

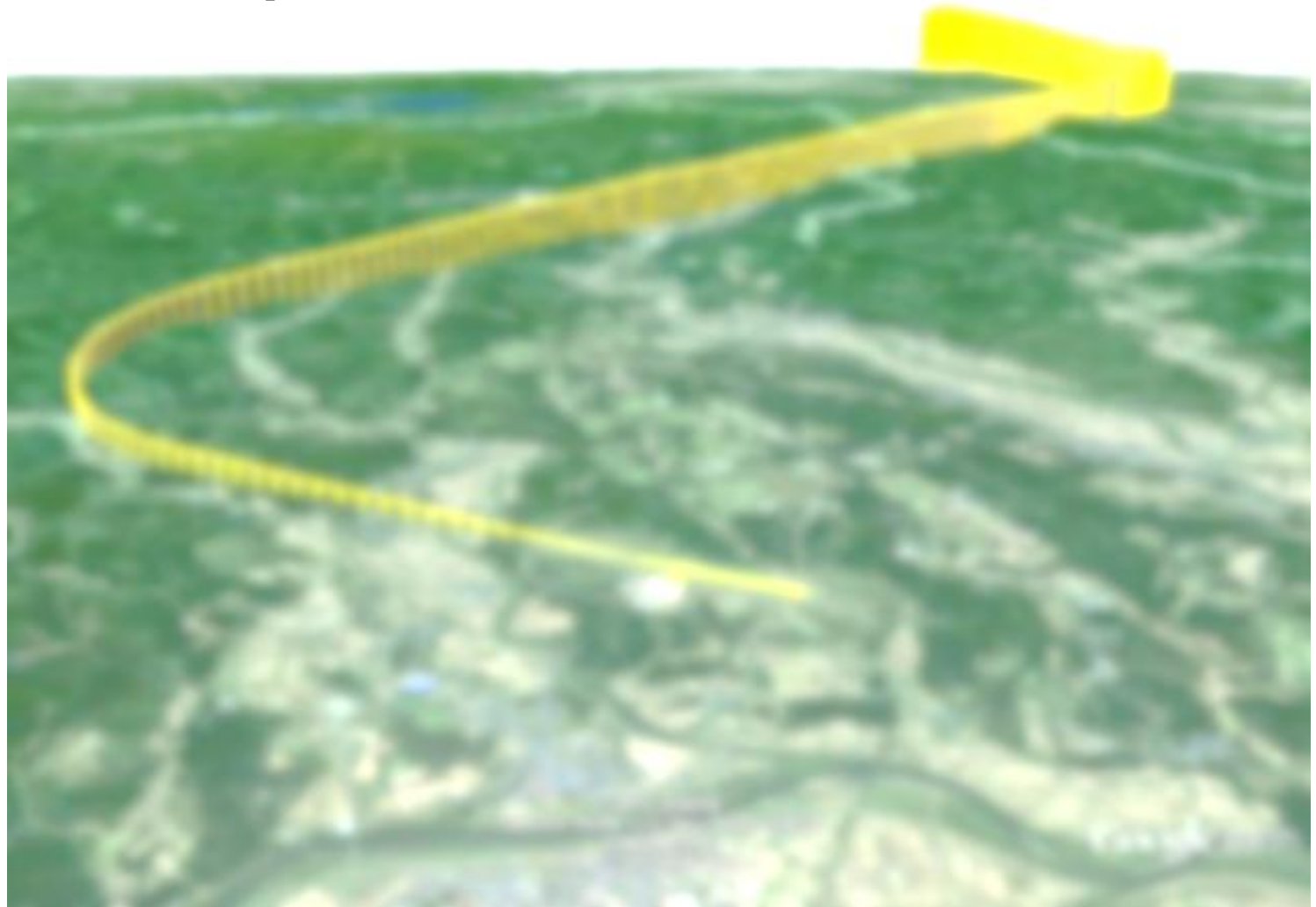
# Eco-Flight Activities by Japanese Operators

Japan-US Aviation Environmental Workshop  
Fukutake Hall University of Tokyo  
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B787 Technical Pilot, Dr. Eng.



