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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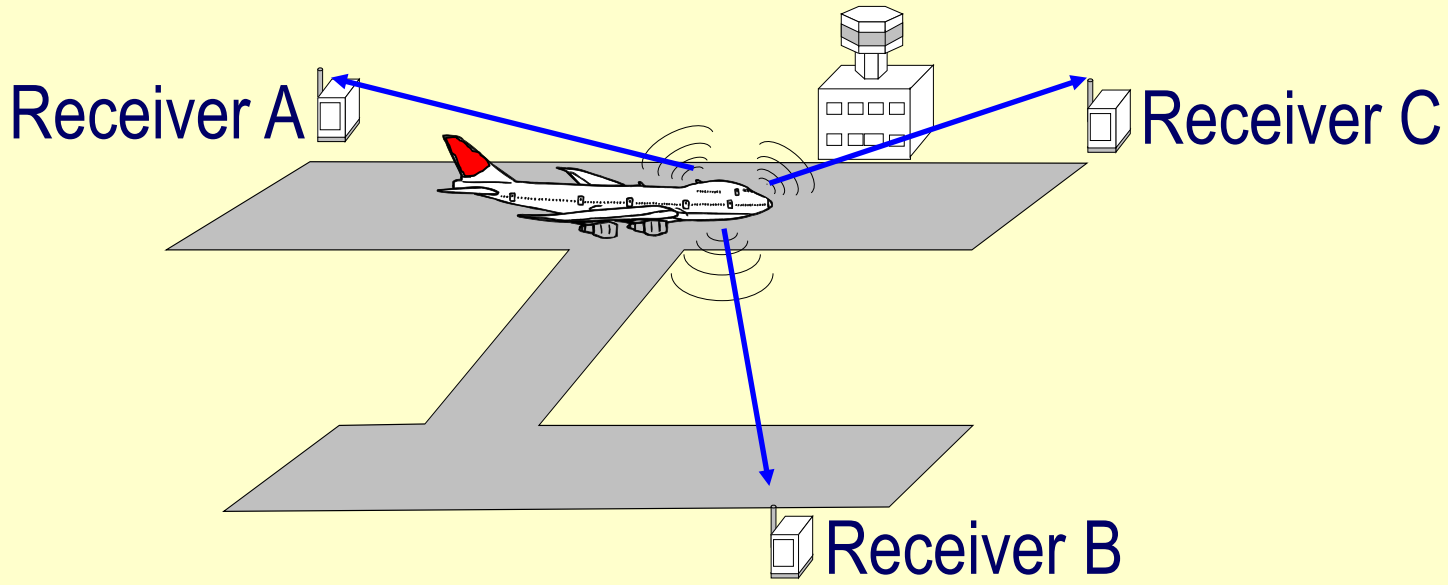
What is the Multilateration?

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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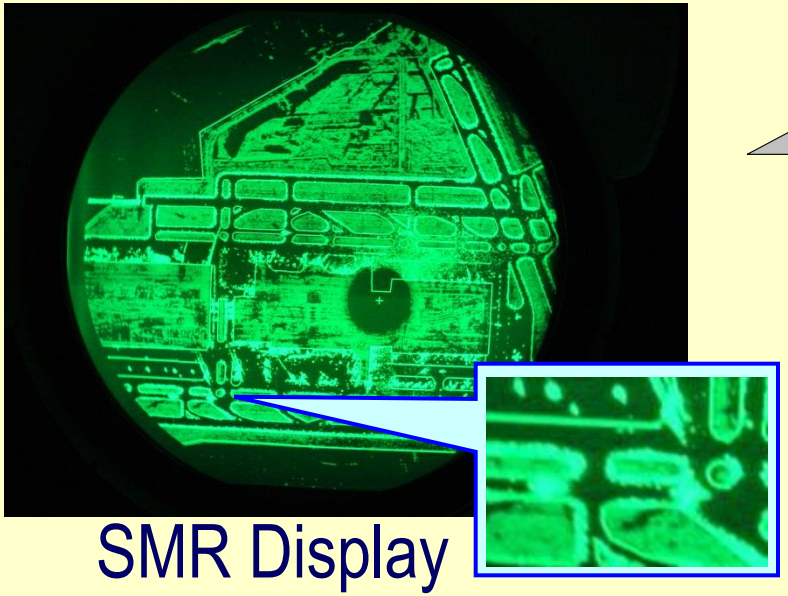
View from ATC tower

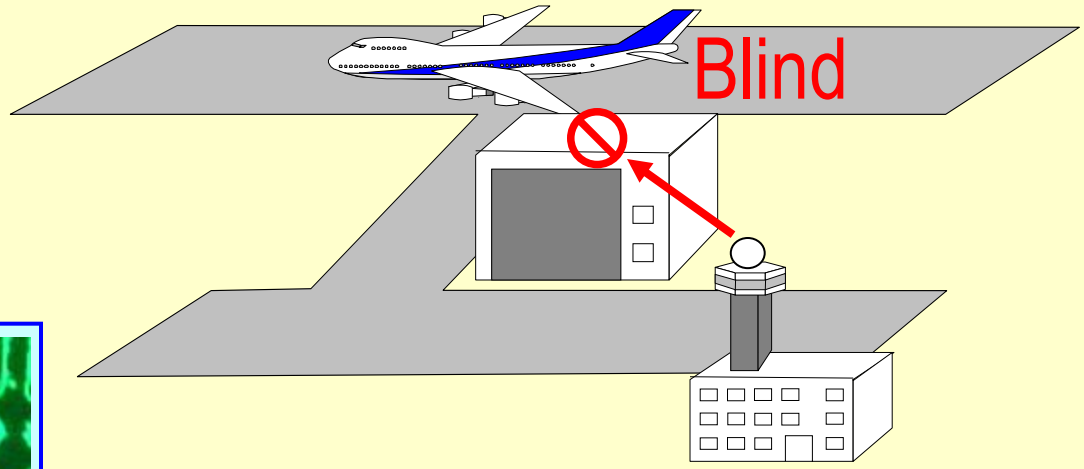
Conventional Surface Surveillance System

