

International Flight Inspection Symposium

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JCAB Activities and Considerations on RNAV Flight Inspection

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Contents

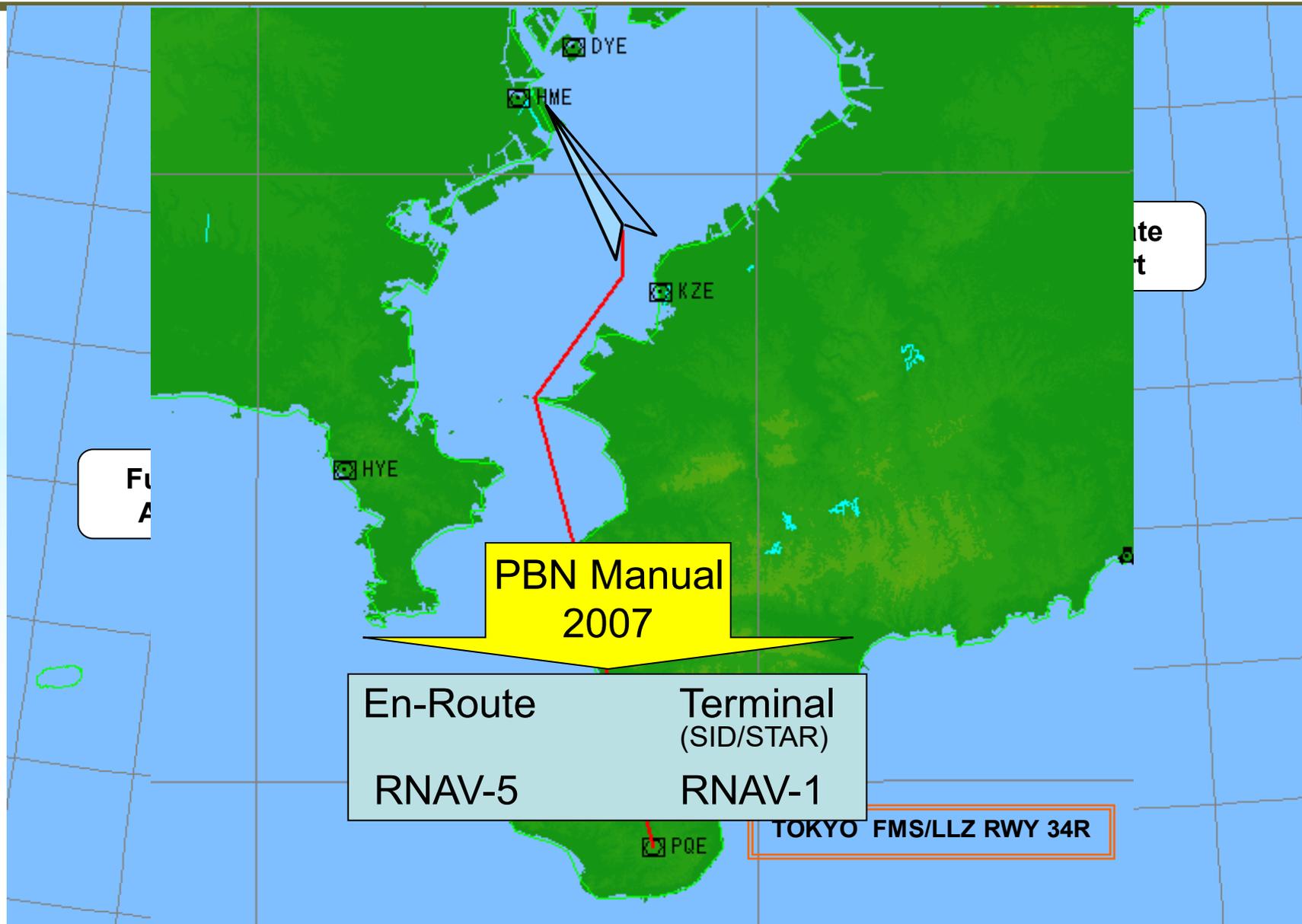
RNAV Introduction Process in Japan

by Yutaka Oikawa

RNAV Flight Inspection in Japan

by Yoshiyuki Sasaki

History of RNAV in Japan



PBN Manual
2007

En-Route	Terminal (SID/STAR)
RNAV-5	RNAV-1

TOKYO FMS/LLZ RWY 34R

RNAV ROADMAP (1)

- JCAB RNAV Roadmap (Initial Version)
 - Short-term (FY 2005~ 2007)

Introduction and development on RNAV route for the purpose to improve operational efficiency mainly
 - Medium-term (FY 2008~ 2012)

Expansion of airspace capacity corresponding to the Phase 2 Project at Kansai International Airport and the Further Expansion Project at Tokyo International Airport
 - Long-term (FY 2013~)

Direction for future RNAV operations which Japan should aim at

Foundation of RNAV Implementation Team

- Office of RNAV Implementation Team ...
 - In JCAB Headquarters Building
 - Several desks in small room
- Consists of ...
 - Director for International policy Coordination
 - Air Traffic Controller
 - Flight Procedure Designer
 - ATS Engineer
 - Airline representative
 - Flight Standards
 - Flight Inspector



RNAV ROADMAP (2)

- JCAB RNAV Roadmap (Latest Version)

- Short-term (by the end of FY 2007)

- Early achievement of improvements in operational efficiency by introducing RNAV that meets globally harmonized

- Medium-term (FY 2008~ 2012)

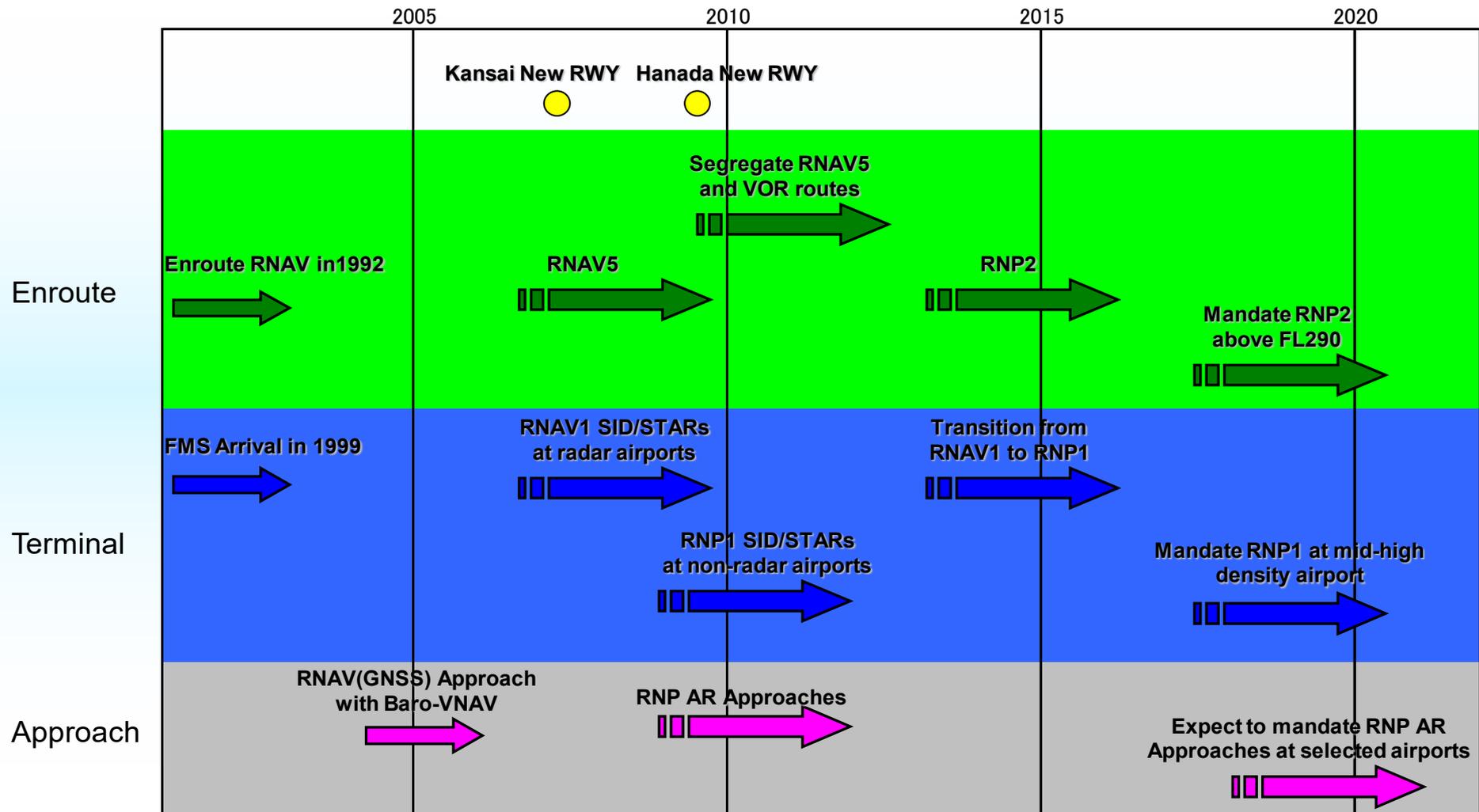
- Improvements in operational efficiency by increasing the airspace capacity step by step in response to the Phase 2 Project at Kansai International Airport and Further Expansion Project at Tokyo International Airport