# Fundamentals of PBN (RNAV / RNP)



## Kinds of Navigation

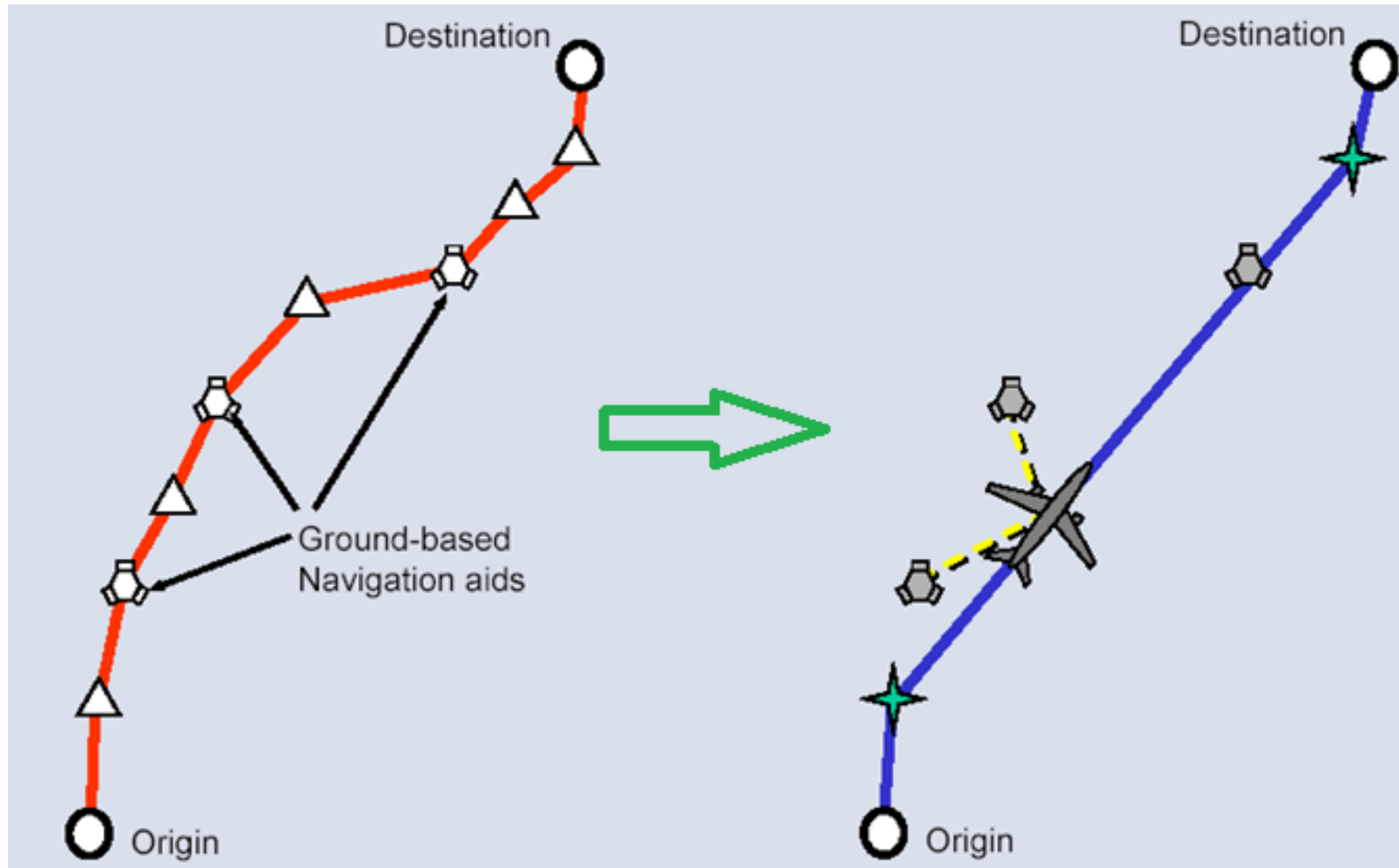
- **Conventional**

- ✓ Route consists of Navigation Radio Station (VOR, DME, NDB, ILS and etc)

- **PBN (Performance Based Navigation)**

- ✓ RNAV or RNP
- ✓ Route consists of waypoints, which are independent from Navigation Radio Station