(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

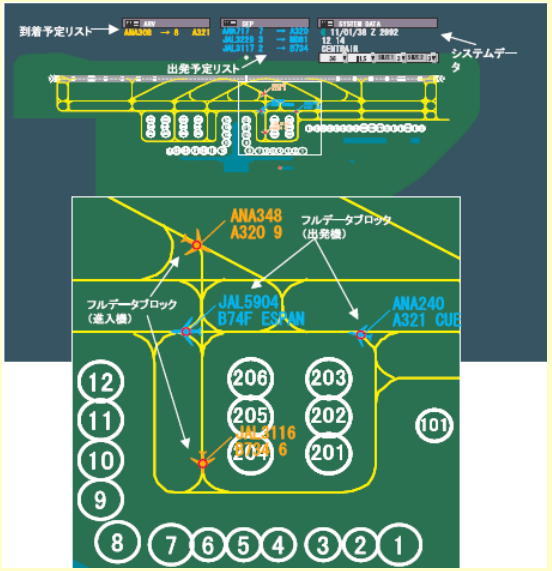


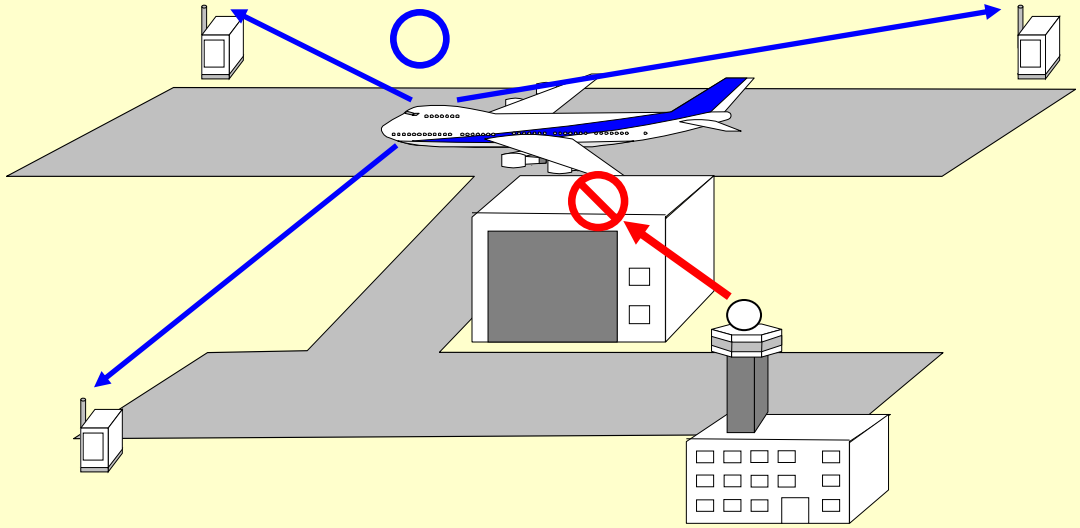
SMR Display



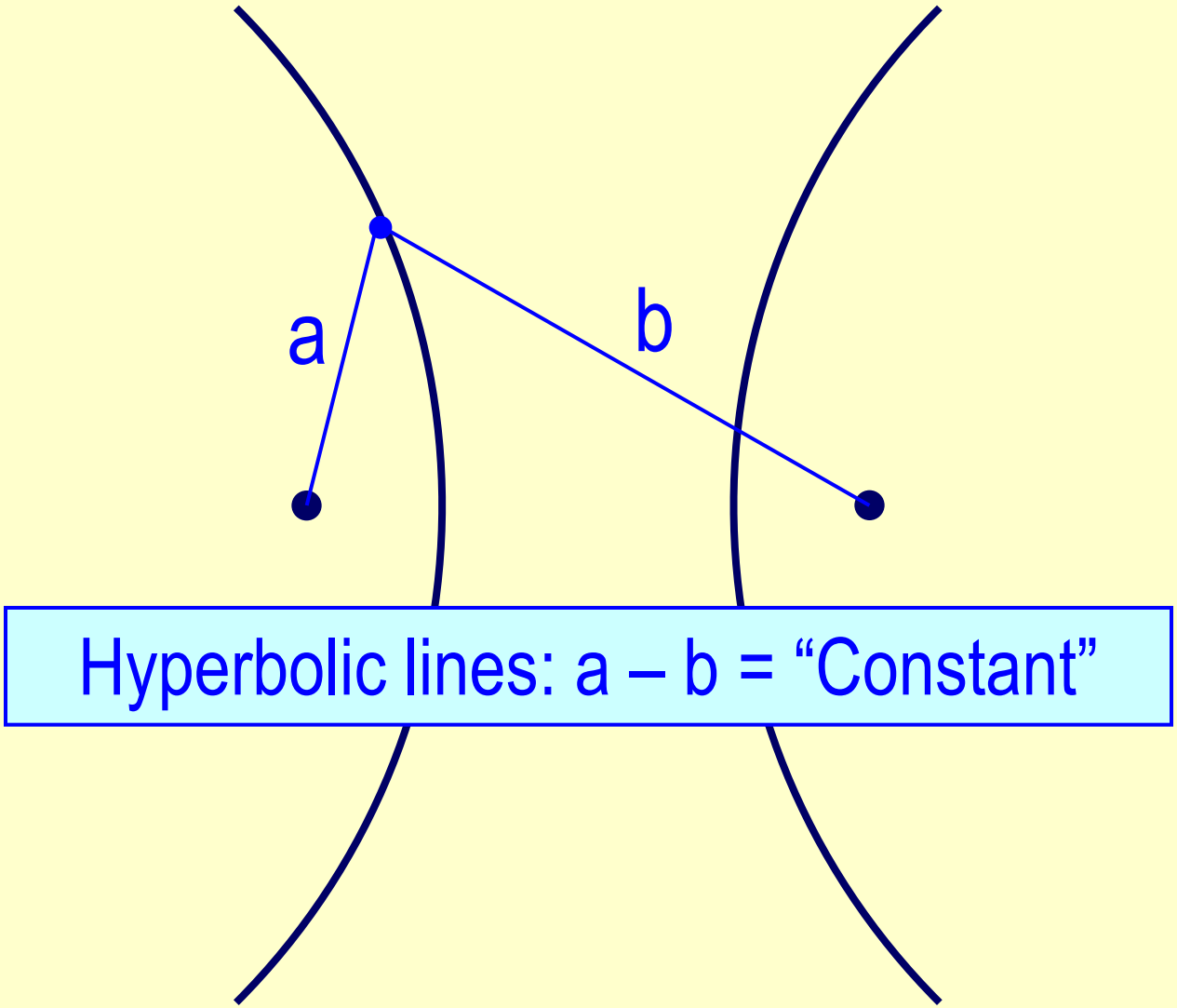
Advantages of MLAT

- 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



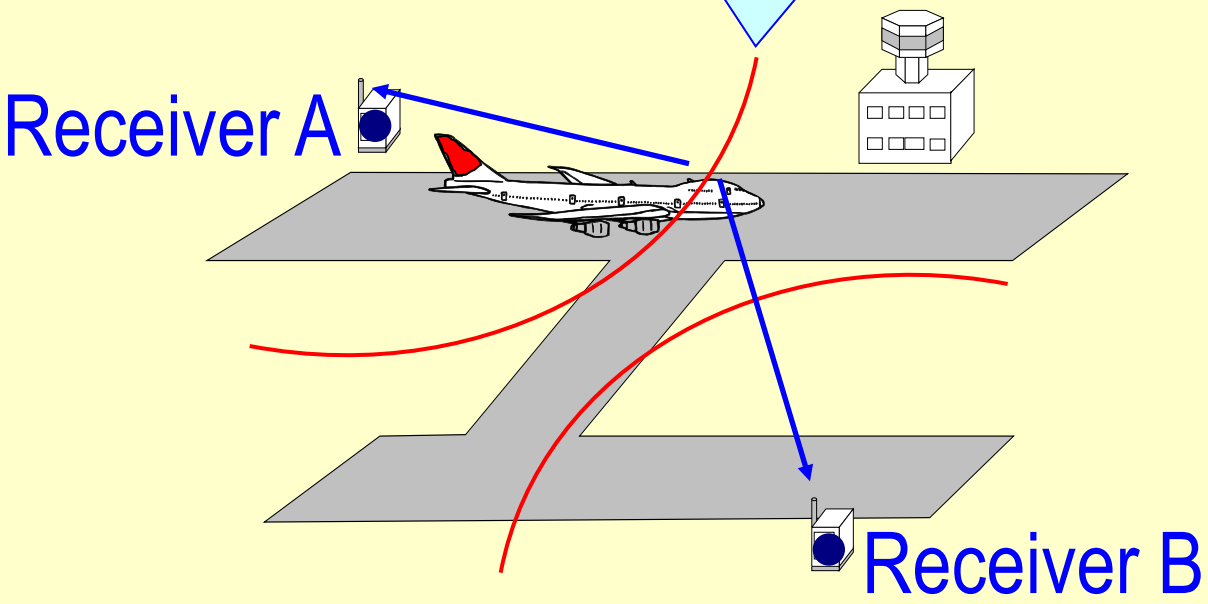


