JAA
Joint Aviation Authorities

EUROCONTROL

SUMMARY AND CONCLUSIONS

OF

THE RNAV SYMPOSIUM

11/12 MARCH

EUROCONTROL INSTITUTE LUXEMBOURG

SESSION 1

WHY RNAV

What will BRNAV offer

What are the longer term plans:

- TMA
- En-Route

WHY RNAV

RNAV needed to support Airspace changes

Increased capacity derived from

- sectorisation efficiency
- routing flexibility

Advantages dependent on 100% equipage

- Mixed RNAV/Non RNAV operations decrease sector capacity

SLIDE NOTES: RNAV offers significant capacity gains which will be derived from the ability to separate routings from the ground infrastructure. As set out in the ICAO FEATS strategy there is a need for uniform airspace as ATC capacity will be reduced in supporting a mixed environment.

RNAV REQUIREMENTS

RNAV has developed over 20-30 years

- variety of performance
- low system integrity/continuity of service
- RNAV Standards Developed

B-RNAV initial RNAV application

- requirements targeted lowest equipment standards compatible with:
- supporting airspace changes
- maintaining safety

SLIDE NOTES: RNAV suffers from the problem of organic growth. The variety of systems developed over a period of up to 30 years results in a wide spread in system performance.

The existing RNAV systems exhibit relatively low integrity and continuity of service.

The new standards result in the long term RNAV development providing the integrity which will ultimately allow conventional navigation techniques to be replaced by “sole” means RNAV.

In the mean time the B-RNAV standard targets a level of RNAV performance [conformant] with existing separation standards. These standards can be met with the majority of systems produced since the early 1970s.

ARN TRUNK ROUTES

Initial RNAV Application

- only above FL 300
- had to interface to non-RNAV routes
- full application required duplicate structure

CONCLUSIONS

Successful use of RNAV capability requires

- Replacement by RNAV routes - not duplication
- Uniform structure (no upper lower division)

SLIDE NOTES: In 1993, following the work established by FEATS and to provide early benefits from RNAV, a new trunk route structure was introduced in the upper airspace above FL 300.

The impact was less than expected caused in part by the limitations imposed by having to provide an unreduced service to non-equipped aircraft. These issues involved included:

- lack of airspace to provide a dual route structure.
- ATC workload associated with providing different levels of service to RNAV and Non RNAV equipped aircraft.
- providing a means to enter and leave the trunk routes in an environment where, for most of the ECAC area, over 40% of traffic is climbing or descending to and from the Trunk rout network.

These together resulted in most routes overlying the existing structure. The experience of this implementation reinforced the FEATS conclusions concerning the need for a uniform airspace.

FLEXIBLE USE OF AIRSPACE

Potential benefits:

Flight economy resulting from Conditional Routes

- shorter routing
- fuel and time saving
- potential for requested FL

Expected reduction in delays, by means of:

- better traffic distribution
- enhanced ATC sectors configuration
- use of ATC sectors currently under utilised
- avoidance of overloaded crossing points
- increase in ATC sector capacity

SLIDE NOTES: With effect from 1998 the need to provide continued support for non-equipped aircraft is removed. This will not result in an instant change in the structure since the existing routes have developed in accordance with the main flows of traffic. However some significant changes will start to occur.

The first relates to the flexible use of airspace in which airspace use can be flexibly managed. This daily activation of temporary segregated airspace and non permanent routes in airspace previously allocated permanently to non-GAT use provides increased airspace for civil traffic - often at busy times of the day. These additional routes increase system capacity and improve operational efficiency.

BUT

- From 1998, many CDRs will require RNAV capability
- ATC capacity would be reduced if uniform equipage not achieved
  - Dealing differently between RNAV/Non RNAV aircraft

SLIDE NOTES: With effect from March 1998 many of the Conditional Routes will require B-RNAV equipage. If the use of RNAV routes were to be introduced without a requirement for carriage of RNAV equipment, the controller would need to treat RNAV and non RNAV equipped aircraft differently. This will increase controller workload, in turn reducing sector capacity.