## Conventional vs. PBN



## RNAV defined in PBN

**RNP** (Required Navigation Perf)  
Onboard perf. monitoring and alerting system required

En-Route

- RNP4
- RNP2

Terminal

- RNP1

Approach

- RNP APCH
- RNP AR APCH

**RNAV** (Area Navigation)  
Onboard perf. monitoring and alerting system **NOT** required

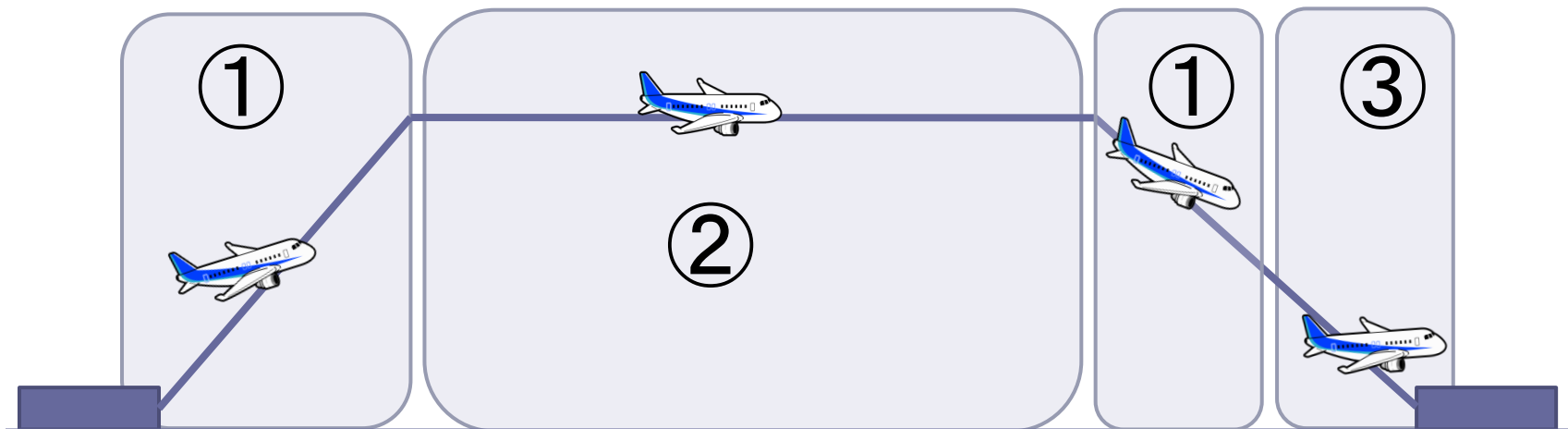
En-Route

- RNAV10
- RNAV5

Terminal

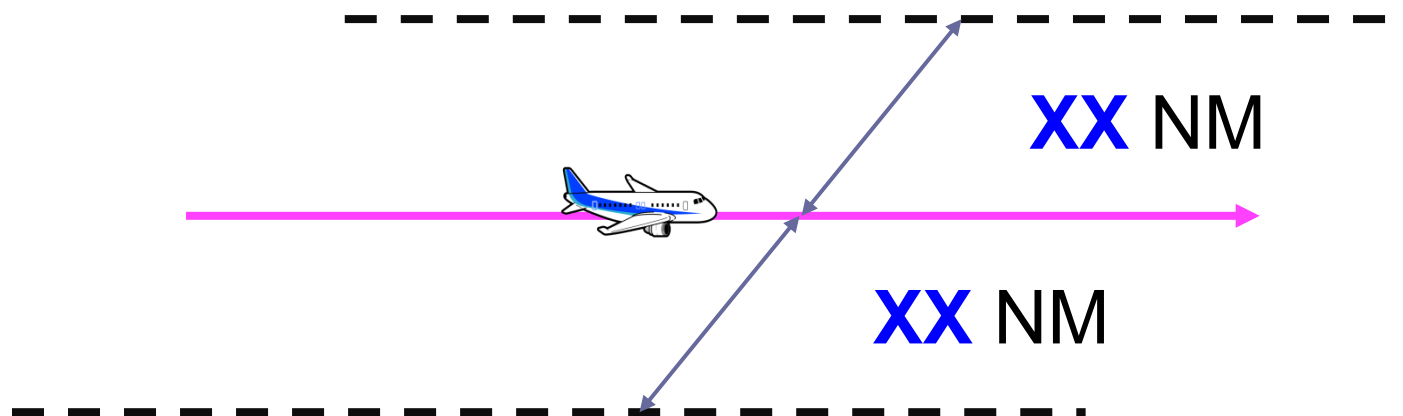
- RNAV2
- RNAV1

## RNAV defined in PBN



	RNP	RNAV
① Terminal	RNP 1	RNAV 1 RNAV 2
② En-Route	RNP 2 RNP 4	RNAV 5 RNAV 10
③ Approach	RNP APCH RNP AR APCH	N/A

