Contextual note – SESAR Solution description form for deployment planning

Purpose:

This contextual note introduces a SESAR Solution (for which maturity has been assessed as sufficient to support a decision for industrialization) with a summary of the results stemming from R&D activities contributing to deliver it. It provides to any interested reader (external and internal to the SESAR programme) an introduction to the SESAR Solution in terms of scope, main operational and performance benefits, relevant system impacts as well as additional activities to be conducted during the industrialization phase or as part of deployment. This contextual note complements the technical data pack comprising the SESAR deliverables required for further industrialization/deployment.

Improvements in Air Traffic Management (ATM)

The SESAR Solution “Enhanced terminal operations with automatic RNP transition to ILS/GLS” consists of an innovative Required Navigation Performance (RNP) approach procedure transitioning to a final precision segment provided by Instrument Landing System (ILS) / Ground Based Augmentation Landing System (GLS).

The SESAR Solution focused on the initial, intermediate and final approach segments:

- A-RNP or RNP APCH (RNP values from 1 to 0.3NM) with Radius to Fix (RF) legs for lateral navigation in preference to fly-by or fly-over waypoints, and, where appropriate, the provision of an RF leg in the Intermediate Approach Segment joined directly to ILS/GLS Final Approach Segment.

This SESAR Solution could be integrated with the following operations:

- Continuous Descent Operation (CDO), where possible, for the vertical profile with barometric vertical reference;
- Increased Glide Slope Final Approach Segment (FAS), taking into account ATC and Aircraft limitation in terms of final approach segment length/slope;

Traditionally there have been two different types of approach procedure, Precision Approach (PA) and Non-Precision Approach (NPA) procedures. Instrumental Landing System (ILS) and GBAS Landing System (GLS) are classified as precision approaches and are considered the safest; furthermore practically all aircraft equipped for instrument flight have ILS capability, which is the most commonly used PA.

Improvements to safety are achieved by more accurate positioning of the aircraft during the approach (RNP part).

Improvements in Environmental and Fuel efficiency Noise Sustainability are delivered through the improved flexibility of airspace design (through RF leg) aiming at avoiding noise sensitive areas (thus reducing noise) and at shortening the approach path (thus reducing emissions/fuel burnt and distance flown).

Operational Improvement Steps (OIs) & Enablers

- AOM-0605: Enhanced terminal operations with automatic RNP transition to ILS/GLS/LPV. Only the RNP transition to ILS/GLS part of the OI Step is covered by this Solution.
- A/C-07 Flight management and guidance for RNP transition to ILS/GLS/LPV

Applicable Integrated Roadmap Dataset is DS15.

Background and validation process

The SESAR Solution has been validated through a series of activities including six Fast Time Simulations, five Real Time Simulations, and Flight Trial and Demonstration, focusing on a range of objectives that encompasses the performance assessments, the acceptability, usability and feasibility of Curved RNP transition to ILS/GLS precision approach procedures by ATCOs, the (airborne) flyability and acceptability by Flight Crew. A high level summary of each validation is presented hereafter:

- Fast Time Simulation
    1. Validation, of Curved RNP transition to GLS Precision Approach and combination of Curved RNP transition to GLS Precision Approach and Increased Glide Slope concepts addressing capacity, predictability, environmental sustainability and fuel efficiency KPA, for Malpensa, Stockholm and Frankfurt airports at V2 level of maturity using “AirTOp” platform.
    2. Validation of RNP to GLS placed in V2 phase taking into account Palermo Airport Scenario through “RAMS Plus” platform in order to address capacity, environmental sustainability and efficiency KPA.
    3. Validation of RNP to GLS placed in V2 phase taking into account the Palermo Airport Scenario on “FPSAT” platform used for ground validation purposes to address flyability point of view.
    4. RNP to GLS precision approach transition flight simulations at V2 level of maturity addressing procedure design criteria using FPSAT platform on Palermo airport environment.

- Real Time Simulations:

1. RNP to xLS flight simulations reproducing Boeing B737-300,Boeing B777-200, Airbus A320-200, Airbus A340-300, Embraer E190, Bombardier Q400 to study procedure design criteria for RNP to xLS transitions.
2. RNP to ILS simulations at V2 level of maturity on Thales ATR-600 cockpit bench to validate the flyability and technical feasibility to assess the flyability and technical feasibility from an aircraft point of view of the RNP to ILS transition.
3. Validation of RNP to GLS approach procedures on A320 cockpit simulator, at V3 level of maturity, and focusing on a realistic scenario at the location of the Palermo airport addressing human performance and safety TA from a flight crew point of view.
4. Validation, for Malpensa airport at V2 level of maturity using “eDEP” and “GRA simulator” platform, of Curved RNP transition to GLS Precision Approach and combination of Curved RNP transition to GLS Precision Approach and Increased Glide Slope concepts addressing human performances and safety TA from both flight crew and controllers points of view.
5. Validation, for Malpensa airport at V3 level of maturity using “IBP” platforms, of Curved RNP transition to GLS Precision Approach and combination of Curved RNP transition to GLS Precision Approach and Increased Glide Slope concepts addressing human performances and safety TA from controllers point of view.

- Flight Trials and Demonstration:
    1. Flight Trial validation at V3 level of maturity using “Malpensa airport” and “Airbus A320 Test aircraft” of Curved RNP transition to ILS Precision Approach concept addressing human performances and safety from both flight crew and controllers’ point of view;
    2. Demonstration at early v4 level of maturity using Larnaca and Paphos airports of Curved RNP transition to ILS Precisions Approach concept addressing Safety impact reduction, increase flight efficiency and environment impact mitigation (mainly noise).

