D3.4.100 - PJ.10-W2-93B TLR4 Contextual Note

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PJ10-W2 PROSA

PJ10-W2 PROSA

Abstract

The objective of the SESAR Solution PJ.10-W2-Solution 93 is to explore the different possible cases of delegation of provision of ATM Services amongst ATSUs based on traffic / organisation needs (either static on fix-time transfer schedule (Day/Night) or dynamic, e.g. when the traffic density is below/over certain level) or on contingency needs.

In the scope of PJ.10-W2-Solution 93, Solution 93B is planned to reach TRL4 and be officially proposed for supporting PJ.10-W2-Solution 93 to reach V3. However, this Contextual Note shows the technical elements developed for the Technological Solutions 93B. This Technological Solution is corresponding to "D" Virtual Centre architecture as proposed in the taxonomy issued by the EUROCAE WG122.

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1 Purpose

This Contextual Note provides to any interested reader (external and internal to the SESAR programme) an introduction to the Technological SESAR Solution 93B, in terms of scope, main Technical definition to the Virtual Centre improvements defined as "D" Architecture.

This Contextual Note shows the results for technological Solution 93B, PJ.10-W2, and for hosting PJ.32-03 contribution to Virtual Centre service improvements and the "D" architecture.

This Contextual Note defines the architecture of each PJ.10-W2-93 technological solution, as well as the common interface requirements for the ATM Data Service Provider (ADSP) and the Virtual Centre ATSUs (VC ATSUs) necessary to support the various possible cases of delegation and contingency of ATM services between ATSUs.

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2 Improvements in Air Traffic Management (ATM)

2.1 Challenges and Scope

The delegation of ATM services provision concept applies when one ATSU delegates a portion of its airspace, or the entire airspace, to another ATSU based on a particular condition. The Solution 93 investigates Use Cases for the Delegation of ATM and Contingency in conjunction with the Virtual Centre Technology where the ATM Data Service Provider (ADSP) is geographically separated from the Virtual Centre ATSU providing ATS to a region of airspace.

These technological solutions have been created in the project for structuring the development of different technical architecture options in support to the main ATM solution, thus allowing different levels of maturity to be reached for the proposed technical architectures.

In this model airspace delegation is managed thanks to the ability of the ATSU to manage additional sectors not initially belonging to its AOR.
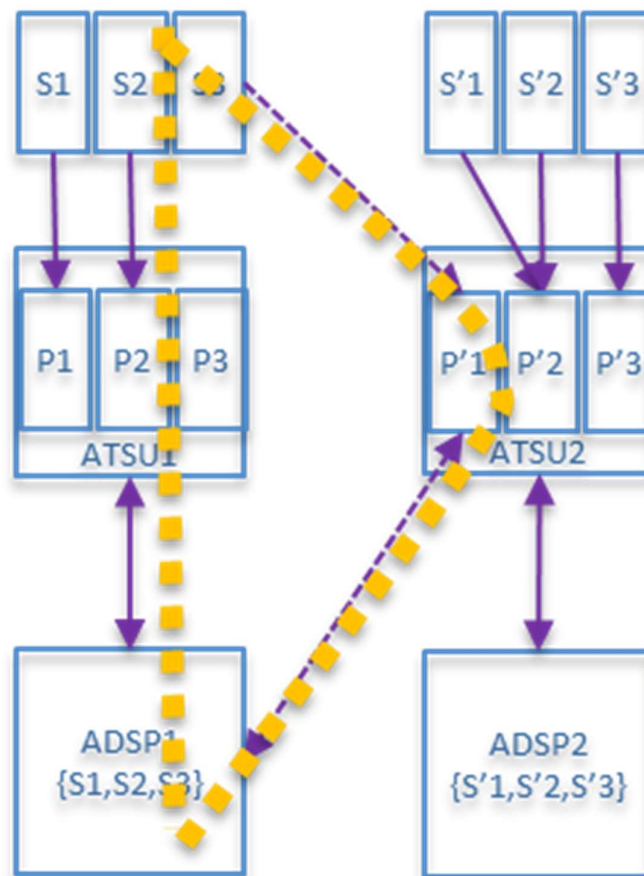
Figure 1: D Architecture in a Virtual Centre Environment

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2.1.1 Introduction

The provision of Virtual Centre standardized services allows a CWP to subscribe to services of different ADSPs. In particular, an ATSU supported by a specific ADSP can delegate ATM services provision to another ATSU, served by another ADSP, by just allowing CWPs of this ATSU to subscribe to the other ADSP services, thus keeping the ATSU AoRs unchanged. This delegation configuration set-up is referenced as the "D" architecture. Such an architecture is also well fitted for supporting ATSU contingency scenarios.