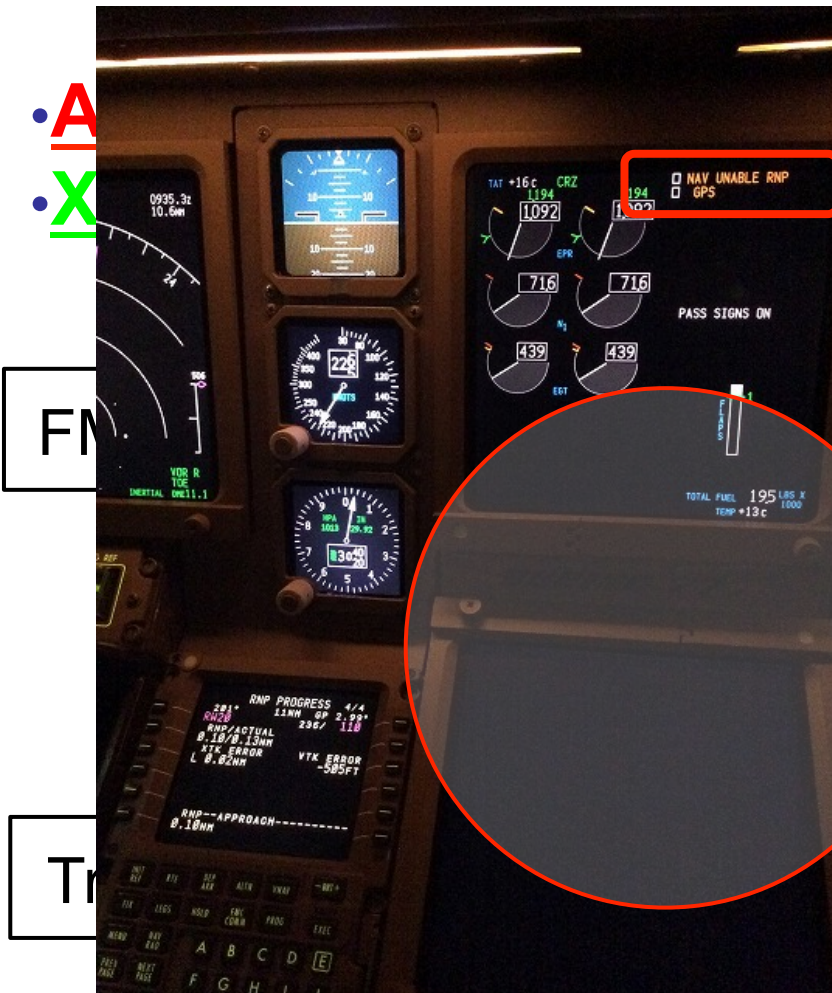
## What is RNP **XX** / RNAV **XX**



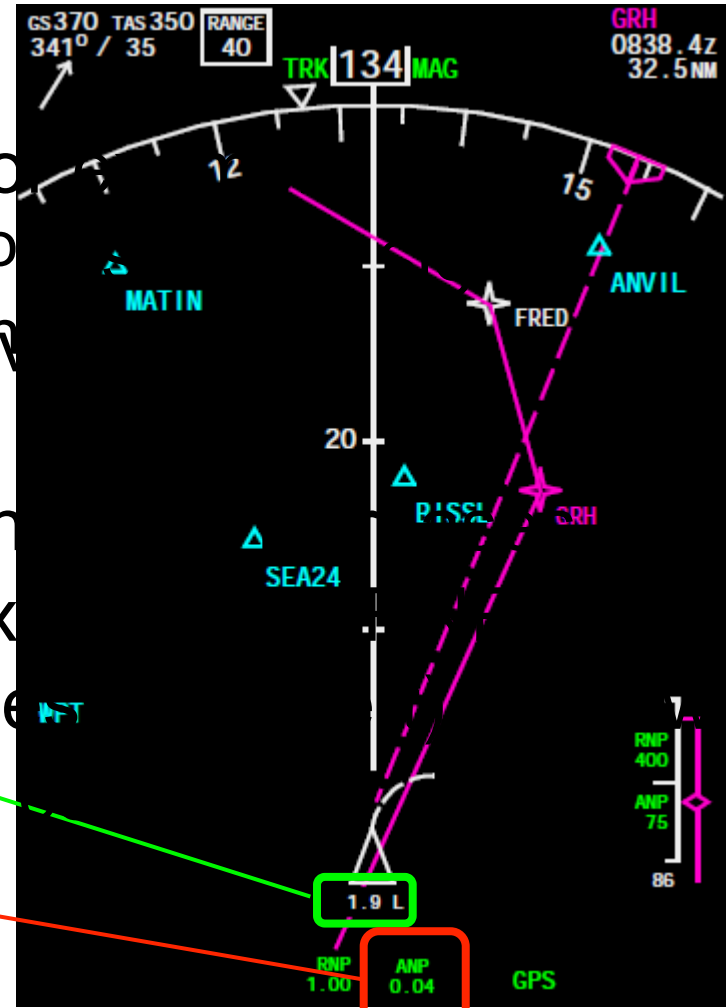
For RNP APCH, **XX** = 0.3 NM

For RNP AR APCH, **XX**  $\leq$  0.3 NM

## What is “Onboard perf. monitoring and alerting system”

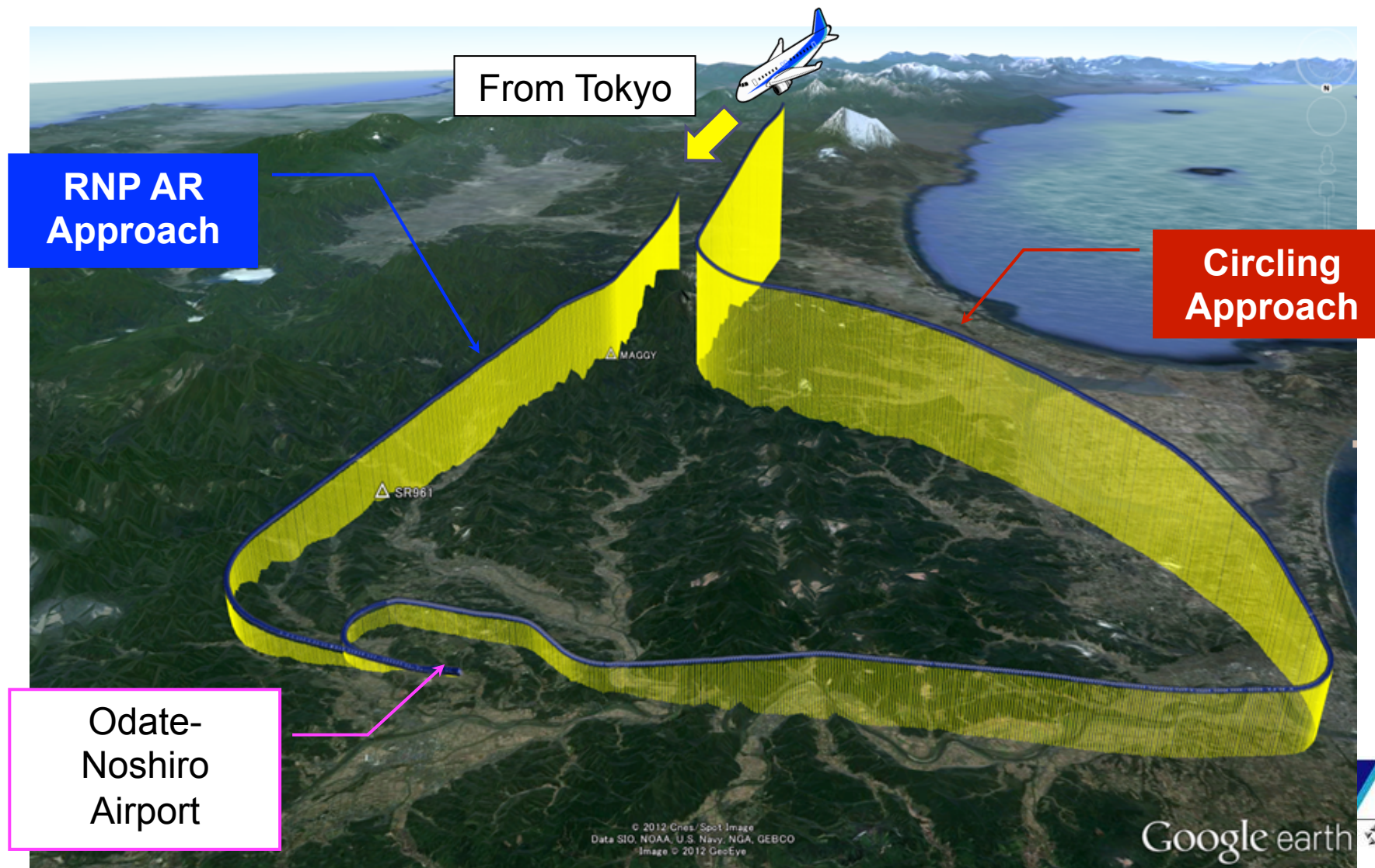