Principle of Positioning



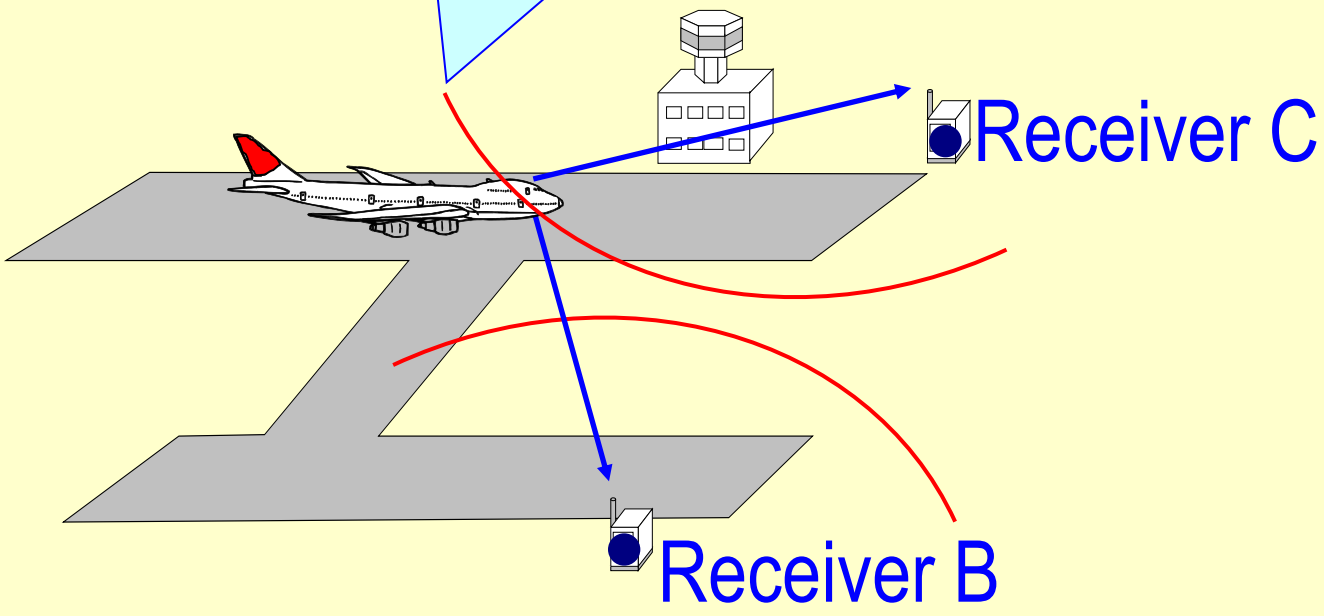
Principle of Positioning

Hyperbolic lines calculated by TDOA between Receiver A and Receiver B



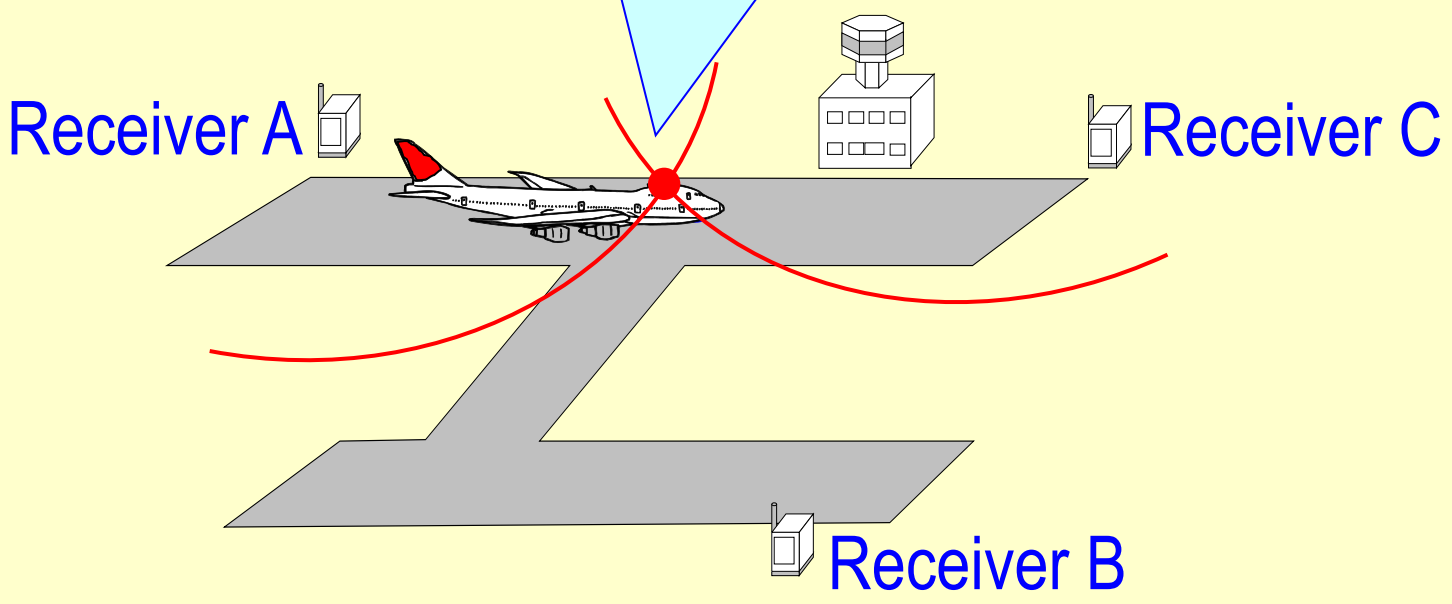
Principle of Positioning

Hyperbolic lines calculated by TDOA between Receiver B and Receiver C