- Long-term (FY 2013~ 2018, and beyond)

- Direction for future RNAV operations which Japan should aim at

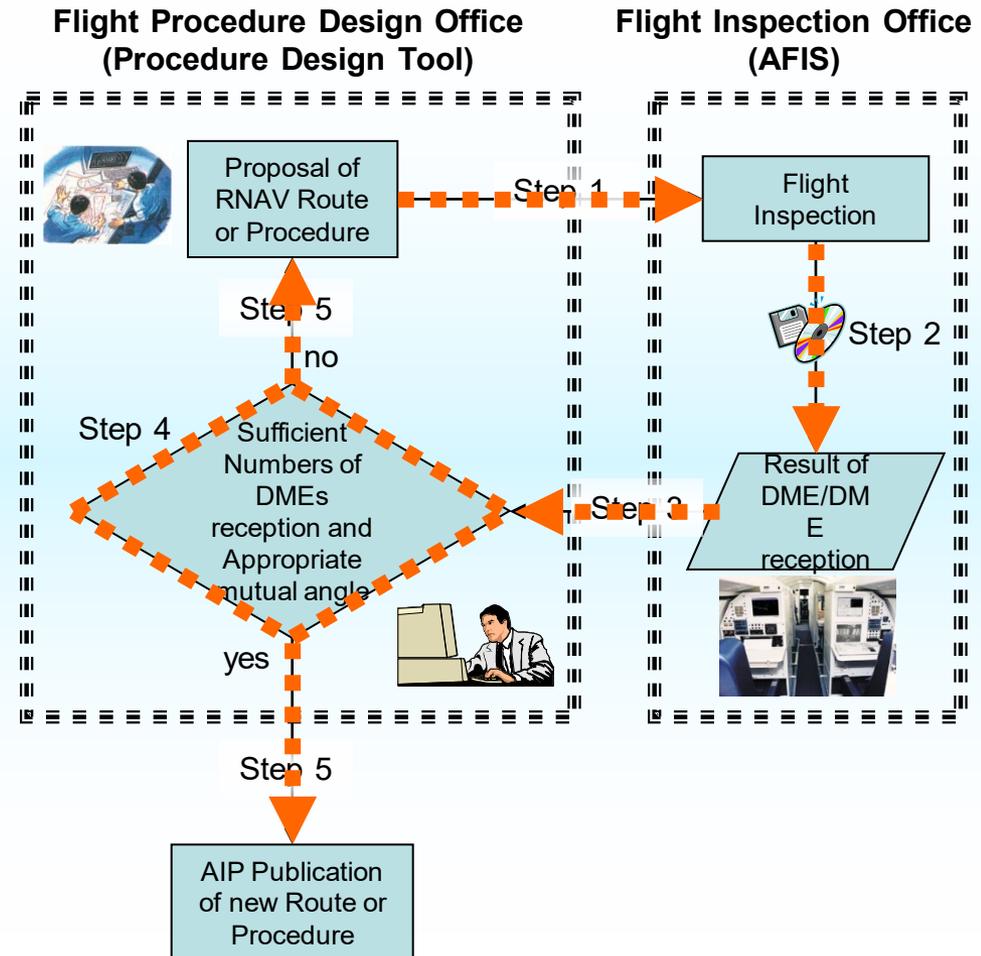


Outline of RNAV Roadmap

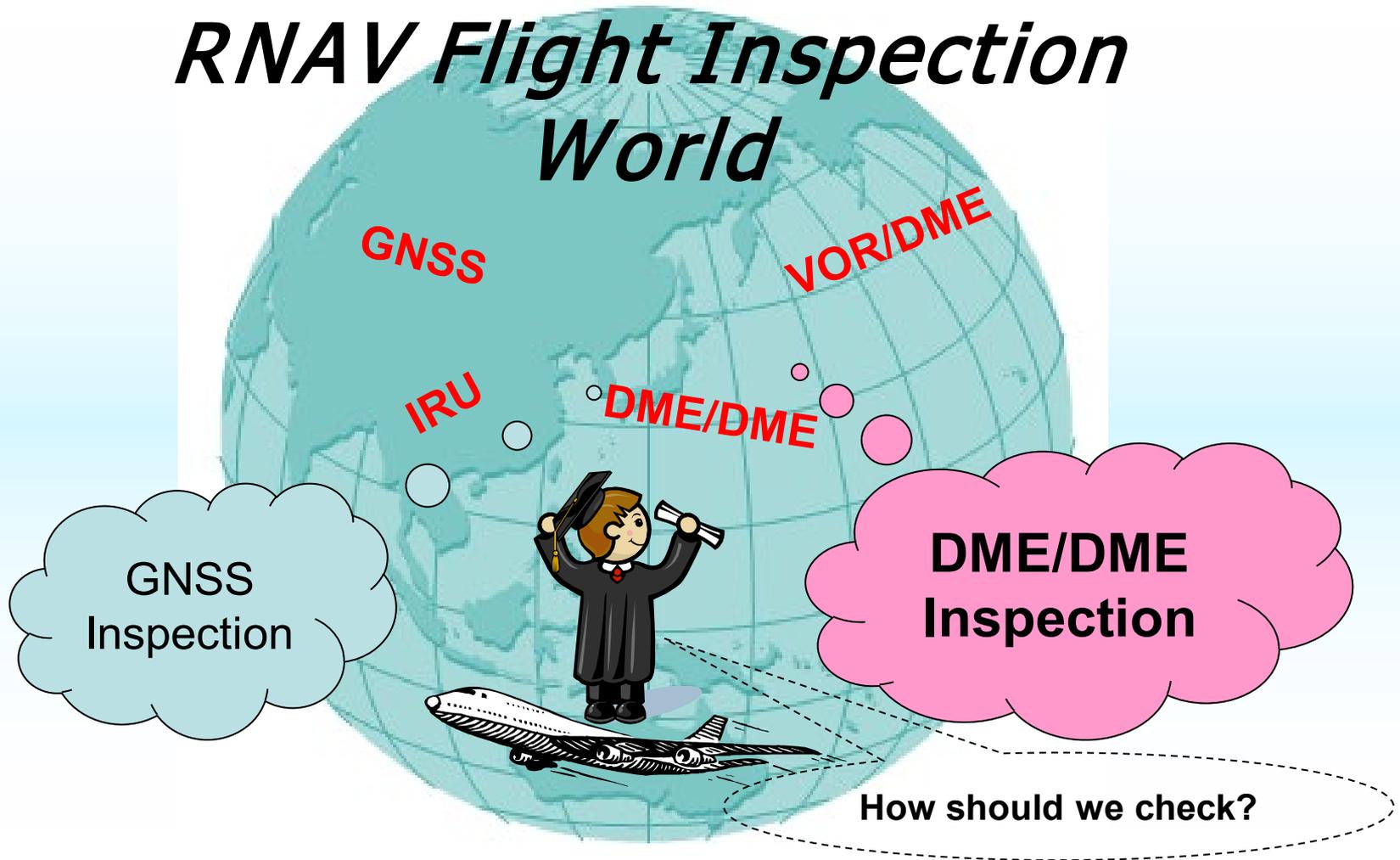


Work Process for Transaction of RNAV Flight Procedure

- Step 1: Proposal of RNAV Route or Procedure including candidate DMEs proposed from Procedure Designer to Flight Inspection
- Step 2: Check DME/DME surroundings by Flight Inspection aircraft
- Step 3: Result of confirmed DME/DME reception from Flight Inspection to Procedure Designer
- Step 4: Screening DME/DME surroundings considering mutual angle (30~150) between DMEs by procedure design tool
- Step 5: Depending on Step 4, back to Step 1 or Publication of AIP