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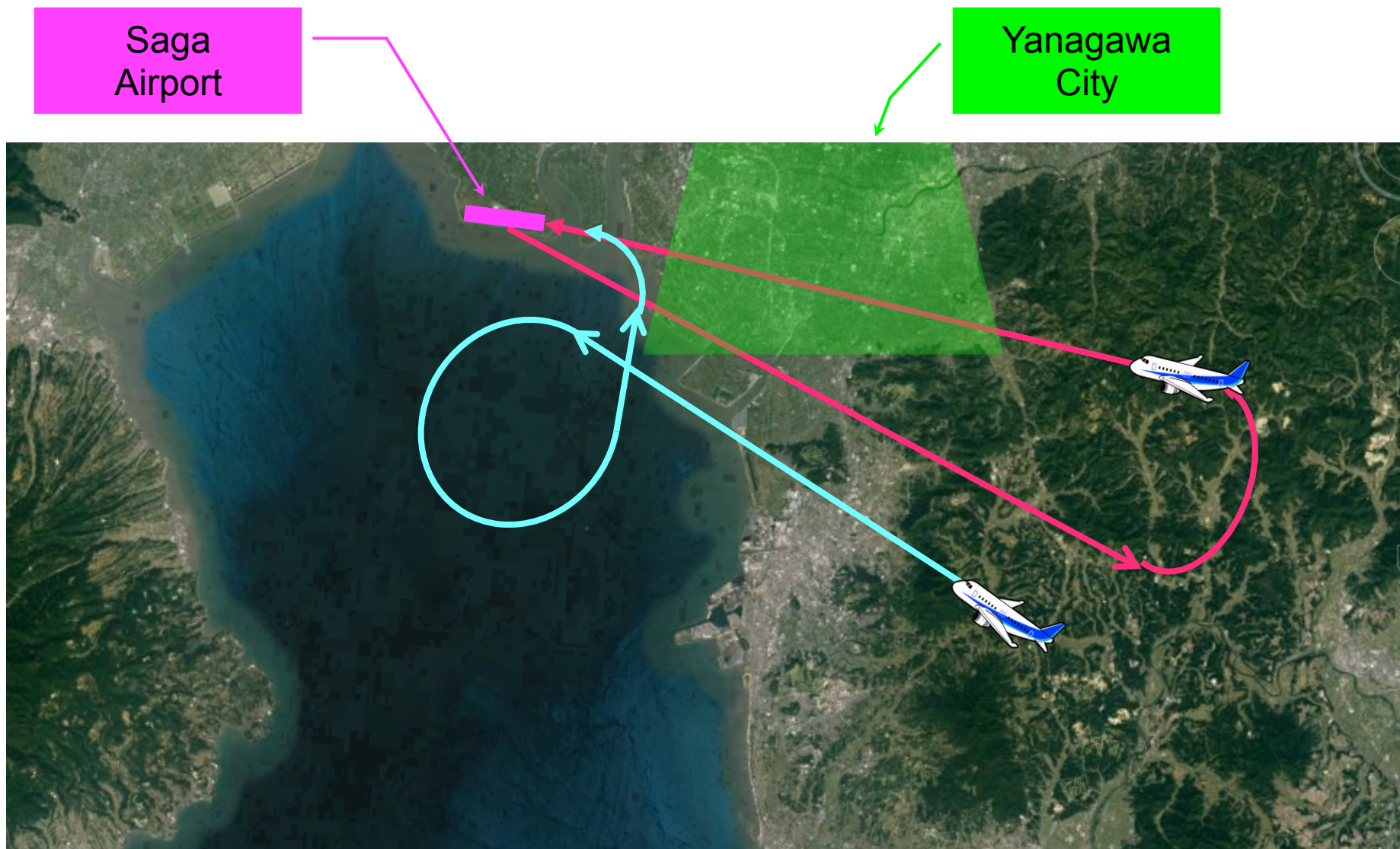




## Conventional vs. PBN (Odate Noshiro)



## Conventional vs. PBN (Saga)



## Summary of PBN

### ● Improves Flight Efficiency

- ✓ Shortest route results in less CO2 emission and shorten flight time

### ● Improves Flying Rate

- ✓ Instrument approach for runways without nav aids, which allows to land with worse weather conditions

### ● Improves Air Traffic Control

- ✓ Separations between aircrafts can be reduced, which results in increment of flights