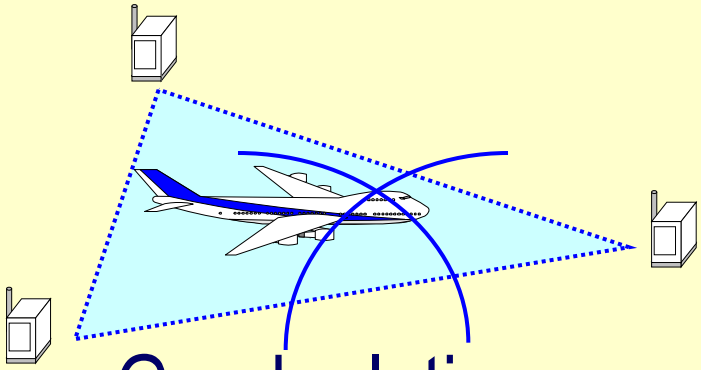
Principle of Positioning

The aircraft position is fixed as Intersection of two hyperbolic lines

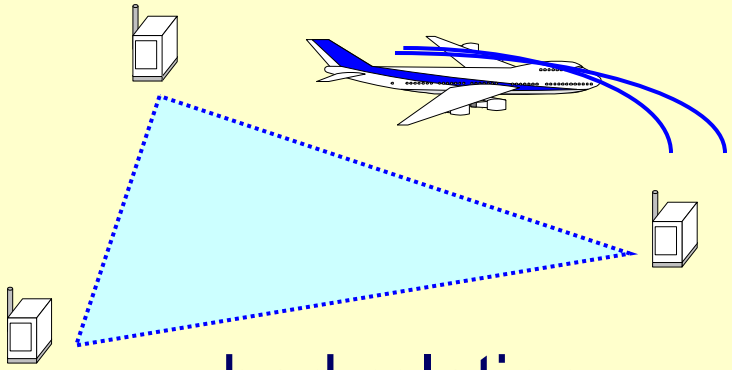


How to Get High Performance

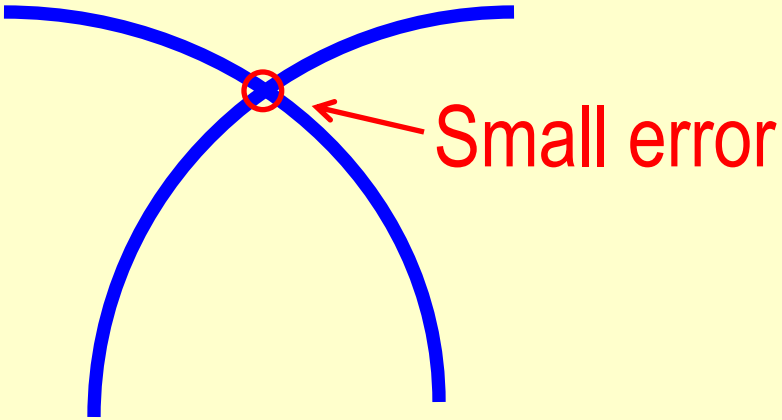
- Positional relationship between aircraft and receivers

