ANNEX F  PRELIMINARY IMPACT ASSESSMENT ON CIVIL-MILITARY ORGANISATION

F.1 Introduction

F.1.1 PBN Mandate covers civil-military coordination

The European Commission mandated Eurocontrol to develop a draft interoperability implementing rule on PBN. This mandate makes reference to the Essential Requirements set out in Annex II of the interoperability Regulation including: “civil-military coordination”. EUROCONTROL was consequently invited to cover civil-military integration alternative solutions and to address the impact of the proposed solutions on civil/military organisation.

The draft PBN IR shall, amongst other aspects, be applicable to a mixed-mode environment thus satisfying the needs of all airspace users including the military by incorporating the civil-military interoperability requirements necessary to facilitate military operations and accommodate State aircraft.

F.1.2 Purpose

The purpose of this annex is to develop a preliminary impact assessment on civil-military organisation of the different possible alternatives for the development of the draft interoperability implementing rule on PBN. This assessment is conducted in support of the preparation of the draft RAD. It was initially prepared by the EUROCONTROL and subsequently submitted to the Military Harmonisation Group (MILHAG) for informal consultation. Extended Impact Assessment on civil-military organisation will be part of the second phase of the mandate work - the development of the draft Final Report.

F.1.3 Document structure

Section F.1 sets out the scope of civil-military coordination and defines the purpose of this annex.

Section F.2 defines the State aircraft perspective in draft PBN IR.

Section F.3 examines the impact of PBN on State aircraft on the basis of proposed options.

Section F.4 discusses the necessary transition arrangements for State aircraft.

Section F.5 identifies sources of reference material.

Section F.6 presents some economic impact considerations.

Section F.7 provides conclusions and recommendations.

Appendix 1 analyses the technical impact of PBN on one modern military transport aircraft (Airbus A-400M) and fighters (Eurofighter Typhoon).

F.2 State aircraft perspective in draft PBN IR

The following specific objectives for the development of the draft PBN IR have been identified.

- Ensure optimal use of airspace through the introduction of airspace structures and procedures based on common navigation performance requirements and functionalities in en-route airspace by 2020;
• Increase access to airports through the introduction of arrival and departure routes and approach procedures based on common navigation performance requirements and functionalities in terminal airspace by 2020;

• Reduce CFIT by the full deployment of approaches with vertical guidance by 2020;

• Maximise the use of flexible approaches in terrain rich environment as well as in noise sensitive areas across Europe;

• Maximise the horizontal and vertical flight efficiency across Europe;

• Enable decommissioning or non replacement of conventional navigation aids (e.g. VOR);

• Introduce new requirements in a manner which minimises operator’s certification and approval costs;

• Facilitate the transition to SESAR Trajectory Based Operations concept through the introduction of functional requirements and procedures by 2025;

• Ensure harmonised PBN operations in en-route and TMA.

The PBN Mandate identified the need for civil-military coordination as an essential element to satisfy the increasingly demanding performance levels that need to be met by the EATMN in terms of capacity, efficiency, predictability, and environment and to address the density of air traffic in the ECAC upper airspace as well as fulfilling military requirements for larger and more mobile reserved airspace.

The draft PBN IR is expected to be applied in a mixed-mode environment thus satisfying the needs of all airspace users including the military by incorporating the civil-military interoperability requirements necessary to facilitate military operations and accommodate State aircraft. That approach is also a facilitator for the introduction of free route operations as it reduces the level of required airspace segregation.

The need to accommodate State aircraft flying GAT/IFR on the basis of seamless interoperability was justified by the need to reduce segregation and limit ATC workload by minimising special handling and exemptions.

The regulatory provisions to be included in the draft PBN IR to enable State aircraft access to the airspace where the draft applies shall include: 1) some measures for particular new transport type State aircraft to be compliant with the mandated navigation performance requirements and functionalities; 2) transition arrangements and obligations for the air traffic service providers to accommodate other types of State aircraft and fleets with lower capability.