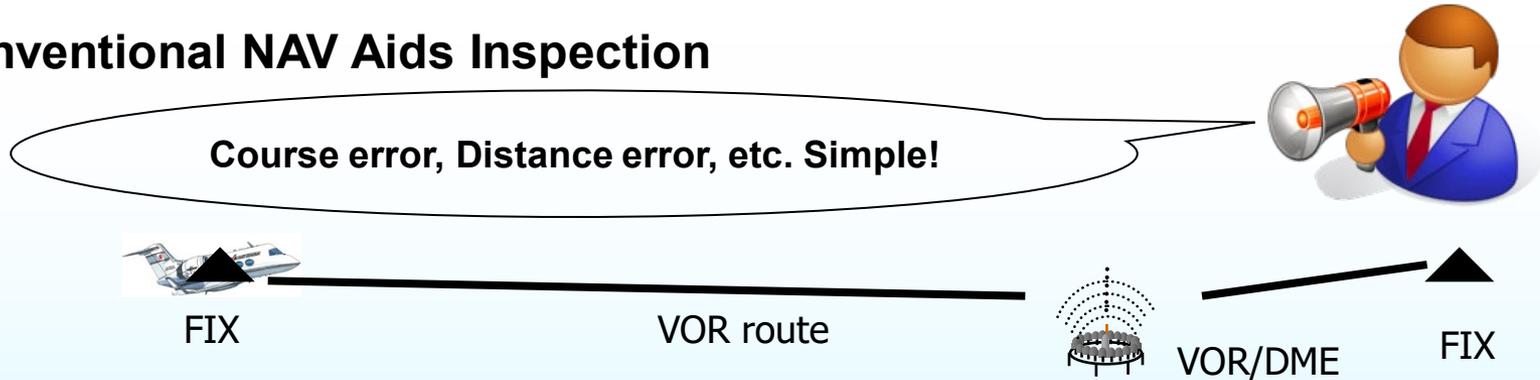


Flight Inspection on RNAV Route

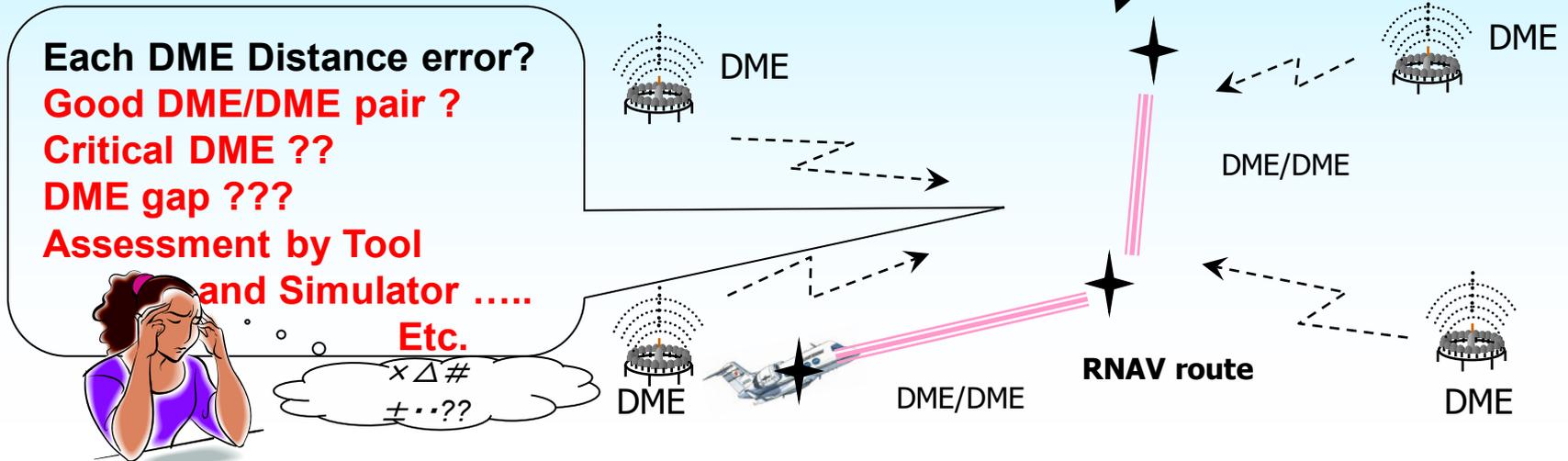


Different Points

Conventional NAV Aids Inspection



DME/DME RNAV Inspection



DME/DME pair

DME pairs ($30^\circ \leq \text{related angle} \leq 150^\circ$)

