Release 5 SESAR Solution ID #19

Automated support for traffic complexity detection and resolution

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)

Within the SESAR environment, the need to apply tactical measures and re-negotiate the RBT is considered as an exception because of the use of Trajectory Based Operations. New ATM systems should result in a higher incidence of traffic that is conformant with the trajectory data published in the NOP. This situation drives the need for development and implementation of a real-time integrated process (solution 19) for managing the complexity of the traffic with capability to reduce traffic peaks through implementation of fine-tuned measures for workload balancing.

Solution 19 has validated the use of automated tools to continuously monitor sector demand and evaluate traffic complexity (by applying predefined complexity metrics) according to a predetermined qualitative scale. Three approaches to assess complexity have been investigated. They have reached different maturity levels: Algorithmic approach (V3 complete), Cognitive approach (V3 with acceptable issues) and Convergence-Lyapunov approach (V3 on-going).

Continuous monitoring enables to forecast demand and complexity over a specific airspace. These forecasts of complexity and demand permit taking timely action to adjust capacity, or demand profiles through various means (such as STAM) in collaboration with ATC and airspace users.

The resolution of traffic complexity issues in the planning phase (-3 hours to -30 mins) is also part of this solution. The use of what-if capabilities enables the identification of potential solutions that are either based on tailored pre-determined scenarios or on ad-hoc solutions. In both cases, the automated tools allow making evaluations of their impact on the local systems.

Operational Improvement Steps (OIs) & Enablers

The solution addresses OI steps CM-0103-A and CM-0104-A. The following text identifies both required and optional enablers for each of the OI steps.

- **CM-0103-A**[1][2]: Automated Support for Traffic Complexity Assessment
  The following enablers are considered as required for the solution (changes are required in DS15 (used as reference) to align OI step definition to the SESAR Solution scope.
  - **NIMS-37**: Basic Complexity assessment tools
  - **PRO-220a**: ATC Procedures related to Detection and Resolution of Complexity, Density and Traffic Flow Problems
  - **PRO-220b**: FCM procedures to describe how detection and resolution of complexity, density or traffic flow issues are managed.

  The following enablers are considered as optional for the solution (changes are required in DS15 (used as reference) to align OI step definition to the SESAR Solution scope:
  - **A/C-37a**: Downlink of trajectory data according to contract terms
  - **ER APP ATC 100**: 4D Trajectory Management in Step 1 - Synchronization of Air and Ground Trajectories
  - **ER APP ATC 149a**: Air-Ground Datalink Exchange to Support i4D - Extended Projected Profile (EPP)
  - **ER APP ATC 162**: ATC Flight Data Exchange with NM Using the Flight Object
  - **ER APP ATC 82**: Enhance FDP to use SBT/SMT, RBT/RMT
  - **SWIM-APS-03a**[3]: Provision of ATFCM Information Services for Step 1
  - **SWIM-APS-04a**: Consumption of ATFCM Information Services for Step 1
  - **SWIM-INFR-05a**: General SWIM Services Infrastructure Support and Connectivity.
  - **SWIM-NET-01a**: SWIM Network Point of Presence
  - **SWIM-SUPT-01a**: SWIM Supporting Registry Provisions
  - **SWIM-SUPT-03a**: SWIM Supporting Security Provisions
  - **SWIM-SUPT-05a**: SWIM Supporting IP Network Bridging Provisions

- **CM-0104-A**[4]: Automated Controller Support for Trajectory Management
  The following enablers are considered as required for the solution (changes are required in DS15 (used as reference) to align OI step definition to the SESAR Solution scope):
  - **ER ATC 92**[5]: ATC tools to re-organize traffic flows to reduce complexity

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[1] ER APP ATC 93 “Enhance Resource Management and Planning Tools to use Traffic Complexity Assessment” needs to be unlinked to CM-0103-A. It will remain linked only to CM-0102-A (and solution #66).
[2] PRO-220a needs to be updated to cover only procedures related to the detection and analysis of complexity and the preparation for solutions to reduce complexity. Procedures to be applied by the appropriate actor to whom CAR activities (mainly related to resolution phase) will be entrusted have not been fully covered and should be removed from the definition of the enabler.
[3] SWIM-NET-01a, SWIM-SUPT-01a, SWIM-SUPT-03a and SWIM-SUPT-05a are required in DS15. Since the Solution has not been validated with this option, these four SWIM enablers should be identified as “optional” for this SESAR Solution.
[4] APP ATC 92 “ATC tools to re-organize traffic flows to reduce complexity”. Not addressed by the solution. The enabler should be unlinked to CM-0104-A and linked to CM-0104-B as a backlog to be addressed in SESAR2020.
[5] ER ATC 92 needs to be limited to the scope of the solution #19: traffic complexity resolution in the planning phase

- **PRO-220a**: ATC Procedures related to Detection and Resolution of Complexity, Density and Traffic Flow Problems
- **PRO-220b**: FCM procedures to describe how detection and resolution of complexity, density or traffic flow issues are managed.