Not all State aircraft will be capable of complying with the draft PBN IR requirements by the due dates currently envisaged within the framework of the Regulatory Approach. While the need to accommodate State aircraft is justified by the legitimate sovereignty roles and national security and defence missions that require unrestricted access to the airspace, the need for transition arrangements has a bearing on the procurement and technical constraints that military organisations face when confronted with ATM improvements. Some State aircraft will never be PBN compliant thus airspace design should pay due regard to mixed mode environment.
Likewise for previous SES interoperability implementing rules the transition arrangements for State aircraft that need to be included in the draft PBN IR shall comprise provisions including:

a) for modern transport-type State aircraft forward fit provisions for identified PBN functionalities allowing sufficient transitional lead times or exemptions/derogations that consider the size of the fleets and the diversity of aircraft types and its life cycle;

b) reversionary (conventional) ATS support\(^1\) to handle non-equipped or lower capability aircraft; and

c) voluntary opportunities to use available military capabilities and specific military airborne configurations which might be considered as equivalent means of compliance on the basis of the demonstration that determined performance levels can be attained.

In all options under consideration for the Regulatory Approach, the specific requirements associated with the accommodation of State aircraft will have to be considered. Subsequently in this annex the specific approaches for accommodating State aircraft in the different options under consideration are further described.

**F.3 PBN Impact on State aircraft**

The approach described above is justified by the impact that the PBN solution and associated navigation functionalities has on State aircraft considering its typical equipage and other procurement and technical constraints.

**F.3.1 Draft Regulatory Approach Options**

The table below summarises the envisaged aircraft capabilities. Some requirements are not applicable below FL195.

<table>
<thead>
<tr>
<th>Option 1: Minimum Regulatory Coverage by 2020</th>
<th>Option 2: Complete Regulatory Coverage to Enable Deployment of Operational Improvements in EATMN by 2020</th>
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</thead>
<tbody>
<tr>
<td>• Advanced RNP (1NM TSE) (2020)</td>
<td>• Advanced RNP (1NM TSE) (2020)</td>
</tr>
<tr>
<td>• RF</td>
<td>• FRT above FL 195 (2020)</td>
</tr>
<tr>
<td>• RNAV Holding</td>
<td>• Tactical Parallel Offset (2020)</td>
</tr>
<tr>
<td>• VNAV</td>
<td>• Capability to meet a single time constraint (2020)</td>
</tr>
<tr>
<td>En-Route</td>
<td>Terminal Airspace</td>
</tr>
<tr>
<td>• Advanced RNP (1NM TSE)</td>
<td>• Advanced RNP (1NM TSE)</td>
</tr>
<tr>
<td>• RF</td>
<td>• RF</td>
</tr>
<tr>
<td>• RNAV Holding</td>
<td>• RNAV Holding</td>
</tr>
<tr>
<td>• VNAV</td>
<td>• VNAV</td>
</tr>
<tr>
<td>Final Approach</td>
<td>Final Approach</td>
</tr>
<tr>
<td>• APV and LNAV (2020)</td>
<td>• APV and LNAV (2020)</td>
</tr>
</tbody>
</table>

\(^1\) ATS support in this context means the special handling services (within safety limits) provided by the Air Navigation Service Providers (ANSPs) to accommodate non PBN capable State aircraft using conventional procedures like, for example, alternative routing via VOR/DME-defined ATS routes or non-RNAV-based SIDs and STARs in TMA.
**REGULATORY APPROACH**

**Interoperability implementing rule on Performance Based Navigation**

**SES/IOP/PBN/REGAP/0.4**

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**Table 1 - Summary of aircraft functionalities required per regulatory option**