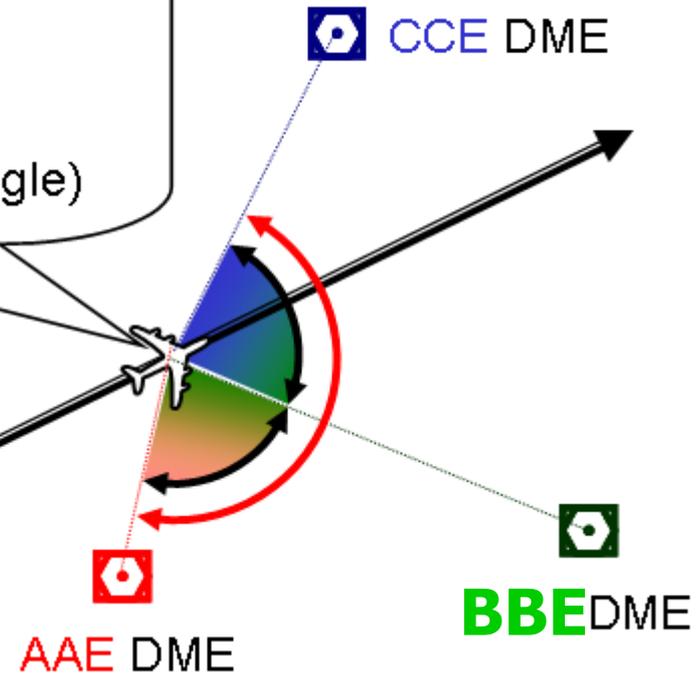
AAE – **BBE**

BBE – CCE

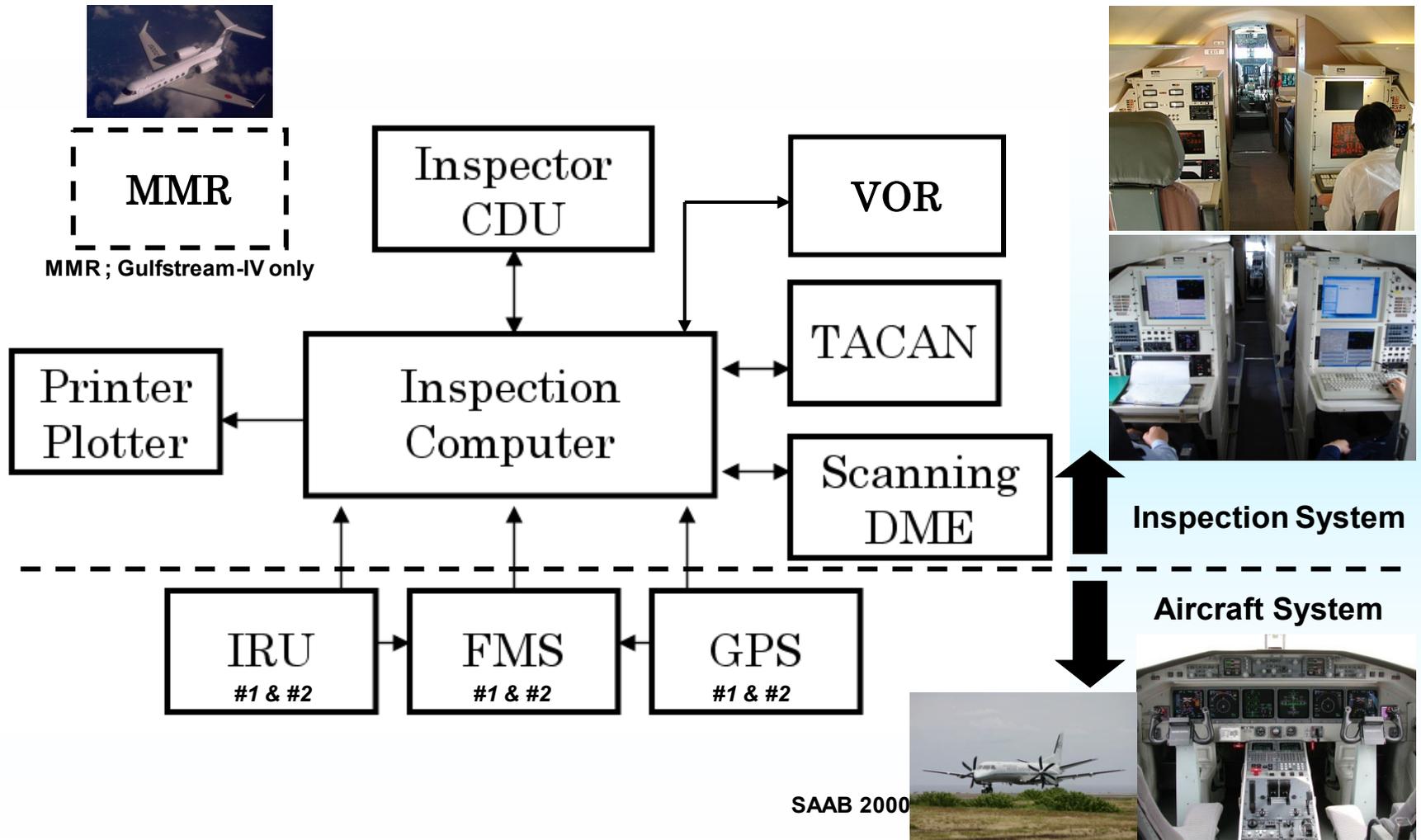
AAE – CCE No! ($150^\circ \leq \text{related angle}$)



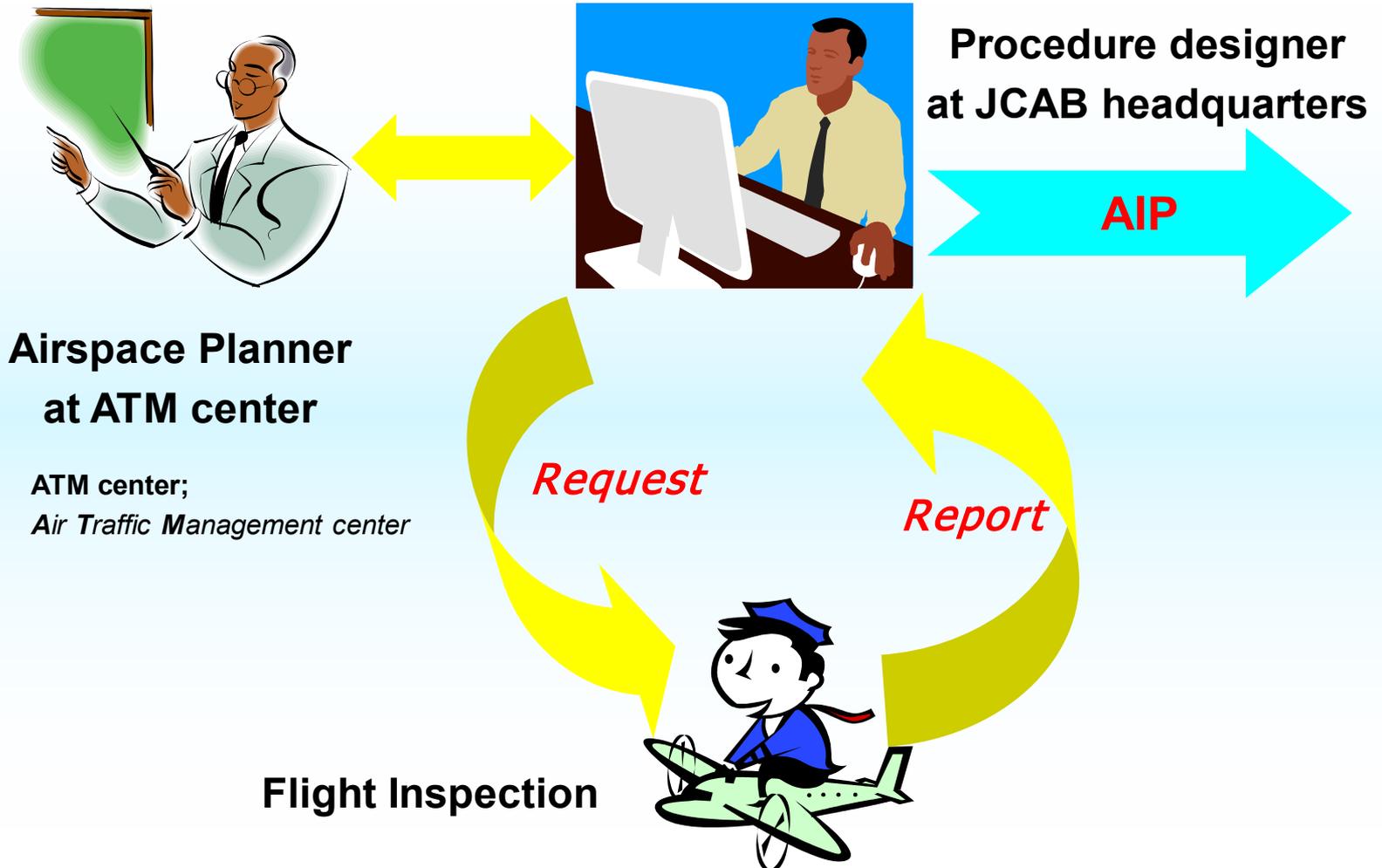
**BBE station is
Critical DME!**



Inspection System

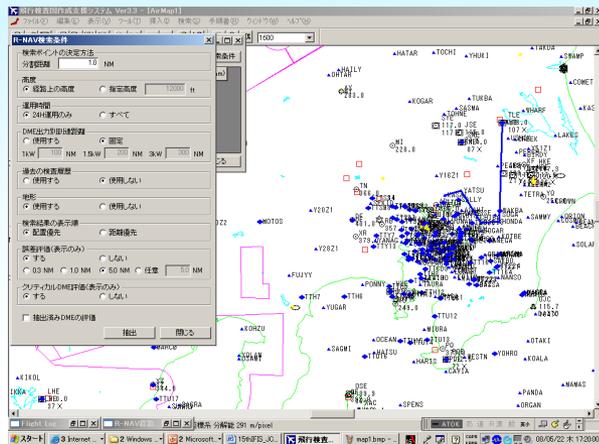
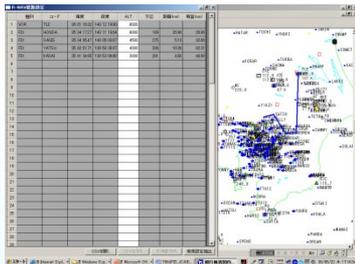


JCAB regime



Preparation before Flight

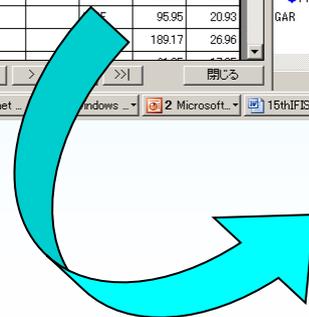
Entering route information



Setting requirements

番号	ウェイポイント	高度	位置	DME	方位	距離(nm)
				CVC	268.82	30.01
				NZE	181.41	67.99
				NRE	234.89	11.31
24		8000	4.0	SYE	150.06	28.17
				HYE	59.71	37.42
				CVC	266.95	30.20
				NZE	181.53	68.98
				HME	85.25	21.52
25		8000	3.0	SYE	151.31	28.95
				HYE	60.92	36.79
				HME	87.87	21.30
				NZE	181.64	69.98
				CVC	265.11	30.43
26		8000	2.0	SYE	152.50	29.74
				HYE	62.16	36.18
				HME	90.53	21.13
				NZE	181.75	70.97
27		8000	1.0	SYE	153.62	30.55
				HYE	63.45	35.59
				HME	93.23	21.00
				NZE	181.86	71.96
				KZE	58.81	17.88
28	HONDA	8000	5.1	SYE	154.69	31.37
				HYE	64.78	35.02
					95.95	20.93
					189.17	26.96

Creating DME list



DME list file!!



