A SNAPSHOT OF **STATE AIRCRAFT'S ON-BOARD EQUIPAGE FOR PERFORMANCE-BASED NAVIGATION** (PBN)

Military aviation flying as general air traffic

Decision-making processes in the field of communications, navigation and surveillance (CNS) can be supported by knowledge derived from data elements related to State aircraft operations under either operational air traffic (OAT) or general air traffic (GAT) rules. This paper looks at data elements which support GAT-related decision-making in strategic, operational and economic domains.

An approach is to provide responses to CNS technological questions based on State aircraft's[1] on-board capabilities by utilising flight plan data which are submitted to the Network Manager's Integrated Initial Flight Plan Processing System (IFPS)[2].

In this context, the first set of insights hinge on the military GAT traffic density in Europe. Specifically, two main questions arise: How many flights are carried out by State aircraft under GAT rules? What is the level of on-board equipage of State aircraft?

The information depicted in Figure 1 demonstrates that State aircraft do indeed fly as GAT in Europe, and therefore make use of both civil and military air traffic services and infrastructure. Consequently, military stakeholders should be deeply involved and engaged in airspace concept development activities in order to contribute to European responsibilities/activities in areas such as security, defence and peacekeeping.

Understanding the reasons behind the variation in the GAT military traffic figures from 2017 to 2022 is challenging, but can be associated to economic, health and security crisis. This period is divided into three timelines for the assessment of the potential reasons of the variation of the number of flights over time.

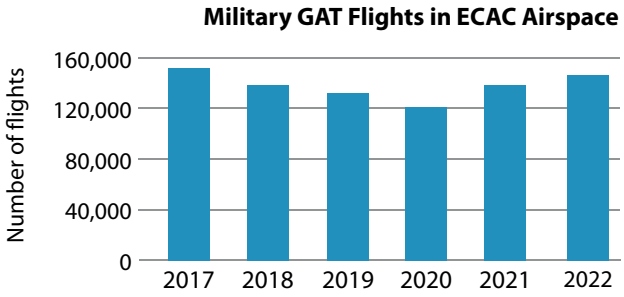

Figure 1
Number of military flights carried out in ECAC airspace under GAT rules.

1. *Military, customs and police, but in this document extrapolated to military aircraft only.*

2. *The representativeness of the data elements is confined to flight plans which are submitted to the Network Manager by State aircraft operators flying under GAT rules – that is, the GAT flight plans in which the letter "M" for "military" is indicated in Field 8.*

From 2017 to beginning of 2020, the decrease in GAT flights could have been undertaken as consequence of the economic crisis in the previous years, as well as defence- and security-related priorities in Europe, which could have affected the large spectrum of operations conducted by the military.

The decrease in number of military GAT operations in Europe was sharpened with the COVID-19 pandemic in 2020. Nevertheless, the growth in the number of flights in 2021 is notable which infers an interpretation that goes beyond the analysis of the aviation recovery from the COVID-19 pandemic per se. The growth in number of military GAT operations in Europe is also sustained by the war in Ukraine.

Nevertheless, the level of contribution of military GAT flights to the overall number of flights operated in Europe has been decreasing with the gradual recovery of aviation from the COVID-19 pandemic. The tendency might be to reach the same levels as before 2020 in the coming years.

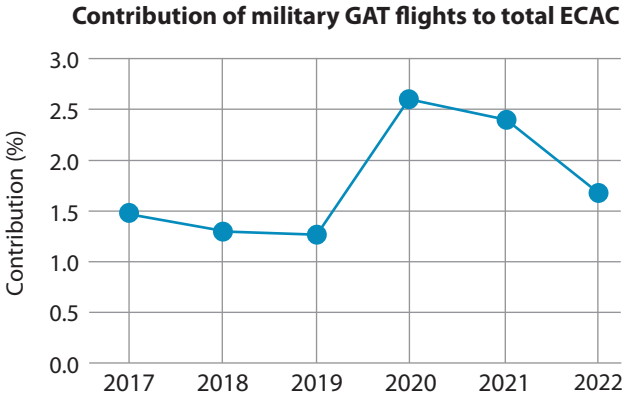

Figure 2
Ratio between military flights and total flights

Given these facts, civil-military coordination and inter-operability become pivotal and involve:

- military mission planning,
- operations execution,
- military aircraft equipage planning,
- military procurement life cycles, and
- space- and ground-based infrastructure planning and rationalisation.