<table>
<thead>
<tr>
<th>Regulatory Option</th>
<th>Aircraft Functionalities Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 3</td>
<td>Advanced RNP (1NM TSE)</td>
</tr>
<tr>
<td></td>
<td>FRT above FL 195</td>
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<tr>
<td></td>
<td>Tactical Parallel Offset</td>
</tr>
<tr>
<td></td>
<td>Capability to meet a single time constraint (2020)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Advanced RNP (1NM TSE)</th>
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<tr>
<td></td>
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<tr>
<td></td>
<td>VNAV</td>
</tr>
<tr>
<td></td>
<td>Capability to meet a single time constraint (2025)</td>
</tr>
</tbody>
</table>

|               | APV and LNAV (2020)               |

In the “Do-Nothing” Scenario (see Annex C, Section C.3.3.1), State aircraft will continue to be accommodated on the basis of exemptions and special handling.

For all other options, the specific requirements associated with the accommodation of State aircraft will have to be considered in the draft IR. This entails provisions with the proposal of implementation dates aligned with military procurement cycles, taking due account of new production transport type State aircraft, considering forward fit with the set of navigation functionalities as for civil aircraft. Measures for transitional accommodation of lower capability State aircraft by ATS providers will also be envisaged. (“Lower capability” in this context means the inability to support the required PBN functionalities.)

For options 1 to 3 a recital shall be included offering the opportunity to the States (on a voluntary basis) to seek performance-based equivalent compliance for all State aircraft types, established on the basis of national certification arrangements.

State aircraft applicability should take into account the existing national PBN policies.

**F.3.2 Navigation Performance Requirements and Functionalities**

a) **En-Route and Terminal airspace** – as needed to achieve the performance targets and the operational needs in the European en-route and terminal airspace, through:

- better navigation accuracy than currently required, and
- a new package of functionalities required to be considered by the EC mandate on PBN as basis for the development of the draft IR:

  - required navigation performance (RNP);
  - radius to fix (RF);
  - fixed radius transition (FRT);
  - reduced airspace holding;
  - required time of arrival (RTA);
  - vertical navigation path (VNAV Path); and
  - tactical parallel offset.

b) **Final Approach** - In order to increase safety and reduce the incidence of CFIT, there is a need for an approach specification based on GNSS which enhances
lateral and (preferably) vertical operations. This new navigation specification is known as RNP APCH.

- GNSS positioning inherent in RNP APCH
- VNAV using either barometric altimetry or SBAS augmentation of GNSS
- Moving away from conventional non-precision approaches to RNP approaches

**F.3.3 State Aircraft Equipage**

Indicative information on typical navigation avionics suite for a representative set of different types of State aircraft is available as it was delivered in the context of EUROCONTROL studies and contribution to a SESAR military avionics study and SESAR project 15.3.1 (Navigation Technologies Specifications).

A very high level summary of equipage information is included in the table below. It is based on a rather restricted number of aircraft types, it was derived in many cases from open sources and it was not fully validated in all cases (except for the SESAR military avionics study where some national Military Authorities have been consulted).

The table below was derived from the studies mentioned above and provides indicative equipage estimation for modern platforms. These elements shall be taken with caution only to formulate a high level view of the equipage situation in terms of navigation capabilities.

<table>
<thead>
<tr>
<th>CAPABILITIES</th>
<th>TRANSPORT TYPE</th>
<th>FIGHTER</th>
<th>LIGHT</th>
<th>HELICOPTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAV (HUD, EVS, FMS/MMS, FM Immunity)</td>
<td>&gt;75%</td>
<td>&gt;25%, &lt;75%</td>
<td>&gt;25%, &lt;75%</td>
<td>&gt;25%, &lt;75%</td>
</tr>
<tr>
<td>NAV app+land (ILS, MLS, DGPS, GBAS, ABAS)</td>
<td>&gt;25%, &lt;75%</td>
<td>&gt;25%, &lt;75%</td>
<td>&gt;25%</td>
<td>&gt;25%</td>
</tr>
<tr>
<td>NAV bearing (VOR)</td>
<td>&gt;75%</td>
<td>&gt;75%</td>
<td>&gt;75%</td>
<td>&gt;25%, &lt;75%</td>
</tr>
<tr>
<td>NAV rang+bearing (DME, TACAN)</td>
<td>&gt;75%</td>
<td>&gt;75%</td>
<td>&gt;75%</td>
<td>&gt;25%, &lt;75%</td>
</tr>
<tr>
<td>NAV route+app+land (GNSS)</td>
<td>&gt;75%</td>
<td>&gt;75%</td>
<td>&gt;25%, &lt;75%</td>
<td>&gt;25%, &lt;75%</td>
</tr>
<tr>
<td>PNT (GPS PPS, GPS SPS, INS/IRU)</td>
<td>&gt;75%</td>
<td>&gt;75%</td>
<td>&gt;25%, &lt;75%</td>
<td>&gt;75%</td>
</tr>
</tbody>
</table>