Requirements for creating DME list

Creating DME list

番号	ウェイポイント	高度	位置	DME	方位	距離(nm)
				CVC	268.82	30.01
				NZE	181.41	67.99
				NRE	234.89	11.31
24		8000	4.0	SYE	150.06	28.17
				HYE	59.71	32.42
				CVC	266.11	30.20
				NZE	181.53	68.98
				HME	85.25	21.52
25		8000	3.0	SYE	151.31	28.95
				HYE	60.92	36.79
				HME	87.87	21.30
				NZE	181.64	69.98
				CVC	265.11	30.43
26		8000	2.0	SYE	152.50	29.74
				HYE	62.16	36.18
				HME	90.53	21.13
				NZE	181.75	70.97
				KZE	56.45	18.54
27		8000	1.0	SYE	153.62	30.55
				HYE	63.45	35.59
				HME	93.23	21.00
				NZE	181.86	71.96
				KZE	58.81	17.88
28	HONDA	8000	5.1	SYE	154.69	31.37
				HYE	64.78	35.02
				HME	95.95	20.93
				TLE	189.17	26.96

- ☞ **Aircraft position and topography data**
 - ※ *Candidate DMEs are selected within line of sight*
- ☞ **Creation of DME/DME combination based on DMEs located within 160 NM**
 - ※ *First, the combinations are made in such a way that the relative angle between DMEs becomes approximately 90 degree.
(30 degree \leq related angle \leq 150 degree)*
- ☞ **Exclusion of ILS DME, foreign DME, etc. from DME/DME combination**
- ☞ **Extracting 5 DMEs in each segment from the candidate DME/DME combinations as considering distance between aircraft and DME station**
 - ※ *Basically, 5 DMEs are selected from the nearest DME station to aircraft in distance order.*
 - ※ *In the case of RNAV5, 5 DMEs operated for 24 hours
In the case of RNAV1, included the Terminal DME*
- ☞ **Calculation of position error based on the best DME/DME combination**

Before Actual Flight



DME list file!!



Check DME list with FMS Flight Plan

OK!

Check RNAV route on FMS

OK!



Let's start flying!!



During Flight

JCAB/SAAB 2000 AFIS

Mode Page Facility Nav Control Plot Print Final Report Refresh

DME/DME 20/09/07 05:08:13

APT ID RJOR RWY ID 28 CSV FILE NAME Y13NRE.CSV

RTE TYPE G-ROUTE

TYPE PERIODIC

EXEC SETUP

VOR IDENT HWE

P-RNG 022.41

R-BRG 046.06°

2DXTK ERR 000.41

RNG ERR 00.0

BRG ERR 000.09°

MAN VOR/DME OFF

SS 159

RX/DME ID

PEE TEST ANGLES

PEE TSE

PEE DME 1 031° PRS 0.06 0.06

PEE DME 2 334° AVG 0.07 0.07

INCL ANGLE 057° STATUS PASS PASS

DME CHECK DELAY TIMER 090

ROLL 0.2°

PITCH 0.2°

VARIABLES 00050

ISS 00000

ALT-R ***** FT

ALT-L ***** FT

ALT-F 10000 FT

SPD 298.8 KT

L 029.2°

RJOR *****

464.9

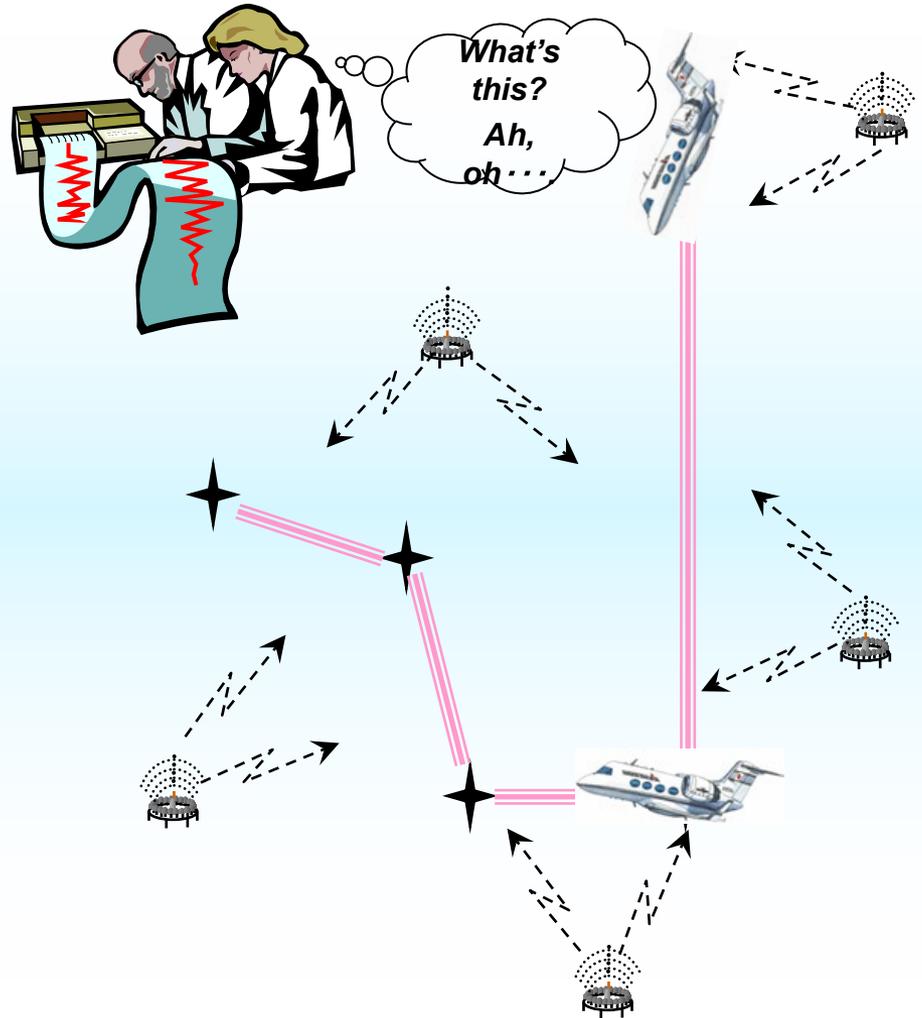
POSUPD: HYBRID FIMODE: NORMAL FMS: 1

FLIGHT PLAN MAN WPT

WPT	DSG	BRG	RNG	PRS SE...	TOT SE...
SMELT		029.2°M	034.65		
A/C		029.5°M	033.95		
SIRAO		029.5°M	012.00	01	01
NASEL		029.4°M	035.00		03
CHE					

DTLG: RUN STATUS: RUN ALERT PLOTTER: ON IEEE: READY Page 1 of 3

start JCAB/SAAB 200... Removable Disk... Untitled - Part 2:09 PM



Check! Check!