The following enablers are considered as optional for the SESAR Solution (changes are required in DS15 (used as reference)):

- **A/C-37a**: Downlink of trajectory data according to contract terms
- **ER APP ATC 162**: ATC Flight Data Exchange with NM Using the Flight Object
- **ER APP ATC 82**: Enhance FDP to use SBT/SMT, RBT/RMT

Applicable Integrated Roadmap Dataset is DS15.

Background and validation process

This solution has been validated through two distinct validation streams: The first one was concerned establishing the validity of the traffic complexity estimations and the second one with the use of the traffic complexity management procedures. Given the strong dependence of this solution on human performance (complexity is typically translated into operator workload), the validation techniques have focused strongly on the use of Real-Time simulations. These simulations have been completed with a shadow-mode and a live trial.

The different traffic complexity estimation techniques were validated within real-time simulations. In all cases, the simulation analysed the accuracy of the estimations within different environments (i.e. high and low complexity, high traffic density, etc.). This variety of environments allowed validating and calibrating the different complexity estimation models, whilst maintaining a realistic operational environment.

Shadow mode and live trials completed the validation. These techniques allowed testing the proposed tools in the actual operational environment, with close to final operational procedures and real traffic load.

Results and performance achievements

Although CAR concept contributes to increasing safety and make an efficient use of airspace capacity, it could not be quantified the increase of the declared capacity of the sectors due to the reduction of the protective buffers (capacity buffers) as a consequence of the improvement in the prediction of sector overloads.

Furthermore, validation results support the adequacy of the proposed CAR operational concept in terms of actual and potential gains. Validation results indicate that the Algorithmic Traffic Complexity is mature enough to be implemented.

The validation was not limited to the estimation of complexity; it also has explored validation aspects in the areas of "Sector Configuration Management" and "Traffic Management". In the area of sector configuration, validation has shown the positive impact of "sector configuration management" (including analysing the impact of dynamic sectorisation based on complexity estimations). In the area of trajectory management, validation showed that Trajectory Management Measures had a positive impact on predictability and capacity, although it was not possible to prove an improvement in capacity exploitation.

Recommendations and Additional activities

The following activities are relevant once transitioned to industrialization (V4):

- Develop appropriate training to ensure a safe and efficient application of the solution.
- The Cognitive approach has been assessed to be V3 mature, although further work to calibrate the scales is required before achieving V4.
- The Convergence-Lyapunov approach has shown great promise, but further work is required to attain a V3 level of maturity (especially in the areas of result stability, accuracy and computational load).
- Further work has to be performed to ensure full integration of the a/c derived data into the different forecasts.
- The responsibility to use these tools has been validated partially for both the Supervisor and Planner actors. Results indicate the need to further explore the distribution of roles (i.e. LTM and ACC Supervisor) to the different actors which is however highly depending on local working environment including ATC system capabilities.
- The CAR tasks should be entrusted to a dedicated actor that is focused on the detection and resolution of local complexity issues 20' – 40' in advance considering the traffic situation of a broader area (not limited to a sector) and coordinating the complexity measures with adjacent centres.
- Additional FTS or mathematical modelling techniques are recommended to quantify capacity (en-route throughput) improvements.

Please note that roles related to CAR in Step 1 are LTM and ACC Supervisor defined at concept level. However, the final decision on which specific actor should be assigned to those roles will be made at local working environment, considering that he/she must have a global view of a set of sectors under his/her responsibility

Actors impacted by the SESAR Solution

Airspace Users (Pilots), En-Route and TMA Controllers, Flow Managers, Network Managers.

Impact on Aircraft System

No impact on the aircraft systems is foreseen.

Impact on Ground Systems

Interoperability between the Network Manager and the Local Tools.

Regulatory Framework Considerations

This solution is directly linked to one (identified as S-AF4.2 “Automated Support for Traffic Complexity Assessment” under AF-4 “Network Collaborative Management”) of the six ATM Functionalities identified in the Implementing Regulation (EU) No 716/2014 on the establishment of the Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan.

Standardization Framework Considerations

No Standardisation impact has been identified. Please refer to previous section.

Considerations of Regulatory Oversight and Certification Activities

No regulatory oversight or certification activities are foreseen.

Solution Data pack

OSED:

- P04.07.01 (2016). D68 - STEP1 V3 Final Complexity Management OSED, Edition 00.02.01, 10/10/2016

SPR

- P04.07.01 (2016) D69 - STEP1 V3 Final Complexity Management SPR, Edition 00.02.00, 23/09/2016.

INTEROP

- P04.07.01 (2016) D70 STEP1 V3 Final Complexity Management INTEROP. Edition 00.02.00, 23/09/2016

TS

- P10.08.01 (2016). D18 - Step 1 final Technical Specification, Edition 00.02.00, 29/04/2016.

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