# Fundamentals of GLS (GBAS Landing System)



## Kinds of Approach

### Non-Precision

VOR

LOC / LDA

Circling

RNAV / RNP

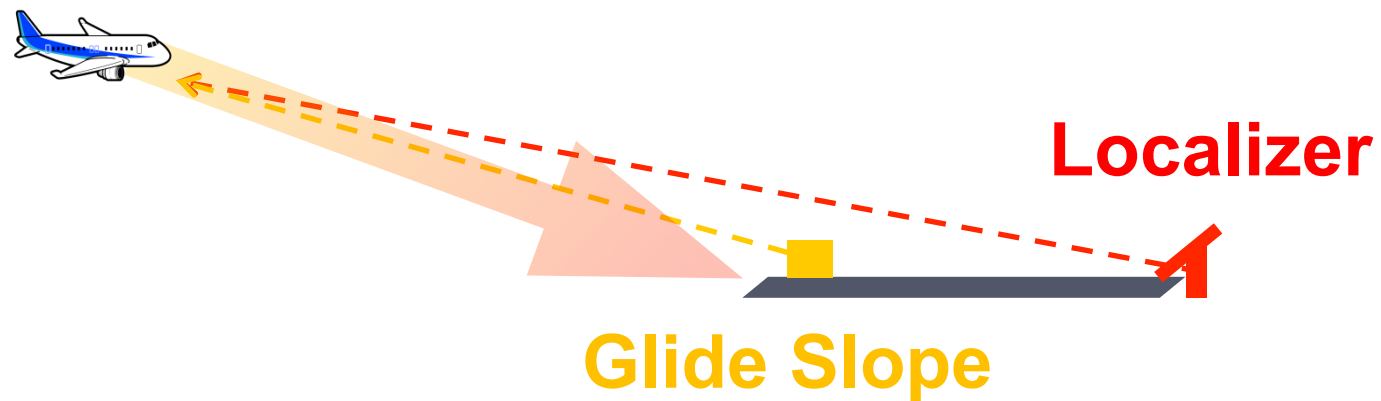
RNP AR

### Precision

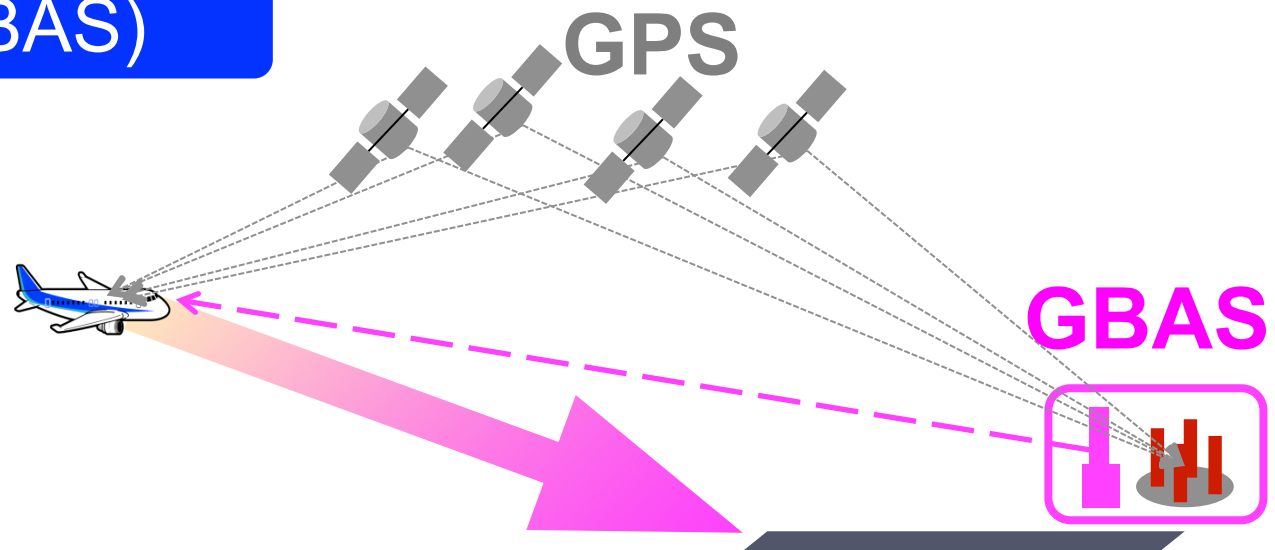
ILS (LOC, G/S)

GLS (GBAS)

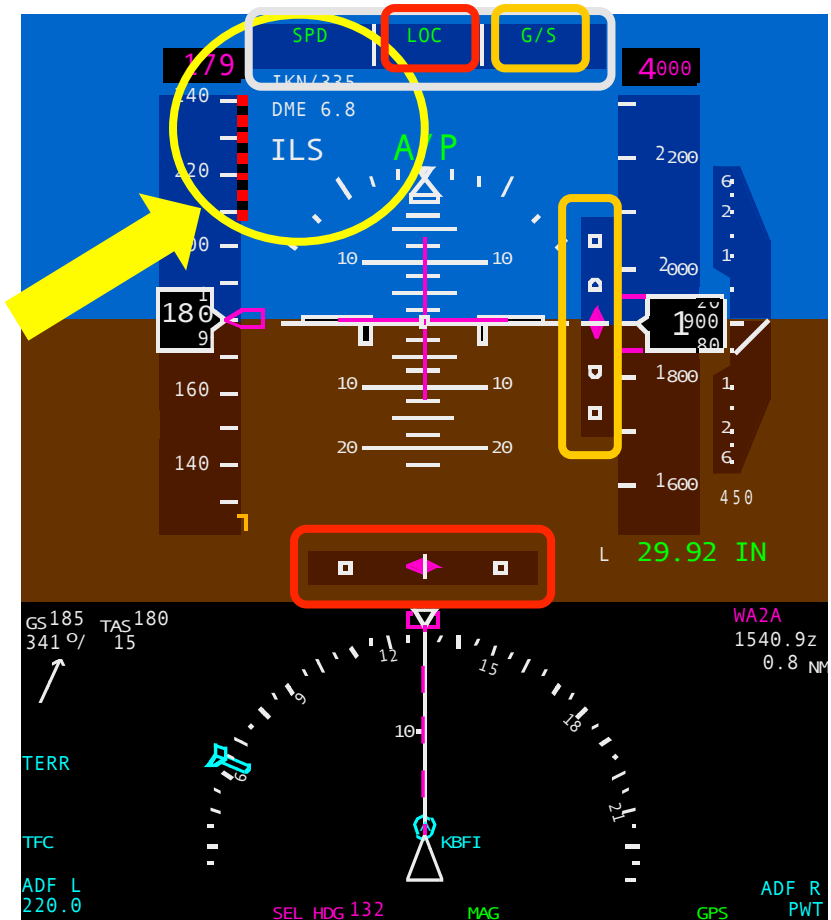
## ILS (LOC, G/S)