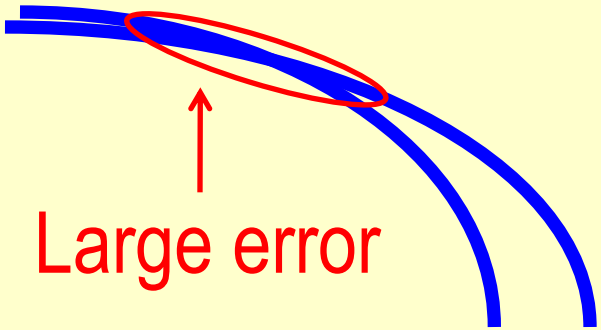


Good relation



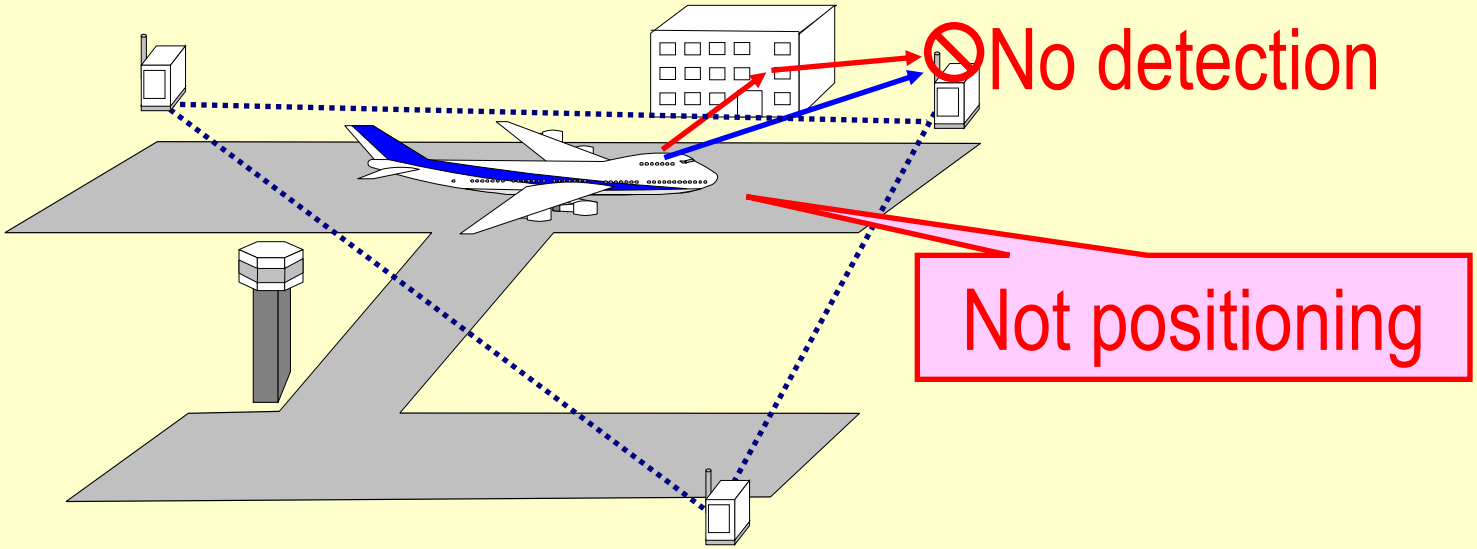
bad relation

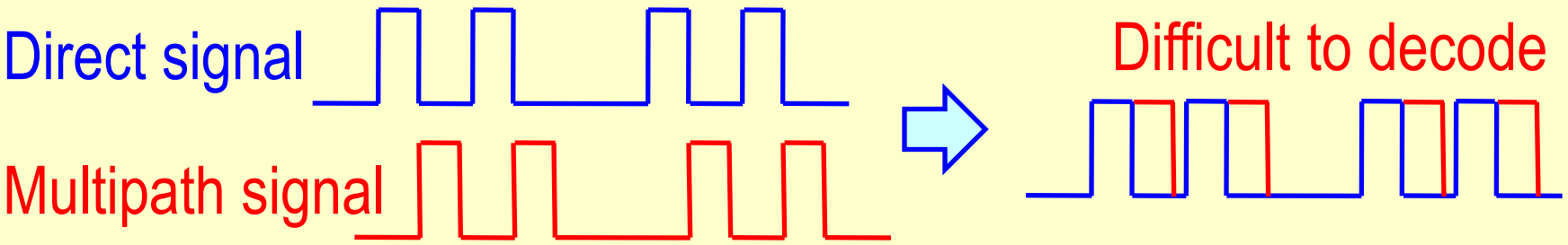




How to Get High Performance

- To avoid signal interference by reflection of buildings





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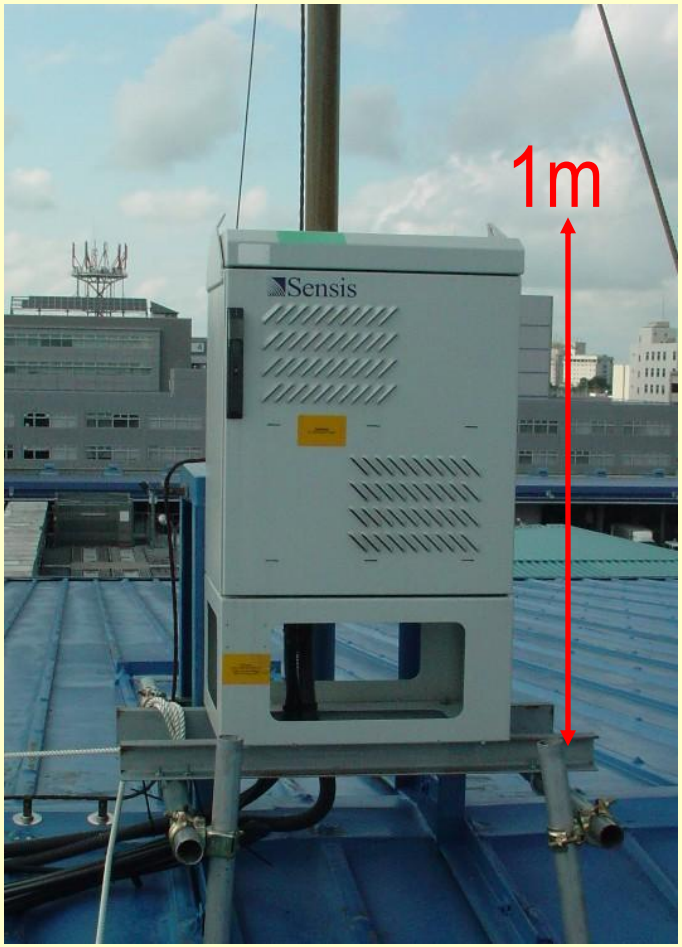
Evaluation Method

- Evaluation items: Detection rate, Position Accuracy
  - European standard: Performance requirement

	Detection Rate	Position Accuracy
Runway/Taxiway	More than 99.9% (2s)	Less than 7.5m
Gate (Spot)	More than 99.9% (5s)	Less than 20m