**F.3.4 State Aircraft Technical Limitations**

On the basis of the results of a study commissioned by EUROCONTROL (2009) on Feasibility of Navigation Equivalent Verification of Compliance for State Aircraft against ATM Navigation Standards\(^2\) technical limitations in modern military aircraft (the study evaluated Eurofighter Typhoon and Airbus A400M), in reference to PBN requirements, can be summarised as follows:

- The PBN Manual limits the eligible sensors to those mainly used by civil aviation

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On many military aircraft the absence of navigation database is identified as the first major difficulty

Compliance of military navigation computers with ARINC 424 path terminators and flight plan management is a problem still to be further studied

There are limitations due to old generation CRT displays

Functions like VNAV and RTA are a concern due to vertical navigation limitations of some military platforms and inability of military mission systems to process certain data formats

It is important to highlight that the referenced study included also additional information on the applicability and impact assessment of requirements per navigation specification and that in all cases possible mitigation measures have been identified for both military aircraft types.

An important conclusion that emerges from those technical considerations is that missing State aircraft navigation capabilities, in reference to PBN requirements, could likely require major aircraft avionics changes for a significant number of aircraft types being these changes not different for any of the three PBN regulatory options considered. Some PBN requirements will never be supported by some aircraft types.

As a consequence of the limitations described above, in order to meet the draft PBN IR regarding the navigation performance homogeneity of the fleet there is a need to:

- Optimise the timelines and the capabilities to reduce as much as possible the impact on State aircraft (for example offering sufficient time to plan upgrades or packaging different requirements for one single intervention)
- Build new aircraft in accordance to this new rule (provided that the required functionalities are fully described in relevant standardisation materials and that the proper level of awareness is ensured)
- Establish transition arrangements/exemptions as required for legacy aircraft

These principles are reflected in the approach described above for the consideration of State aircraft in the various options.

Appendix 1 includes a more detailed list of such technical limitations.

F.3.5 State Aircraft Planning Factors, Procurement Constraints and Exemption Policy

When planning the deployment of relevant ATM/CNS capabilities, some factors that limit the ability of ATM planners and military authorities when trying to adopt ATM requirements have to be considered:

- civil nature of ATM/CNS requirement lacking associated military operational justification;
- huge military fleets: about 11,000 military aircraft in the inventory of ECAC States with the vast majority of those aircraft belonging to EU countries;
- multiple military aircraft types (transport-type, fighter and light aircraft, helicopters and UAS);
- significant number of variants for each aircraft type (depending on mid-life upgrades performed or tailored for specific mission/role);
• technical constraints including integration difficulties, lack of cockpit space, co-site interference, absence of service bulletin or technical standards, architecture mismatches, etc;
• development of limited series of equipment for out-of-production aircraft;
• lengthy procurement cycles (in some cases dependent of military force proposal cycles);
• budget constraints (including in some cases the submission of multiyear programmes for parliamentary approval);
• lack of civil-military standards and streamlined certification processes.