Military navigation insights arising from data analytics

The interrelationship between performance-based navigation (PBN) and State aircraft operations is strengthened by the fact that State aircraft do fly under GAT rules, including when conducting missions connected (or in proximity) to conflict zones. This means that the introduction of PBN could pose a challenge to State aircraft operations if conventional procedures are not in place.

Therefore, the PBN requirements advocated in Regulation (EU) 2018/1048 constitute the grounds for assessing the level of on-board capabilities of State aircraft when flying as GAT.

Overall, the number of GNSS-equipped State aircraft which can fly PBN airspace structures has steadily been increasing over the recent years. However, the number of equipped State aircraft is still rather low, which suggests that a sole transition from conventional navigation systems to space-based navigation might raise concerns in terms of infrastructure resilience, flight efficiency and airport accessibility when Military carry out GAT operations.

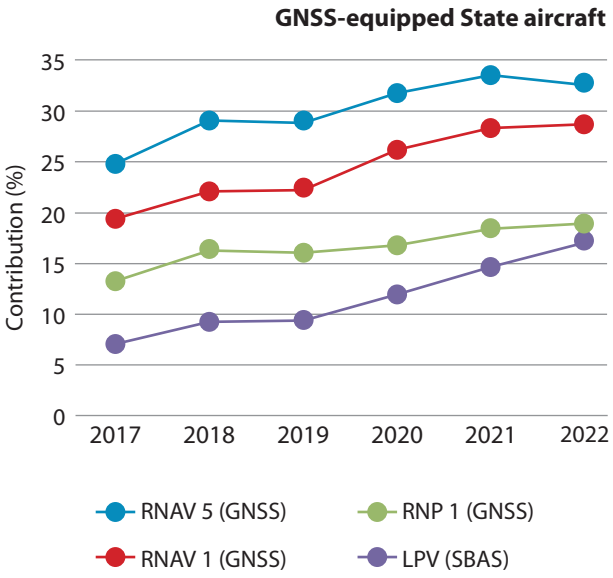

Figure 3
Percentage of State aircraft which declared GNSS-equipped [3]

[3.] *Flight plan descriptors: B2, D2, O2, B.*

The level of on-board State aircraft equipage predicated on GNSS is higher than when compared to ground-based navigation infrastructure (meaning DME/DME and VOR/DME) for en-route and TMA's PBN airspace structures. Another relevant element is that the level of on-board State aircraft equipage that is predicated on DME/DME has not been increasing over time, which could pose a challenge if such infrastructure configuration is adopted as a A-PNT solution without any other layer of infrastructure.

From Figure 5, the continuous increase in the level of navigation systems on board of State aircraft that support RNP APCH shows some level of adoption of PBN for approach and landing by State aircraft operators. Moreover, it could be predicted that PBN-related capabilities for 3D approaches might overtake ILS in the medium-term future, which enlarges the capability of State aircraft to perform 3D approach operations at small to medium-size airports that do not offer ILS-based navigation service.

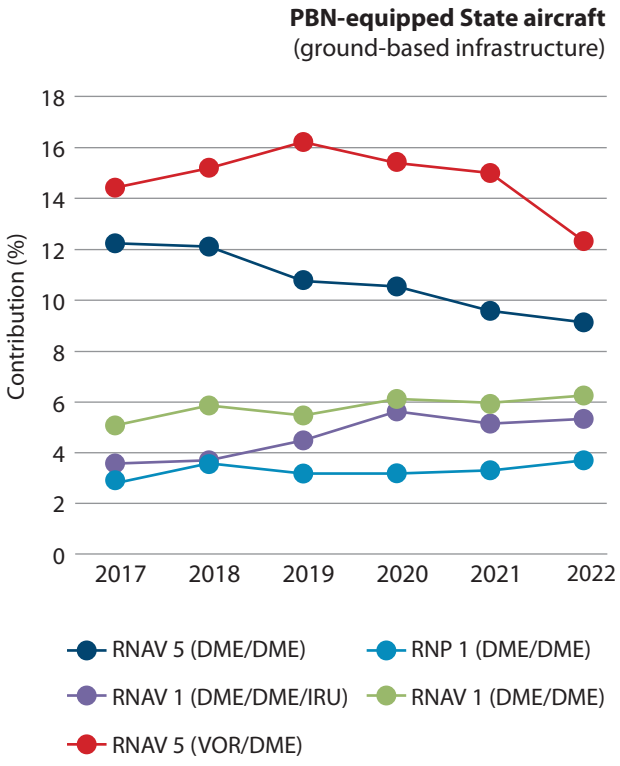

Figure 4
State aircraft compliant with PBN specifications predicated on ground-based infrastructure [4]