DME

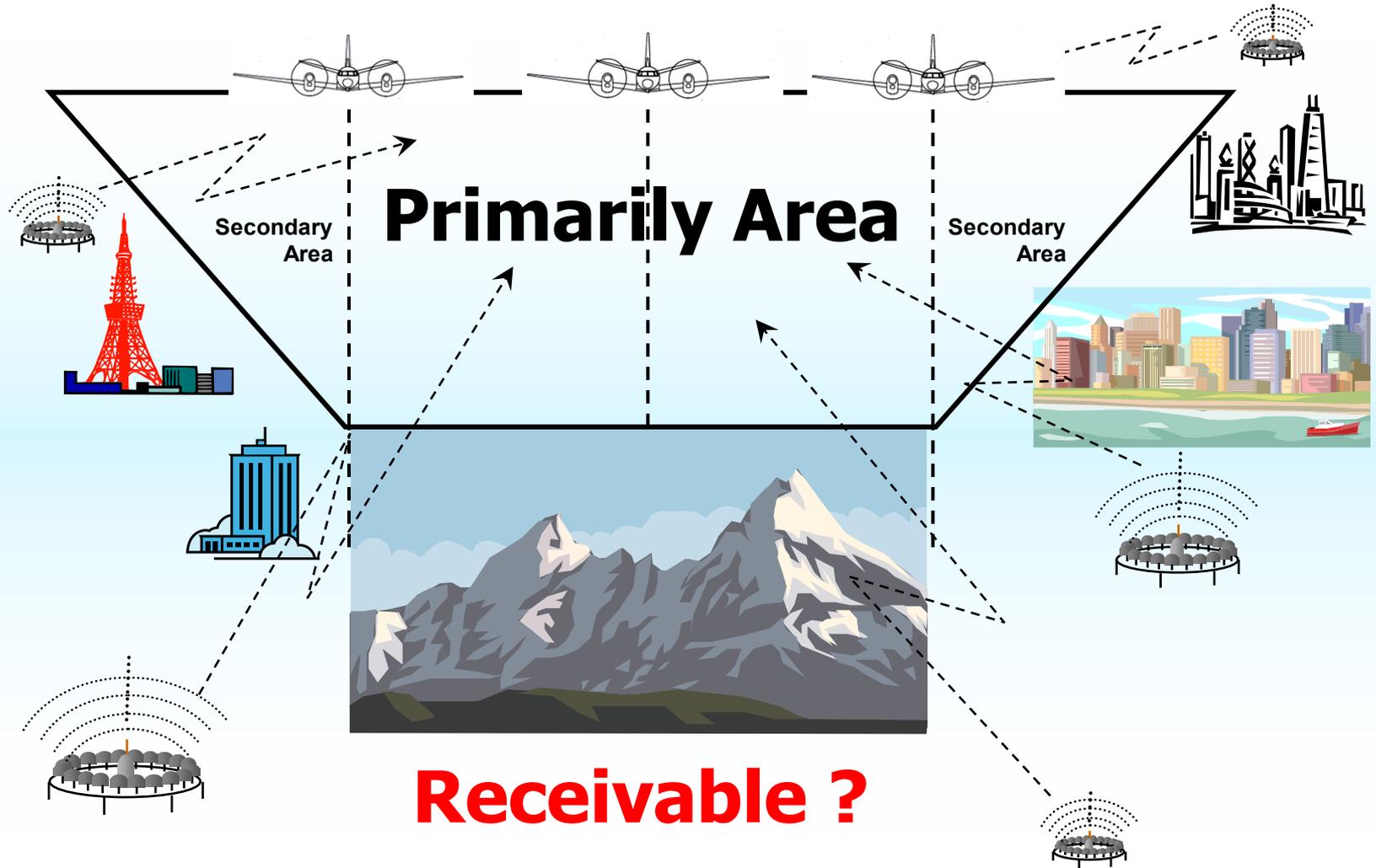
DME

DME

DME

DME

Terminal RNAV Route



JCAB criteria on RNAV route

Item	Tolerance
Data Base Integrity	Distance: within 0.1NM Bearing: within 0.1° ※ <i>between WPs</i>
DME error	Within 0.2NM for locked DME
DME/DME pair	More than 1 pair ※ $30^\circ \leq \text{inclusion angle} \leq 150^\circ$
Critical DME	If yes, report the range to Flight Procedure Designer
DME gap	If yes, report the range to Flight Procedure Designer

Item	Tolerance
Specific DMEs	Report the DME to Flight Procedure Designer ※ <i>Specific DMEs: degrade the navigation solution</i>
Communication and RADAR	Within coverage ※ <i>RADAR: if RADAR service required</i>
Flyability	Flyable
Other	<ul style="list-style-type: none"> • DME signal strength • PEE & TSE • VOR signal, if needed • GNSS signal

PEE: *Position Estimation Error*
TSE: *Total System Error*

Re-assessment after Flight

- ✓ Revised the original DME list based on Flight Inspection results
- ✓ Re-assessment of the candidate RNAV route with the modified DME list

Before Flight

番号	ウェイポイント	高度	位置	DME	方位	距離(nm)
24	CVC	269.82	30.01			
	NZE	181.41	67.99			
	NRE	234.89	11.31			
	SVE	150.06	28.17			
	HVE	69.71	37.42			
	CVC	269.96	30.20			
	NZE	181.53	68.99			
	HME	86.25	21.52			
25	SVE	151.31	28.95			
	HVE	60.92	36.70			
	HME	87.87	21.30			
	NZE	181.64	69.98			
	CVC	265.11	30.63			
26	SVE	152.90	29.74			
	HVE	62.16	36.10			
	HME	90.53	21.13			
	NZE	181.75	70.97			
	KZE	56.45	18.54			
27	SVE	153.92	30.50			
	HVE	63.47	35.33			
	HME	92.22	21.00			
	NZE	181.86	71.96			
	KZE	58.81	17.89			
HONDA	SVE	154.69	31.37			
	HVE	64.70	35.02			
	HME	95.95	20.93			
	TLE	189.17	26.96			

Before Flight

番号	ウェイポイント	高度	位置	DME	方位	距離(nm)
26	*****	30	HME	95.80	18.83	
			PQE	25.43	39.41	
27	*****	1.0	HME	95.61	16.83	
			PQE	22.63	38.83	
			KZE	51.57	14.14	
			NRE	232.28	17.84	
				60.79	31.64	
				96.21	15.83	
				21.27	38.39	
				59.97	30.73	
29	*****	8.0	HME	88.65	14.82	
			PQE	18.97	40.00	
			HVE	55.83	31.04	
30	*****	6.0	HME	81.17	14.17	
			PQE	17.08	41.49	
			TLE		24.97	
			KZE	33.45	15.17	
			HVE	52.24	31.46	
31	*****	4.0	HME	73.12	13.79	
			PQE	15.33	43.01	
			KZE	27.50	16.27	
			TLE	210.23	23.64	
			HVE	48.76	31.99	
32	*****	3.0	HME	68.96	13.70	
			PQE	14.50	43.79	

After Flight

Orange line shows a part of segment existing critical DME. In the case of DME Gap, red line is shown.

DME?

DME



DME

DME

DME?

Report to Flight Procedure Designer



- ☞ List of **available DMEs** on each segment
- ☞ Name of **critical DME**
and the area where it happened
- ☞ Area where **DME gap** happened
- ☞ **Unsuitable DME station** which might deteriorate
position solution
- ☞ Comments on **flyability**

Confusion ??

- ✓ How should we deal with the confused case in which we found the out of tolerance on DME signal?
- ✓ Should we check DME coverage not only on center course but also on edge of route?
- ✓ Every type of RNAV system is supposed to select DME/DME pair from DMEs checked by Flight Inspection or Simulation tool?
- ✓ Flyability checks of RNAV route can be judged only by Flight Inspection aircraft?

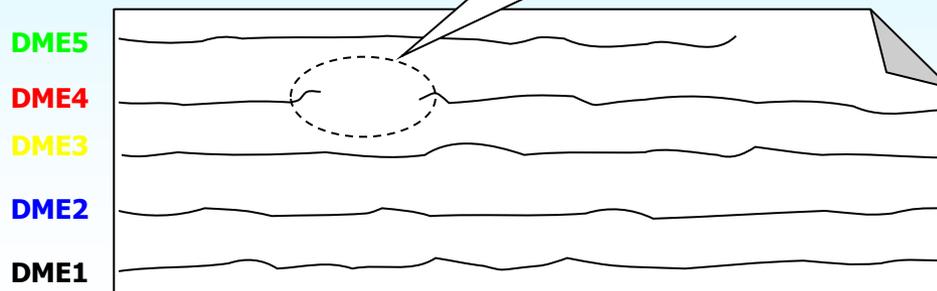


Considerations (1)

- ✓ How should we deal with the confused case in which we found the out of tolerance on DME signal?