Those constraints limit the interoperability levels that are a critical element to ensure a seamless operational environment and to reach the required capacity gains and safety enhancements whenever military aircraft require operating within EATM mixed mode environment. For a residual number of flights where civil-military interoperability is not possible, due to the abovementioned limitations, State aircraft need to be temporarily accommodated on the basis of special handling or exemption policies for the airborne equipage. In summary, the rule should specify the PBN requirements to be implemented in State aircraft together with transitional delays and arrangements that are needed due to the limitation described above.
F.3.6 Considerations on SES Framework, Airworthiness Certification and Operational Approval

F.3.6.1 SES Framework

Member States have adopted, in parallel to the first SES package, a general statement on military issues related to the single European sky\(^3\). According to this statement, Member States should, in particular, enhance civil-military cooperation and, if and to the extent deemed necessary by all Member States concerned, facilitate cooperation between their armed forces in all matters of air traffic management. This statement is commonly referred to as the “Common Declaration”.

Even recognising that military operations and training are not covered by the SES regulatory framework, civil-military coordination was recognised as an Essential Requirement and provisions related with civil-military interoperability are usually included in SES regulations for the overall benefit of EATMN safety, capacity and environmental gains.

Most interoperability IRs include articles or recital provisions that impact State aircraft or military-related service provision. Examples are current IRs on Air-Ground Voice Channel Spacing (VCS), Data Link Services (DLS), Surveillance Performance and interoperability (SPI), Aircraft Identification (ACID), Flight Message Transfer Protocol (FMTP), Aeronautical Data Quality (ADQ) or Mode S IC Code Allocation. A similar approach must be followed for the draft PBN IR.

SES IRs are only applicable to State aircraft operations conducted as GAT/IFR.

F.3.6.2 Certification

This subject shall be left outside the scope of the draft IR but some considerations are deemed important:

The ICAO PBN Manual does not change the regulatory basis of the airworthiness and operational approval processes. National civil aviation authorities, EASA and military authorities keep their respective roles and responsibilities.

PBN brings new requirements for the airworthiness and operational approval which have to be reflected in new certification material at regional (EASA) or national level for the new specifications introduced in the ICAO PBN Manual. These will have to be considered by the certification performed by national military organisations.

As a consequence, national military authorities in charge of airworthiness certification for military aircraft may use civil aviation materials such as EASA AMCs and the ICAO PBN Manual to develop their certification materials. However care must be taken as these materials do not account for technical characteristics of military aircraft.

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\(^3\) Statement by the Member States on Military Issues Related to the Single European Sky, OJ L 96/1 EN, 31.3.2004, p.9
F.4 Transition Arrangements for State aircraft

In consequence of the abovementioned limitations, not all State aircraft will be immediately capable of complying with the navigation performance requirements and functionalities by the due dates defined. While the need to accommodate State aircraft is justified by the legitimate sovereignty roles and national security and defence missions, that entails the need to have unrestricted access to the airspace, the need for transition arrangements has a bearing on the procurement and technical constraints that military organisations face when confronted with ATM improvements.

Likewise for previous SES interoperability implementing rules the transition arrangements for State aircraft that need to be included in the draft PBN IR shall comprise provisions including:

- for modern transport-type State aircraft, mandating capabilities/equipage forward fit with longer lead times or exemptions/derogations that consider the size of the fleets and the diversity of aircraft types and its life cycle;
- reversionary (conventional) ATS support to handle non-equipped or lower capability aircraft; and
- opportunities to cope with available military capabilities and specific military airborne configurations which might be accepted in the future as equivalent means of compliance on the basis of the demonstration that determined performance levels can be attained even if considering only future PBN specifications.

The approach to be followed to include provisions for State aircraft in the draft PBN IR shall be in line with the PC-approved “Policy Guidance for the Exemption of State Aircraft from Compliance with Specific Aircraft Equipage Requirements”.

The method taken for other SES IRs shows that a minimum of 10 years procurement lead time needs to be observed when mandating new capabilities to State aircraft.

It is also desirable that multiple capabilities impacting State aircraft are introduced in packages that should not force retrofit/mid life interventions more than once every 4 years.

