita
Test Results
(Runway/Taxiway Area)

- **B runway area**
  - Accuracy: 6.3m
  - Detection: 100%

- **J3 taxiway area**
  - Accuracy: 6.5m
  - Detection: 100%

- **A runway area**
  - Accuracy: 6.8m
  - Detection: 100%

**Requirements**
- Detection: 99.9%
- Accuracy: 7.5m
Test Results
(Apron Area)

Accuracy: 11m
Detection: 100%

Accuracy: 57m
Detection: 41%

Accuracy: 13m
Detection: 100%

Accuracy: 15m
Detection: 100%

Accuracy: 9.6m
Detection: 100%

Requirements
Detection: 99.9%
Accuracy: 20m
Test Results
(Apron Area)

Accuracy: 57m
Detection: 41%

Surrounded all four side by building

Most difficult area
Most Difficult Area
Lessons learned from the Evaluation

- An apron area where is surrounded on all four sides by building is most difficult area to get good performance

- To improve performance in such area, it is considered that some advanced techniques are required for signal detection and processing
Conclusion

- MLAT is a new surface surveillance system to be able to improve functions and performance.
- Performance values satisfied requirements to almost area.
- Restrictions to install antennas exist in airports.
- Our lessons learned from the evaluation are effective.
- The operation at Kansai A/P will start next year.
Thank you for your attention!!
Any questions?