DME4 No signal !



Error lines of each DME signal

RNAV5 – OK

if.....

*DME/DME pair without bad DME
VOR/DME available in the portion*

GNSS

IRU

RNAV1 – OK

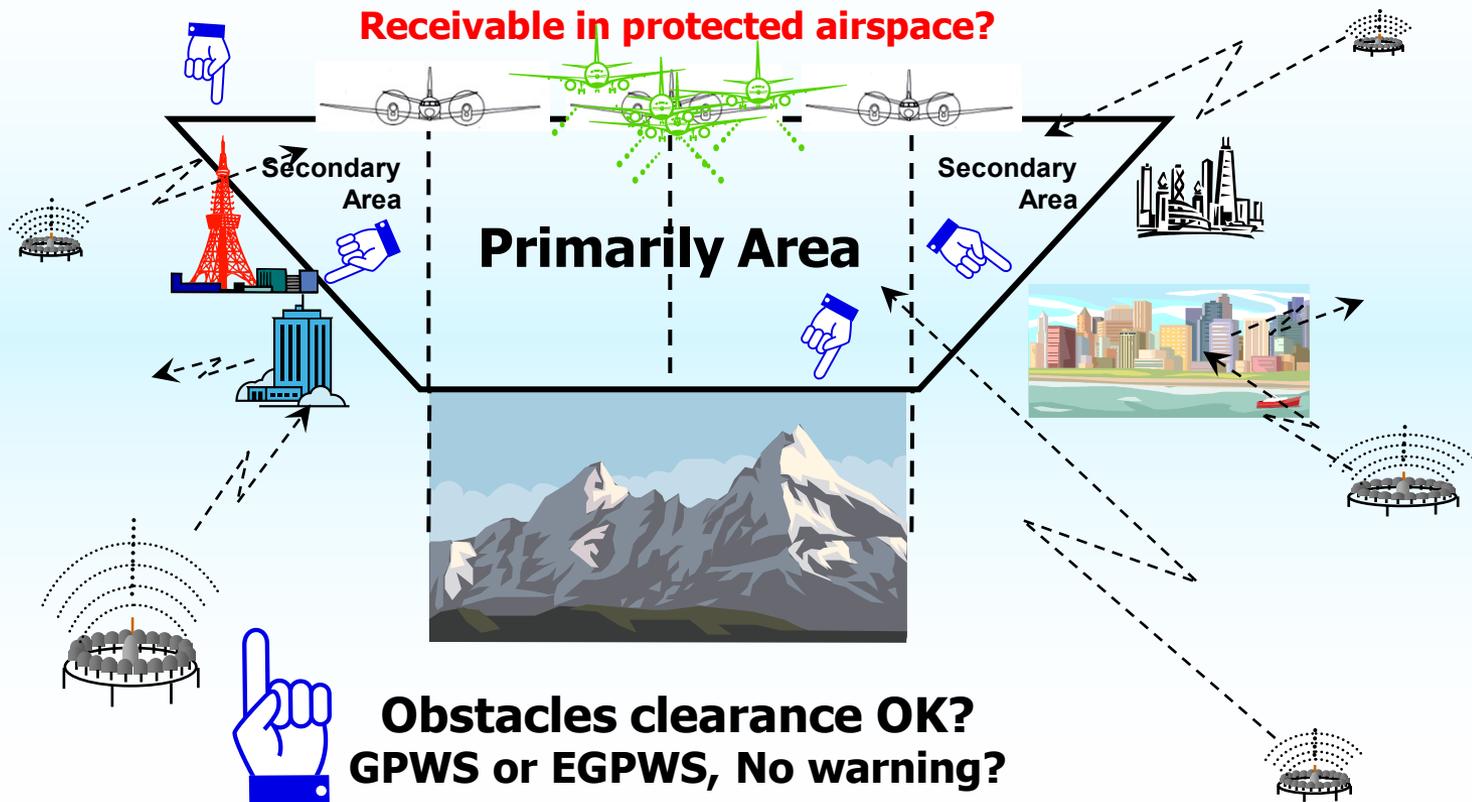
if.....

*DME/DME pair without bad DME
DME/DME/IRU*

GNSS

Considerations (2)

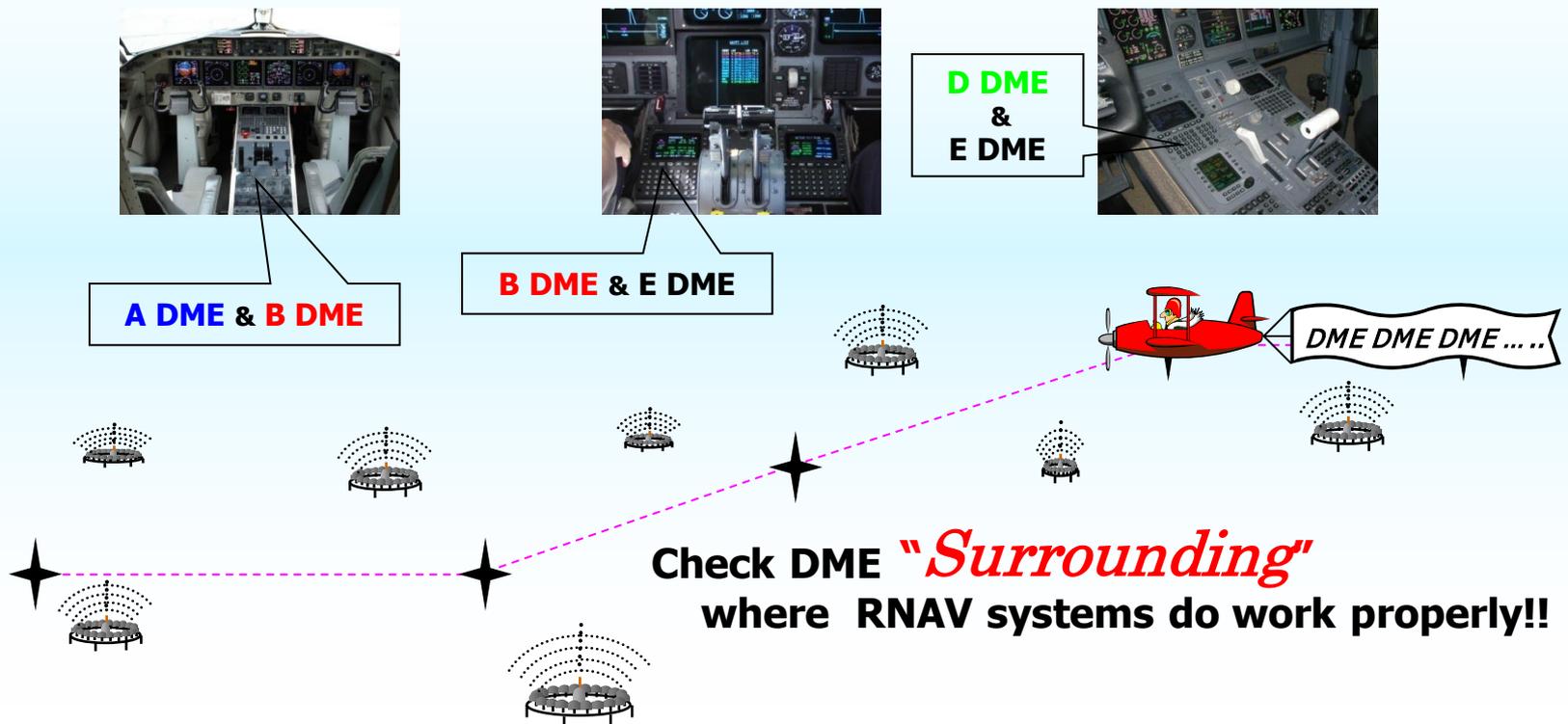
- ✓ **Should we check DME coverage not only on center course but also on edge of route?**