Consequently, the problem becomes much more complex than for GAT/IFR conventional navigation. This analysis could be even more critical for military operators who have additional obligations for their aircraft equipage compared to civil operators as they need to cope with additional military wartime requirements. The verification of availability of reversionary modes for different airborne architectures showed the particular importance of GNSS and IRU sensors which are the common basis for military combat and large aircraft. Single RNAV systems confronted to future navigation specifications, like A-RNP, are particularly weak. Nevertheless, it is well understood that all efforts must be made to minimize equipage exemptions.

A very important aspect is that as the current policy documents for military air navigation do not sufficiently account for PBN, it is not yet possible to define which navigation specifications for the different flight phases are of interest for the military community. If this policy is set at national level without harmonization, it may result in a proliferation of non harmonized navigation capabilities detrimental to ANSPs and airspace users. To same extent this is also valid in the context of PBN IR even if only State aircraft flights conducted as GAT/IFR are within the scope.
F.5 Sources of PBN Guidance

When progressing with the development of a draft PBN IR the existing national regulations, directives or other documents shall be considered. Some of the existing national PBN policy documents contain relevant provisions on State aircraft.

F.6 Economic Impact Considerations

Business case exercises related with the adoption of ATM requirements, including a cost-benefit analysis (CBA), specifically focusing on the military community normally reach the conclusion that it is very difficult to obtain reliable information due to the fact that costs associated with State aircraft are subject to a great deal of uncertainty due to the huge number of aircraft types and variants. One area of uncertainty relates to the non-recurring costs - such as design authority and contract administration costs - which may vary enormously depending on the particular procurement policy being applied in different States.

When civil ATM improvements are introduced, a larger part of benefits go to civil stakeholders and military airspace users are severely impacted in financial terms whereas the benefit for military operations is very limited. This imbalance should ideally trigger compensatory incentives that should be considered in the near future.

This subject needs to be further expanded in the context of PBN IR impact assessment.

F.7 Conclusions and Recommendations

The various options under consideration will impact civil-military organisation at different levels.

Recommendations on the options considered most suited to sustain civil-military interoperability shall be originated at the discretion of States’ military stakeholders during the draft PBN RAD and IR consultation phases.

Nevertheless, it is important to highlight that the “Do-Nothing” scenario would have detrimental effects on the ability to reduce exemptions and derogations as the main option considered adequate to accommodate State aircraft failing to meet interoperability levels to achieve required safety levels, capacity gains and to facilitate military operations conducted in a mixed mode environment.

Considering transport type State aircraft as those flying predominantly as GAT/IFR, Option 1 may offer a good compromise to ensure minimal interoperability levels while accommodating State aircraft flights with minimum impact in terms of airborne equipage. Some national Military Authorities have already expressed their preference for a minimum regulatory coverage due to budgetary constraints.

Option 2 offers multiple advantages introducing important functionalities including the ability to meet a single time constraint in en-route operations but with higher impact on available capabilities. If such additional capabilities are not perceived by military authorities to be imperative for airspace and airport access the allocation of resources for compliance may be hard to justify.

Option 3 introduces as requirement the capability to meet a time constraint in terminal airspace operations which is a very important functionality to enable more advanced 4D concepts but for which only a minority of State aircraft can be expected to be ready in a reasonable timeframe.

Other aircraft types (e.g. fighters) shall not be subject of any regulatory prescriptions but rather accommodated on the basis of performance based compliance to be validated through
national certification processes.

With the understanding that the regulatory impact upon State aircraft must be kept within acceptable limits as justified by military procurement constraints and technical limitations, military authorities should also strive to meet the PBN requirements to the maximum extent possible through their own certification processes and declare these in accordance with their national arrangements.

That will contribute to the ability for ATS providers to design airspace structures using the most suitable PBN functionalities in line with all airspace user capabilities. Transitional arrangements for the accommodation of State aircraft should be further refined to reach an appropriate balance between the national defence and security justifications for unrestricted access and the impact of special handling or reliance on operational mitigation.