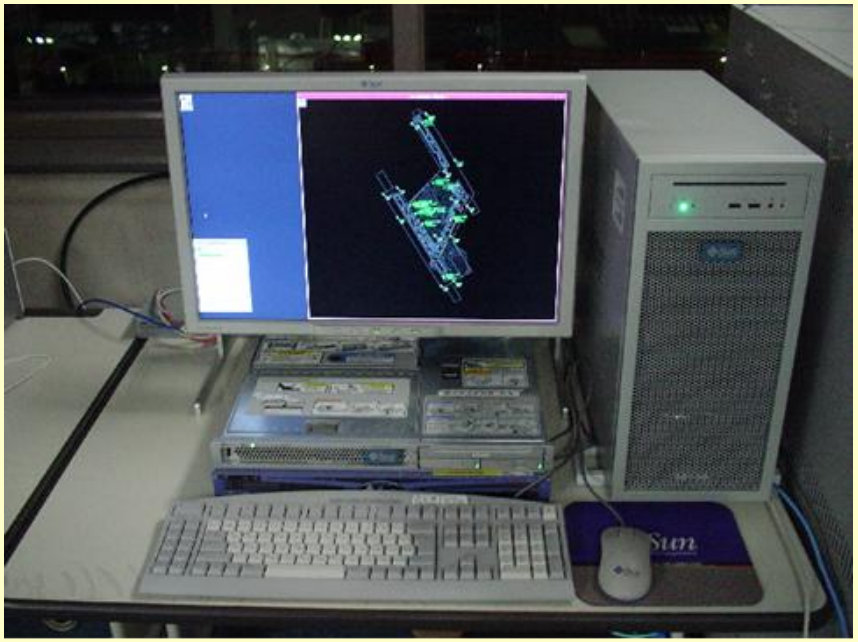
- Evaluation by a Test vehicle equipped with a transponder
  - To collect data efficiently to large evaluation areas

Evaluation System



Receiver unit

Antenna



Target processor

Antenna Layout
(Our Concept)

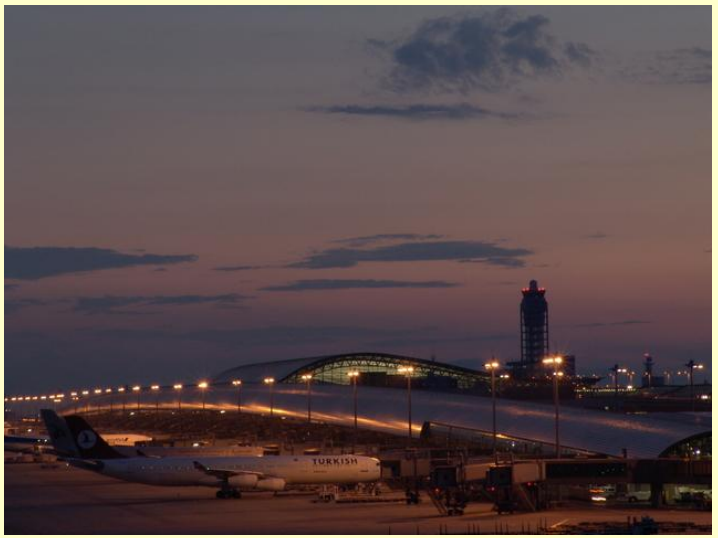
- Our experiences from past evaluations
  - Performance degradation: Signal interference
  - Big problem: Huge installation cost
  - Large number of RUs: Bring overload of the processor
- To avoid above problems
  - To locate antennas as high as possible
  - To install antennas in existing facilities 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

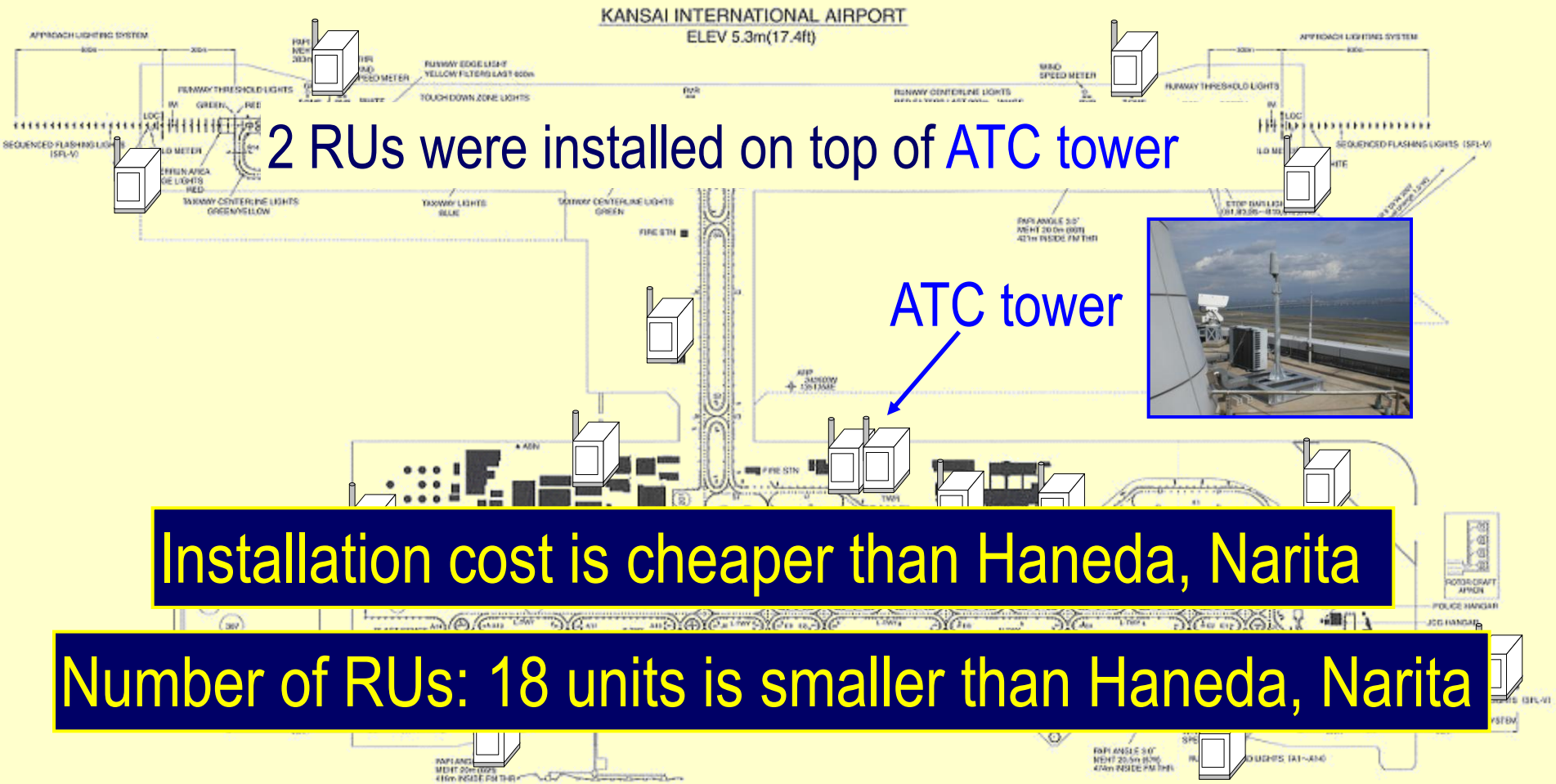
Antenna Layout
(Restricted Conditions)