Results and performance achievements

The main findings from the overall validation exercises can be summarised as follows

Environmental Noise Sustainability

The observed results confirm the expectation of a reduction of noise with an added benefit when RNP to GLS/ILS is combined with Increased Glide Slope.

Fuel and Flight Efficiency, Capacity and Predictability

The results show that there are no significant effect on capacity and depending on the local implementation of the RNP to GLS/ILS procedures it could provide benefit in distance flown as well as in fuel burnt/ CO2 emission and a potential negative effect on arrival delay due to the integration of straight-in approaches and Curved RNP transition to GLS approaches.

Human Performance

- ATC
    - RNP to GLS/ILS was feasible and acceptable in terms of workload, teamwork, situational awareness and usability,.
- Pilot
    - RNP/GLS procedures were easily flown (approach preparation, use of existing SOP, stabilisation gate…), but required a specific monitoring of the transition.

Safety

- ATC
    - The appropriate design of the Curved RNP to xLS approach is fundamental for the integration of the procedure within a real operational environment.
    - Situational awareness was always maintained at an acceptable level (above the mean value). Furthermore safety level was not affected in terms of Traffic Separation and Sequencing, although an increase of traffic monitoring complexity was observed, causing a potential lack of attention about other tasks to be performed. Phraseology was not significantly affected.
- Pilot
    - The stabilization criteria were reached when pilots applied current SOPs.

Procedure Design:

About RNP to GLS/ILS procedure construction:

- Final turn (RF leg) of the RNP transition can end directly at the Final Approach Point;
- The minimum distance from the RF leg end to the runway threshold is 5NM for autoland and stabilization requirements;
- A straight segment (aligned with the FAS) can be included between the RF leg and the FAP. In this case, the FAP can be located as close as 3 NM from runway threshold, while the RF leg respects the aforementioned requirement of 5 NM;
- Designing procedure with RNP value below 0.3 is not recommended. On the other hand, use of GNSS and AP/FD should be required to limit aircraft Total System Error;

- The vertical path of the RNP transition before the FAP shall be designed to allow aircraft systems to ensure that the aircraft is below the GLS glideslope when entering the localizer full scale deflection for a defined range of expected conditions.

Recommendations and Additional activities

The integration of curved RNP to GLS/ILS procedure in the current operational environment is subject to an appropriate procedure design, a potential regulation of usage of such procedures and local evolution of HMI to better support the local procedure.
The challenges of integration are relevant for mixed approach mode and in medium and high traffic density environments: it is recommended to investigate ways to minimise the impact on the integration on current operations when mixing curved RNP to GLS with standard straight in approaches, in particular for medium and high density environments. SESAR Demonstration such as RISE explored how vectoring and step descent clearances could be used in this context.
The proposed charts are globally satisfactory, but the waypoints naming should be defined to ease the crew cross-check and monitoring (name instead of number or sorted waypoints names if numbers used).

Actors impacted by the SESAR Solution

Airspace Users (Flight Crew) and ACC, APP, TWR controllers.

Impact on Aircraft System

There is no impact of RNP to xLS operations on A/C systems.

Impact on Ground Systems

Controller working position should support RNP to xLS operations in terms of HMI.
Air traffic management support tools in terms of sequencing and spacing, when provided, should take into account the RNP to xLS operations.

Regulatory Framework Considerations

No specific regulation exists for RNP to xLS operations. Only separate regulation for RNP operations and for ILS/GLS operations exists. There are some needs to “fill the gap” between these 2 worlds: particularly it should be defined until which point of the procedure RNP requirements (performance and functional) must be demonstrated.

Standardization Framework Considerations

Today, very few specific standards exist for RNP to GLS/ILS operations (PANS-OPS, FAA order 8260.58, FAA PARC recommendations,…).

Today, the main lack is related to RNP to GLS /ILS procedure design standards. Some procedure design criteria were proposed as part of the SESAR validation exercises, so as to ensure the procedure remains flyable (Intermediate segment slope, minimum final segment length,…).

Current PANS-OPS general criteria allow that RF legs ending at the FAF for SBAS CAT I according to PANS-OPS, Part III, Section 2, 2.4.1.4/2.4.1.5. Since RF legs ending at FAF are already authorized for SBAS CAT I operations, a recommendation could be to extend this permission to GLS approaches.

In addition, it may also be recommended to review current PANS-OPS limits for RF legs ending at FAF (track change < 45°and RF radius > 2.55 NM), which seems too restrictive.

Those proposals are to be forwarded to Instrument Flight Procedures Panel (IFPP) who maintains the PANS OPS.

In addition, for precision approaches, the ARINC 424 standard requires that three waypoints be defined for the final approach segment: the FACF (Final Approach Course Fix), the FAF/FAP (Final Approach Fix / Point) and the MAPt (Missed Approach Point fix). Therefore, the coding in a NavDB of an RF leg directly to FAF/FAP is not possible with current ARINC standard.

Considerations of Regulatory Oversight and Certification Activities

Compliance demonstration with interoperability, safety & performance requirements allocated to the airborne domain through dedicated SESAR INTEROP & SPR documents are part of aircraft certification activities. The SESAR standards (INTEROP & SPR documents) have to be recognized by the EASA through dedicated Certification Review Item.

Solution Data pack

The Data pack for this Solution includes the following documents:

- 06.08.08 D05 Enhanced Arrival Procedures Enabled by GBAS - INTEROP – Consolidation (RNP to GLS);
- 06.08.08 D04 Enhanced Arrival Procedures Enabled by GBAS - SPR – Consolidation;

- SESAR 9.09 D25 RNP to XLS functional requirements- Final.

Intellectual Property Rights (foreground)

The foreground is owned by the SJU.