Eco-Flight Activities by Japanese Operators

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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
Fundamentals of PBN (RNAV / RNP)

**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
### Fundamentals of PBN (RNAV / RNP)

**RNAV defined in PBN**

<table>
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<tr>
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<th>RNP</th>
<th>RNAV</th>
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| ① Terminal | RNP 1   | RNAV 1  
|           |         | RNAV 2  |
| ② En-Route | RNP 2   | RNAV 5  
|           | RNP 4   | RNAV 10 |
| ③ Approach | RNP APCH | N/A     
|           | RNP AR APCH |        |
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”

- ANP: 95% Navigation Accuracy of FMS Position.
- XTK Error: Deviation from the intended route.

For example:
In case GPS signal invalid...
The ANP increases and exceeds the RNP, then Message(Alert) is shown in cockpit.
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 navaids, 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

Precision
- ILS (LOC, G/S)

RNAV / RNP
- RNP AR

Fundamentals of GLS (GBAS Landing System)
Fundamentals of GLS (GBAS Landing System)

ILS (LOC, G/S)

GLS (GBAS)

Localizer

Glide Slope

GPS

GBAS
Fundamentals of GLS (GBAS Landing System)

**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 $\geq 200$ft, 550m $\leq$ RVR)
    while ILS is available for CAT-III (DH=0ft, 50m $\leq$ RVR $< 175$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