ROUTE STRUCTURE

- ECAC Airspace Capacity effectively determined by a number of very important bottlenecks
- New route structure in upper and lower airspace
- Without RNAV - operation through large parts of ECAC will not be possible.

SLIDE NOTES: The flexible use of airspace is only one of the changes occurring in 1998. The 1993 ARN Trunk route changes were the first of a series of ARN route modifications gradually improving the European route network. Already many RNAV routes exist. The next major change will be Version 3 of the ARN Route structure planned for Autumn 1998. This will make use of the fact that the non RNAV routes can be discontinued to provide the capability for revised flows of traffic.

Whilst the route structure modifications will continue to be an evolutionary development, Version 3 will allow significant changes at certain key points which are bottlenecks in the existing route structure. The availability of RNAV allows the structure to be modified, separating flows of traffic to permit reduced interaction. This then allows resectorisation and an increase in overall system capacity.

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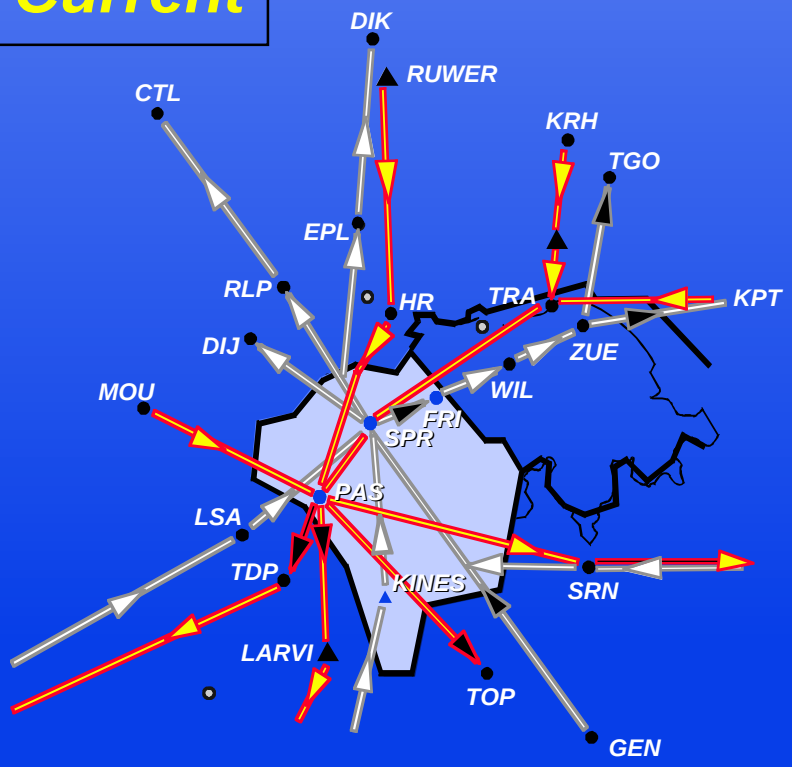
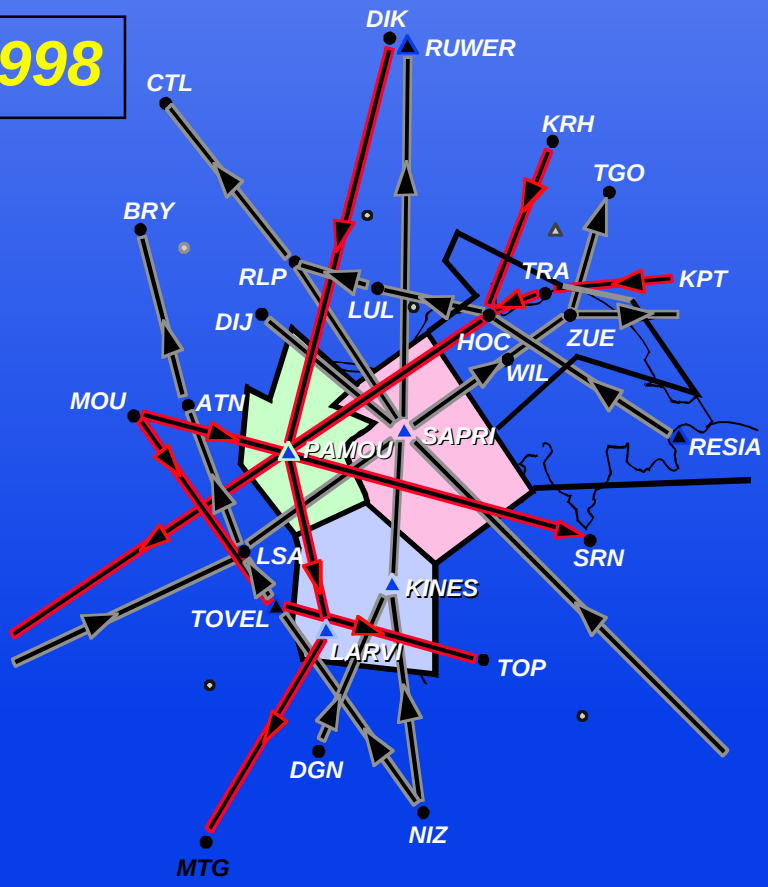
ZOE