- 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

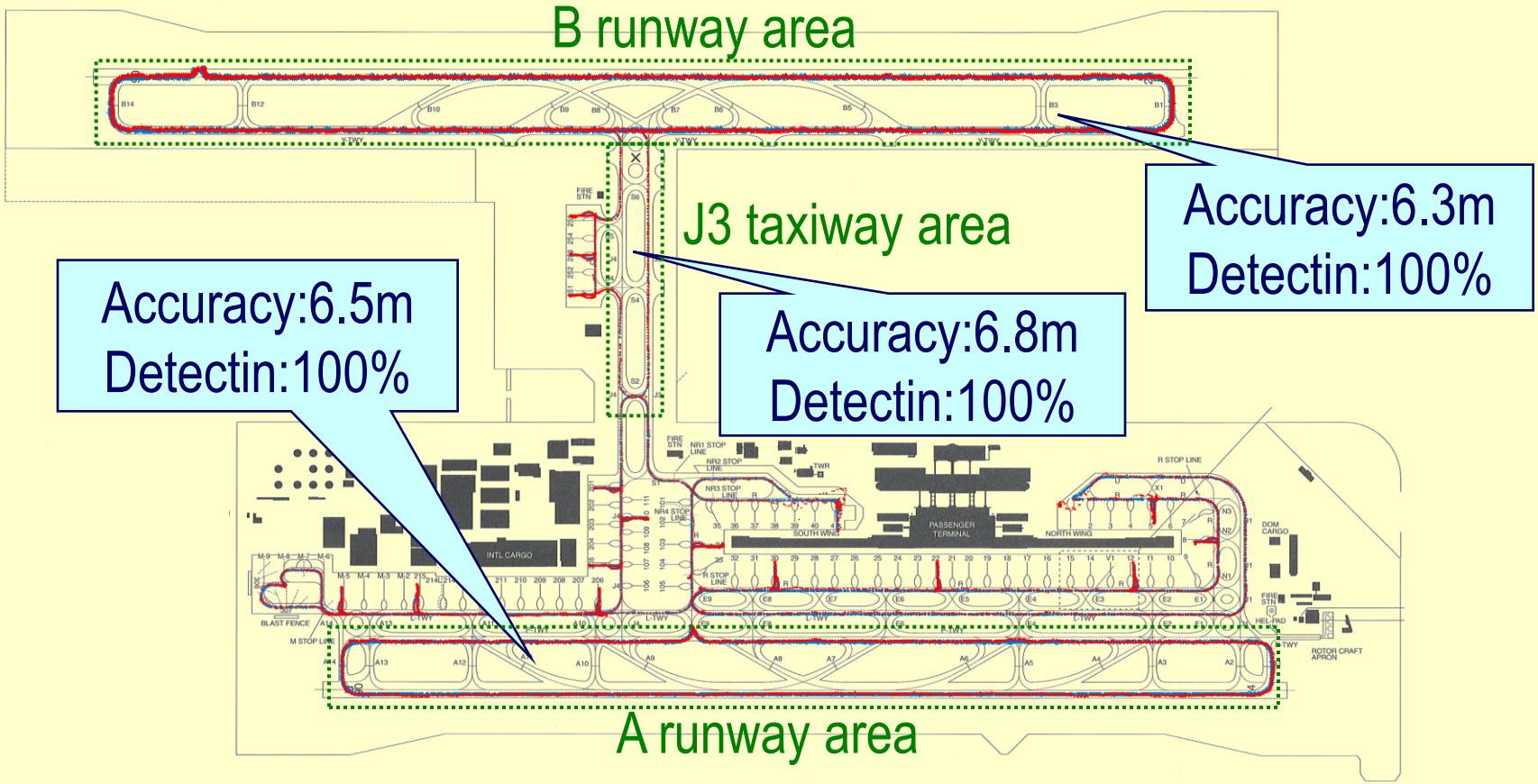


Layout of RU antennas

Layout of RU antennas

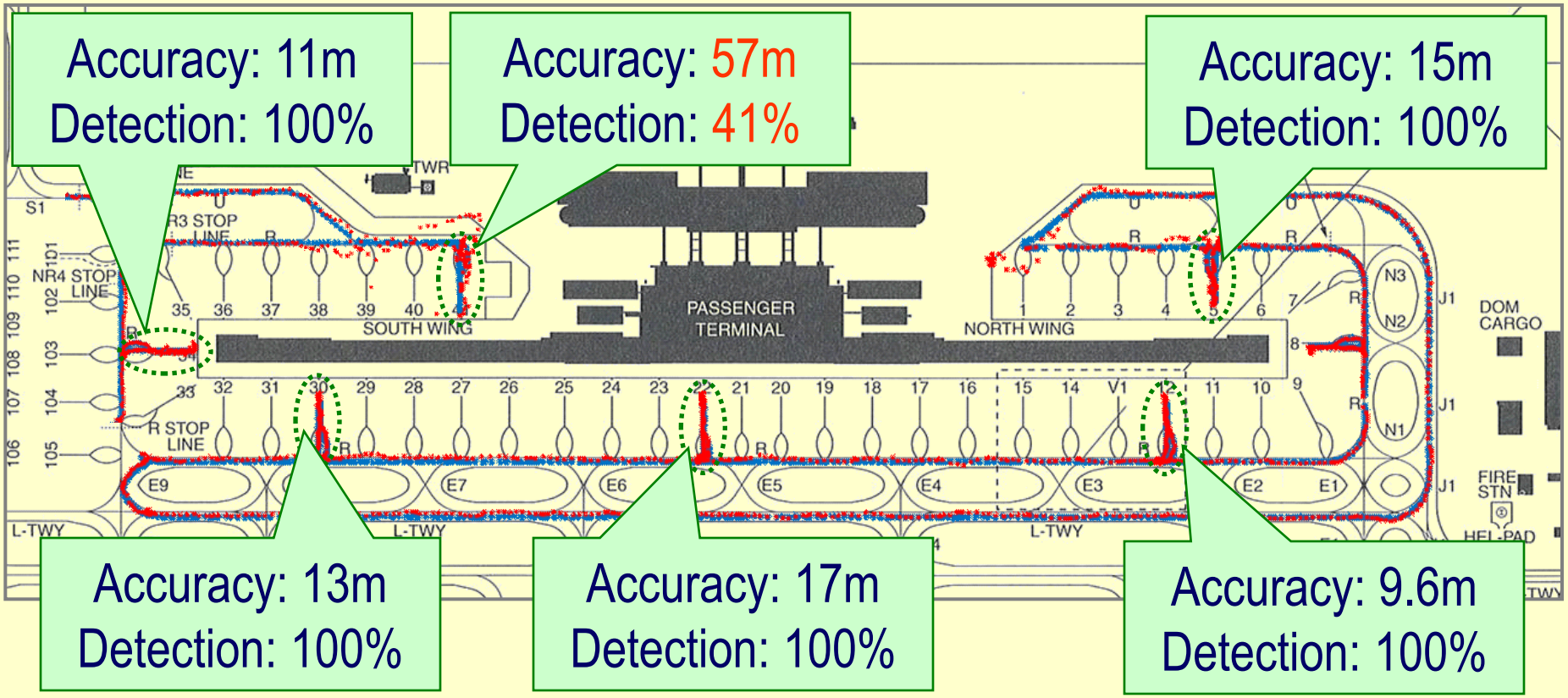


Test Results
(Runway/Taxiway Area)



Requirements	Detection: 99.9%	Accuracy: 7.5m