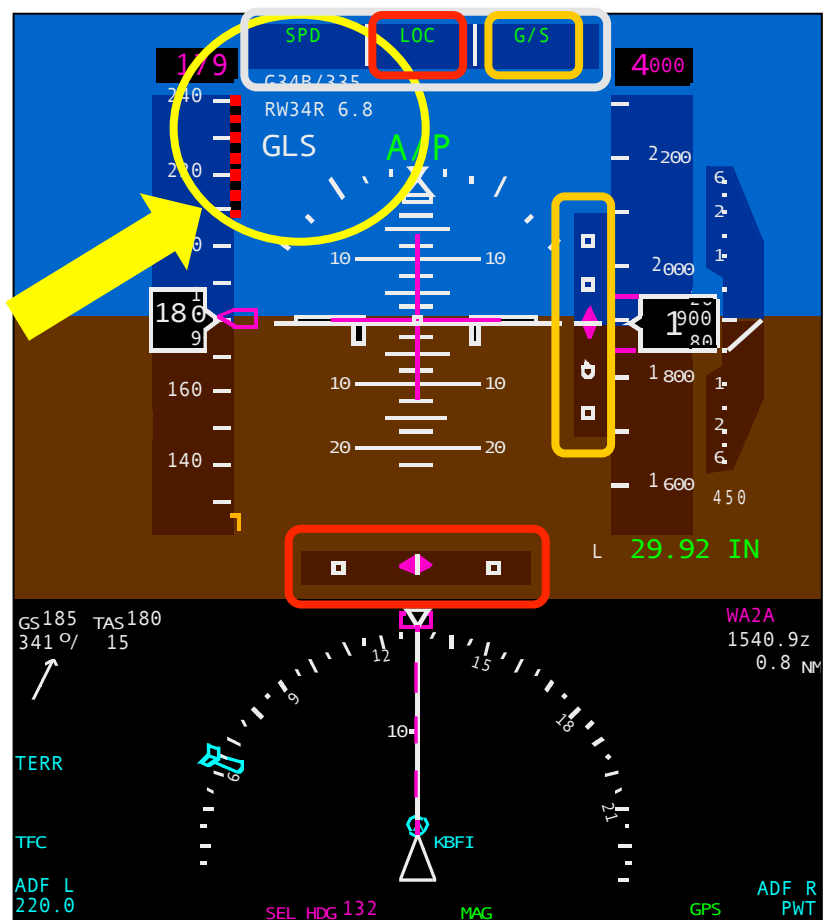
## GLS (GBAS)



## ILS (LOC, G/S)



## GLS (GBAS)



## RNP to xLS (ILS vs. GLS)

- **CAT-III vs. CAT-I**

- ✓ Currently, GLS is only available for CAT-I ( $DH \geq 200\text{ft}$ ,  $550\text{m} \leq RVR$ ) while ILS is available for CAT-III ( $DH=0\text{ft}$ ,  $50\text{m} \leq RVR < 175\text{m}$ )
- ✓ In future, CAT-III GLS will be available

- **Flexible Final Approach**

- ✓ Final approach course for GLS can be shorten than one for ILS, which contributes to establishment of flexible approach course with RNP



## RNP to xLS (RNP AR vs. GLS)

- **Non-Precision vs. Precision**

- ✓ RNP AR approach is non-precision approach, and can't be used for bad weather conditions such as CAT-I(-II,-III)
- ✓ GLS is precision approach, and autoland is available

- **No special training required for xLS**

- ✓ RNP AR approach requires special authorization, which needs flight crew training with simulator every year. On the other hand, GLS doesn't require additional simulator training

## **Summary of GLS**

- **Similar to ILS**

- ✓ Flight crew procedures and cockpit indications are almost identical to ILS

- **Waiting for CAT-II/III Operation**

- ✓ CAT-I is available, but hope to implement CAT-II/III operation in near future

- **Improves Flying Rate**

- ✓ Runways, that can't equip ILS, may be able to equip GLS, which improves possibility of landing in bad weather conditions