A greater focus shall be put on processes for verification of compliance for State aircraft and military authorisations but the bottom line will be that the majority of State aircraft will remain in operation without the required PBN capabilities and will still need to be handled on the basis of conventional support for a certain transition period. Nevertheless, forward fit actions for transport-type aircraft entering into service or suffering major mid-life upgrades may be targeted for compliance with some PBN functionalities.

The abovementioned facts, together with the absence of military justification for some ATM improvements, seem to indicate the need to avoid regulatory measures that are too prescriptive for State aircraft.
APPENDIX 1 – TECHNICAL IMPACT OF PBN ON MODERN MILITARY TRANSPORT AIRCRAFT (AIRBUS A-400M) AND FIGHTER (EUROFIGHTER TYPHOON)\(^4\)

For the particular cases of modern military aircraft considering as examples the Airbus A-400M and the Eurofighter Typhoon the paragraphs below detail the technical constraints that have been identified in the referenced study:

**Sensors**

- The PBN Manual limits the eligible sensors to those used by civil aviation. Specific military sensors like GPS PPS and TACAN are not eligible
- The coupling of IRU is only specified for IRU/DME/DME while military usually hybridize IRU with GPS PPS. Update of INS or IRU with GPS/PPS should be studied from a performance-based perspective
- Only a few military transport aircraft use DME/DME to update IRU or INS and sometimes without an automatic updating function
- The IRU by itself does not raise performance problems. Compliance with A-RNP that could require the carriage of 2 eligible sensors (GNSS and DME/DME) and a redundant RNAV computer may be problematic on combat aircraft or jet trainers
- The need for additional functioning modes (PPS lock out mode) with an SPS/PPS selector should be assessed in order to avoid potential unnecessary complex and costly receiver’s architectures. However, this aspect needs further consideration as MSO\(^5\) compliant aircraft may not have to switch off their PPS receiver.
- The same consideration would apply for Galileo PRS receiver in combination or not with GPS PPS
- The TACAN transceiver could be used instead of DME for positioning update but there are no “scanning TACAN” able to support an automatic update function. The performance of TACAN transceiver should be investigated in the light of civil standards
- For aircraft without DME/DME function (e.g. combat aircraft) the use of radar fixing, Terrain Reference Navigation or the MIDS PPLI message to update the IRU should be investigated
- Eligibility of military GPS as a means of compliance would considerably alleviate the impact severity of PBN requirements on military aircraft

**Navigation computing and interfaces**

- On many military aircraft the absence of navigation database is identified as the first major difficulty
- Military navigation computers offer limited capabilities in term of path computing since they usually comply with only few ARINC 424 path terminators

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\(^5\) Military Standard Order
Another difficulty to comply with ARINC 424 is the flight plan management. Usually the flight plan can accept insertion of Way Points (WPTs) but not a complete sequence of WPTs as it is required.

WPTs format are not standardized in military navigation computer and usually cannot recognize the ARINC 424 format and data structure (e.g. en route WPT, APT or RWY etc.)

Possible mitigation means to be investigated could include the use of the mission planning system (MPS) used in conjunction with the aircraft mission computer to handle the ARINC 424 data.

The MPS would translate the ARINC 424 into appropriate paths coded with a format recognised by the aircraft navigation computer.

Such mitigation would imply manually handled in-flight tactical changes with possible manual creation of WPTs in the flight plan which is not an allowed method in PBN requirements.

The definition of a “minimum reduced” set of path terminators to be implemented could help to overcome some limitations.

The VNAV and RTA functions raise severe problems on aircraft that do not offer a basic vertical navigation mode. This would require important modifications of the aircraft itself in addition to the navigation system modifications.

Fighter aircraft altimetry system is subject to important ASE variations due to changes in external configuration. VNAV and RTA should be considered as hard points.