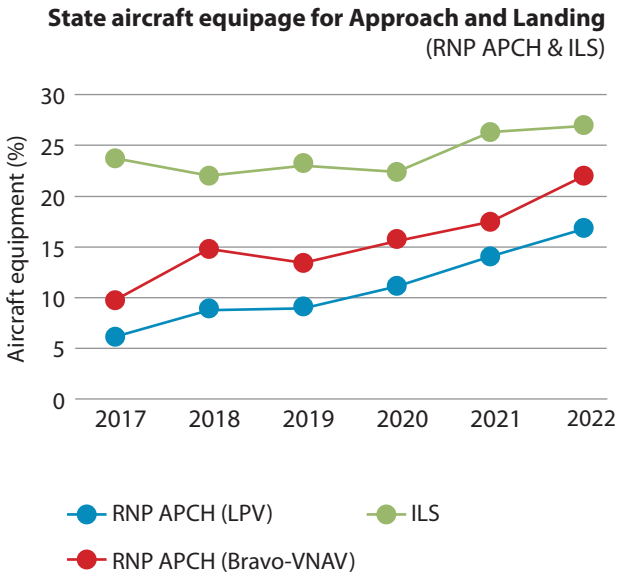

Figure 5
Level of State aircraft on-board equipage for approach and landing (RNP APCH & ILS) [5]

The requirement for precision approach and landing for State aircraft operations is category I which tendentially brings ILS as the main on-board system for this phase of flight. Nonetheless, the figures show that the level of on-board equipage is rather low, not having altered significantly over the recent years.

4. *Flight plan descriptors: B3, B4, D3, D4, O3.*
5. *Flight plan descriptors: B, S2, L.*

For conventional navigation, most State aircraft are equipped with DME and TACAN while VOR portraits a significant lower level of equipage. This might raise a challenge for State aircraft to operate at airports that only offer conventional approaches predicated on VOR/DME and to fly en-route structures that are predicated on VOR.

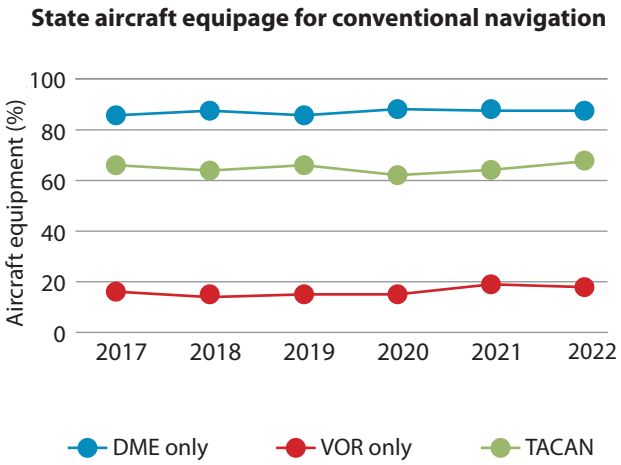

Figure 6
Level of State aircraft equipage for conventional navigation [6]

Conclusions

Data analytics is key to leveraging successful aviation business continuity and helping the aviation sector navigate through challenging events and connect all stakeholders within a common platform of information sharing and services.

Ground and airborne navigation systems are a key enabler for the modernisation and restructuration of air traffic management, sustainability and service provision in Europe. In the field of civil-military navigation, a set of high-level insights can be derived from data analytics based on flight plan information:

- State aircraft do indeed fly as GAT in Europe.
- Military and civil air traffic services and infrastructure support military operations in both peace- and crisis-time.
- State aircraft present low level of on-board systems that support PBN which might pose a challenge when PBN is fully deployed in Europe.
- Conventional procedures that are predicated on "civil" infrastructure only might not be the necessary solution for State aircraft operations.
- The enhancement of the TACAN network is a solution to support both PBN specifications and conventional procedures, providing a cost-beneficial and integrated civil and military aviation network.
- The move from non-PBN-compliant aircraft to PBN compliant aircraft will come at a cost, but it will also bring benefits which might need to be invigorated by incentives.

6. *Flight plan descriptors: D, O, T*

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The data presented in this document is based on flight plan information provided to the Network Manager and should be read as indicative of magnitude rather than exact figures. Extrapolations were avoided in order to keep the figures quoted as close as possible to the information received.

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