Current



1998



2000 and Beyond

Capacity Demands increase enormously

- RNAV an important means to meet demand

Operational efficiency derived from RNAV

- Free Routing

RNAV central to future European ATM System - Gate to Gate

- En-route
- Terminal Airspace
- Surface movement Guidance

SLIDE NOTES: Free routing made possible by RNAV will substantially reduce interactions between aircraft and thereby reduce the number of controller interventions. Whilst this would be expected to reduce controller workload, the geographical spread of the conflicts results in an increase in workload unless controller support tools such as conflict prediction is provided.

The present plans call for the use of Free Routing to be increasingly available from 2002 initially in the upper airspace.

The programmes presently underway in the airspace and navigation domains, namely BRNAV, Free Routes, Reduced Vertical separation will together provide significant increases in Airspace.

However, it is increasingly important that capacity requirements are considered as a whole; ensuring that providing capacity in one area does not simply move the bottleneck elsewhere. For example, the present developments of the en-route capacity will shift the bottleneck toward terminal airspace and airport infrastructure. It is necessary to develop a "Gate to Gate" strategy providing a a coherent plan for developments required to meet the expected capacity demands. In considering such Gate to Gate concepts, surface movement guidance is going to be a further important navigation task in the coming years allowing movement rates to be increased and maintained under all visibility conditions.

SESSION 2

RNAV Standards
Means of Compliance

EUROCONTROL RNAV STANDARD

Standard:

- Covers short and long term RNAV requirements
- BRNAV en-route requirements set to standards met by nearly all RNAV Systems
- Additional functional capability required for Terminal Airspace applications:

Coordinated with Industry Standards

SLIDE NOTES: The development of RNAV resulted in a large range of capabilities. In recognition that this prevented the potential capabilities of RNAV to be fully realised, a EUROCONTROL Standard was developed as a basis for RNAV functional requirements. This document only sets out the ATS requirements for an RNAV system but it has been an important input to the RTCA and EUROCAE RNP Area Navigation MASPS which will become the new industry standard covering foreseen future requirements. The aim has been to develop a standard meeting en-route and Terminal RNAV operations taking account of both the ECAC area and United States requirements.

However, these standards have only been approved in late 1996. These cannot be made mandatory in less than 7 years but it has been demonstrated that benefits can be achieved from 1998 by the application of existing system capabilities. This has consequential effect on the minimum applicable route spacings and constrains the operational application of RNAV. However, while it prevents the maximum airspace capacity improvements to be achieved it still provides the capability for significant gains to be made.

The second part of the task for the navigation domain is the provision of Terminal Area RNAV procedures. Few can be put in place with only Basic RNAV capability. As a result many of the advantages to be derived from RNAV in the TMA will be limited to those aircraft equipped with Precision RNAV. Whether such functionality will need to be mandated post 2005 has yet to be decided on the basis of Cost Benefit criteria.