EGPWS; *Enhanced Ground Proximity Warning System*

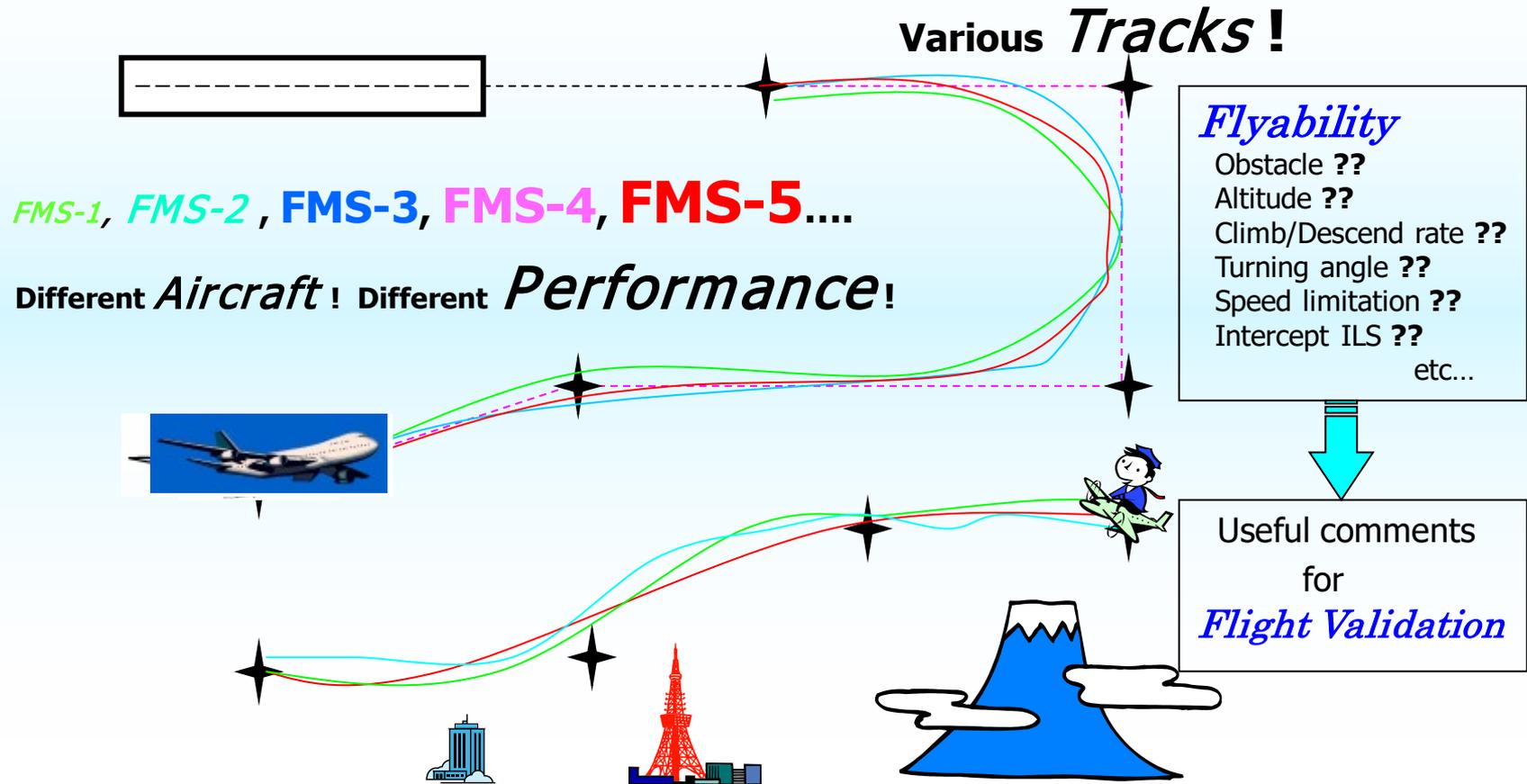
Considerations (3)

- ✓ Every type of RNAV system is supposed to select DME/DME pair from DMEs checked by Flight Inspection or Simulation tool?



Considerations (4)

✓ Flyability checks of RNAV route can be judged only by Flight Inspection aircraft?



Conclusion

Flight Inspector

Skill for Conventional Inspection and...



- ✓ **Complicated knowledge**
- ✓ **Flight procedure design criteria**



Flight Inspection aircraft and system

Depending on purpose...

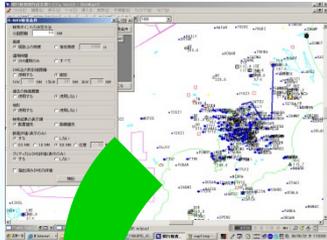


- ✓ **Only check on signal ?**
- ✓ **Flyability ?**
- ✓ **FMS ? Auto Pilot ?**

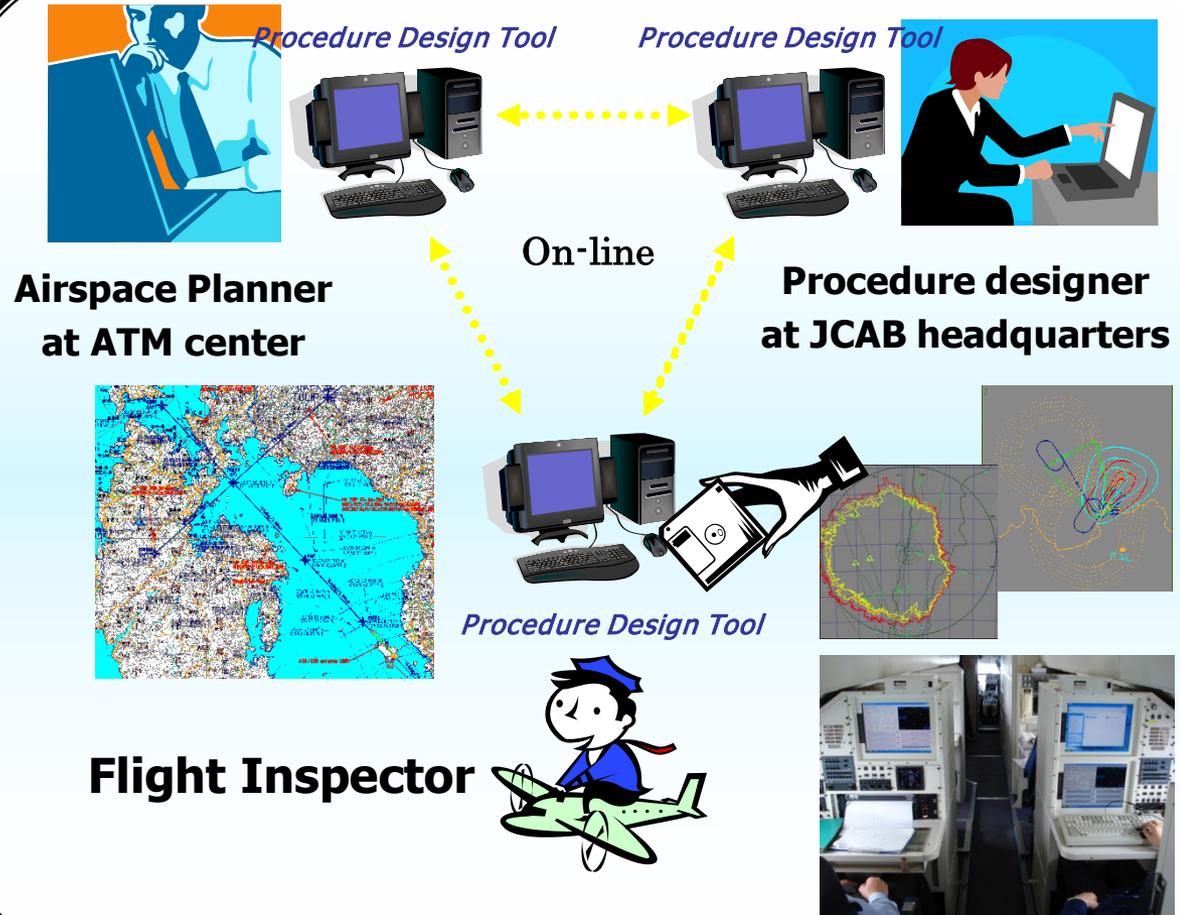


Future work

Present Map Tool



To prevent us from making a mistake in data exchange



Thank you very much!