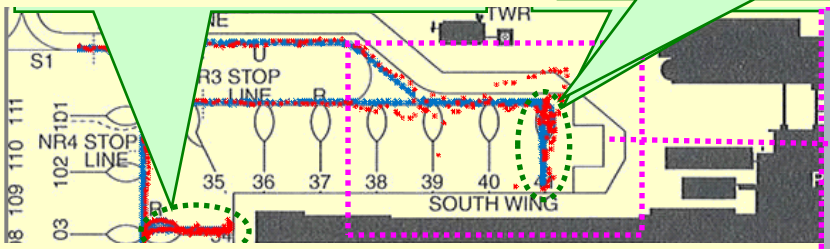
Test Results
(Apron Area)



Requirements	Detection: 99.9%	Accuracy: 20m

Test Results
(Apron Area)

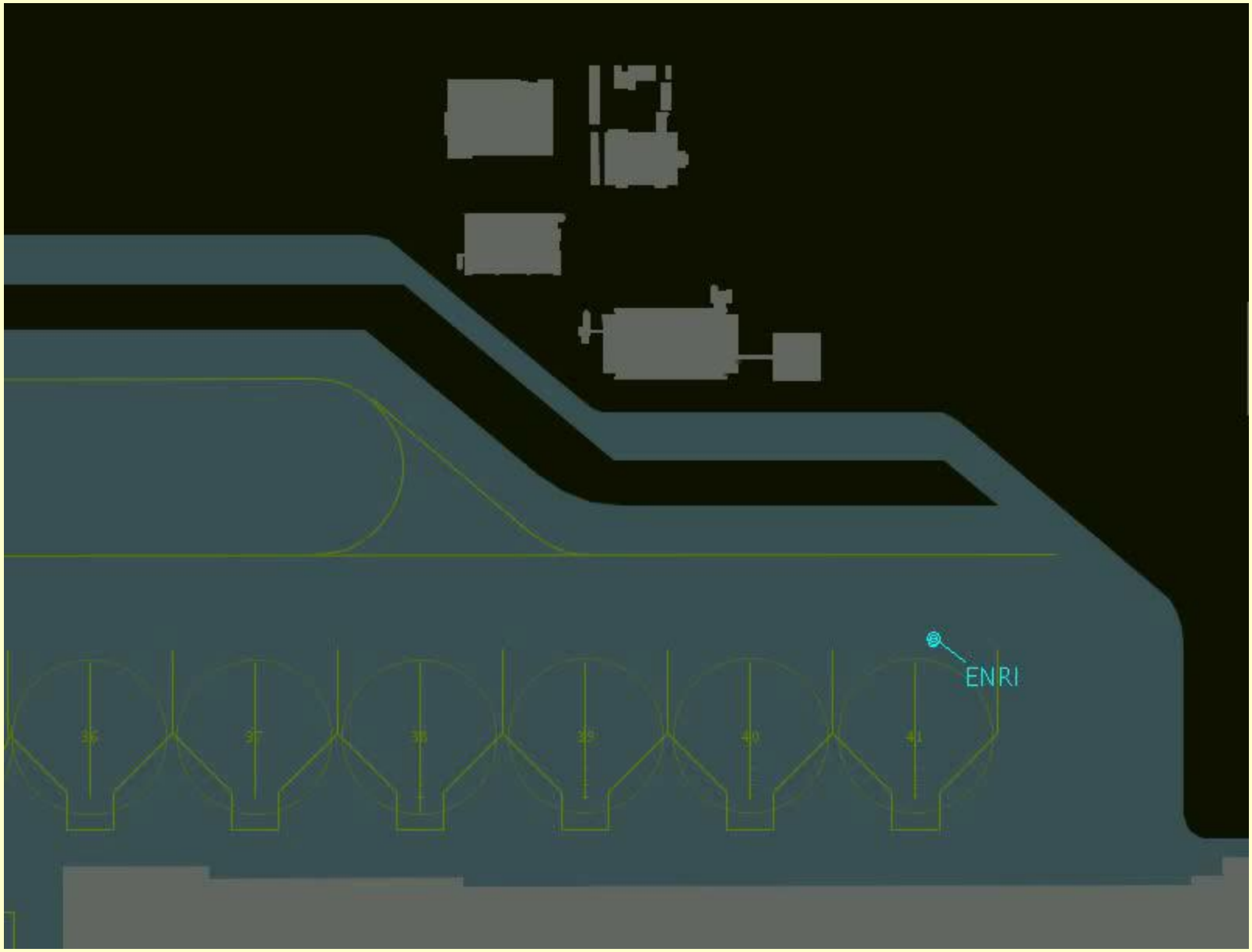
Accuracy: 57m
Detection: 41%



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?