JAA Temporary Guidance leaflet 2 - AMJ 20X-2

Sets out means of compliance for BRNAV:

- VOR/DME
- DME/DME
- Omega - no longer applicable
- INS - has operational limitations
- GNSS when approved

SLIDE NOTES: The JAA requirement for Basic RNAV are set out in JAA Temporary Guidance leaflet 2 otherwise known as AMJ 20X-2.

The position data allowed by AMJ 20X-2 includes the above navigation sources with GNSS available only after suitable approval.

APPLICABILITY OF GPS

Problems for equipage due to:

- Cost - many older aircraft have short remaining life
- Flight deck space limitations
- Equipment Availability

BRNAV requirements limited - Is GPS a potential solution?

Work Underway:

- RAIM studies
- GPS Operational Performance
- Reversionary navigation measures
- Impact on ATC

SLIDE NOTES: Whilst work with operators association and manufacturers has been ongoing since 1993 it is apparent that many operators have not as yet installed RNAV. For most the difficulties set out above are the main reasons for the delay.

The question is whether GPS be used a means of meeting the BRNAV requirement bearing in mind the relatively low integrity and continuity requirements being demanded.

A number of studies are underway to provide information for safety studies.

INITIAL RESULTS

First Safety Case highlighted:

- Importance of training
- Ability to cross check with ground aids following failure
- Planning should include verification of RAIM availability for intended flight
- Long term monitoring to confirm safety of operation

SLIDE NOTES: Two safety Case studies are the key to the decision on the application of GPS. The first has provided an interim report which indicates that it will be possible for GPS to meet the BRNAV requirement.

GPS LIMITATIONS

Suitable to meet BRNAV requirement whilst VOR remains -

- Short term solution only

Need prediction of RAIM availability

- Impact upon dispatch reliability

Not necessarily suitable for TMA application

- Integrity
- Man Machine Interface
- compatibility with ARINC 424 leg type definitions

SLIDE NOTES: However, there are limitations and this must be carefully considered when equipage decisions are being made.

Modified AMJ 20X-2

Proposed modification prepared allowing GPS application as a means of meeting BRNAV:

- Subject to conclusions of safety case and JAA internal approval
- Subject to limitations consistent with safety case conclusions.

SLIDE NOTES: At present a revised AMJ 20X-2 has been prepared allowing GPS as an acceptable means of compliance if certain operational restrictions are applied. This still has to be approved and is subject to satisfactory results from the safety studies.

Whether GPS is an acceptable solution for an operator must be a financial decision since it may affect dispatch reliability.

SESSION 3

How to meet the RNAV requirement

FUTURE STANDARDS

RTCA/EUROCAE MASPS

- Longer term requirements:
- Ensure RNAV system integrity and functionality

Not required before 2005 but shorter term application planned:

- Restricted set of equipment meeting higher standards
- GPS may not be suitable for TMA operation on RNAV procedures

AVAILABLE EQUIPMENT

Many aircraft equipped - standard equipment or retrofit - Typically 80%

BUT

Problems remain

Time short - installation need to be prepared urgently
For many aircraft FMS too costly/large etc.
GPS is seen as a vital means of meeting BRNAV

SLIDE NOTES: In terms of the BRNAV programme the vast majority of aircraft have suitable RNAV equipment either as a result of original fit or from a retrofit to meet the BRNAV programme. For these operators it is important that the expected capacity gains are realised. It is therefore important that the problems encountered by the remaining aircraft can be overcome in the time available.

Whilst the GPS solution has only a short term viability it is seen as a vital means by which the BRNAV programme can be met.

CONCLUSIONS

- RNAV required to enable capacity gains
- The problem of re-equipage understood
- Work underway to verify applicability of GPS

However:

- Many operators equipped to meet RNAV requirements
- Incumbent upon EATCHIP to meet timescales
- Operators must make necessary plans to meet timescale

FUTURE ACTION

GPS Applicability important if timescales to be met:

- Studies continue
- Report by end April
- JAA Review changes to AMJ on 12th May
- If GPS applicability approved, programme continues with implementation date of 29th January 1998