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3 Operational Improvement Steps (OIs) & Enablers

Solution PJ.10-W2-93B Delegation of ATM services provision with a "D" architecture

The delegation of ATM services provision, as described by the OI "*SDM-0217_Delegation of ATM Services provision between ATSUs*", may be achieved with different system architectures. This solution focuses on the "D" architecture relying on a delegation between 2 ATSUs, each with its own ADSP, and using Virtual Centre (service) interoperability for remotely connecting CWPs to one or the other ADSP, without affecting the respective AoRs.

POI-0076 D-Architecture supporting use of Virtual Centre concept for delegation of ATM services provision amongst ATSUs

The provision of Virtual Centre standardised services allows a CWP to subscribe to services of different ADSPs. In particular, an ATSU supported by a specific ADSP can delegate ATM services provision to another ATSU, served by another ADSP, by just allowing CWPs of this ATSU to subscribe to the other ADSP services, thus keeping the ATSU AoRs unchanged. This delegation configuration set-up is referenced as the 'D' architecture.

'D' architecture is also well fitted for supporting ATSU contingency scenarios.

This POI is valid for En-Route and TMA phases of flight but has only been validated for En-Route.

The table below provides a summary of the current Enabler allocations per Technological Solution Architecture (Y, D and U) and the validation coverage at the end of the projects achieved at TRL4 and TRL6

Enabler	Service	Sol93A POI-0075 "Y"	Sol93B POI-0076 "D"	Sol93C POI-0077 "U"	Initial Maturity	Target Maturity
SVC-008	Provision and Consumption of Flight Data Distribution Service in the context of Virtual Centres.	Optional	Optional	n/a	TRL6	TRL6
SVC-009	Provision and Consumption of Flight Data Management Service in the context of Virtual Centres	Optional	Optional	n/a	TRL6	TRL6
SVC-010	Provision and Consumption of Coordination And Transfer Management Service in the context of Virtual Centres	Optional	Optional	n/a	TRL6	TRL6
SVC-013	Provision and Consumption of Airspace Status Distribution Service	Optional	Optional	n/a	TRL6	TRL6
SVC-014	Provision and Consumption of Arrival Sequence Distribution Service	Optional	Optional	n/a	TRL4	TRL4
SVC-015	Provision and Consumption of Arrival Sequence Management Service	Optional	Optional	n/a	TRL4	TRL4

SVC-016	Provision and Consumption of Correlation Distribution Service	Optional	Optional	n/a	TRL6	TRL6
SVC-017	Provision and Consumption of Correlation Management Service	Optional	Optional	n/a	TRL6	TRL6
SVC-018	Provision and Consumption of Medium Term Conflict Detection Distribution Service	Optional	Optional	n/a	TRL4	TRL4
SVC-019	Provision and Consumption of Medium Term Conflict Management Service	Optional	Optional	n/a	TRL4	TRL4
SVC-020	Provision and Consumption of Monitoring Aids Distribution Service	Optional	Optional	n/a	TRL4	**TRL6**
SVC-021	Provision and Consumption of Operational Configuration Distribution Service	Optional	Optional	n/a	TRL4	**TRL6**
SVC-049	Operational Configuration Distribution of Working Position Preview Mode, and Neighbouring ATSU Sector configuration for ATM Service Delegation	Optional	Optional	n/a	new	**TRL6**
SVC-022	Provision and Consumption of Operational Configuration Management Service	Optional	Optional	n/a	TRL4	**TRL6**
SVC-050	Operational Configuration Management of Working Position Preview Mode, and Neighbouring ATSU Sectors for ATM Service Delegation	Optional	Optional	n/a	new	**TRL6**
SVC-023	Provision and Consumption of Safety Net (SNET) Alert Distribution Service	Optional	Optional	n/a	TRL4	TRL4
SVC-024	Provision and Consumption of SSR Code Distribution Service	Optional	Optional	n/a	TRL4	TRL4
SVC-025	Provision and Consumption of SSR Code Management Service	Optional	Optional	n/a	TRL4	TRL4
SVC-026	Provision and Consumption of Support Functions Distribution Service	Optional	Optional	n/a	TRL4	TRL4
SVC-027	Provision and Consumption of Support Functions Management Service	Optional	Optional	n/a	TRL4	TRL4
SVC-028	Provision and Consumption of Surveillance Data Distribution Service	Optional	Optional	n/a	TRL4	TRL4
SVC-029	Provision and Consumption of Technical Supervision Distribution Service	Optional	Optional	n/a	TRL4	**TRL6**
SVC-031	Provision and Consumption of Time-based Separation Distribution Service	Optional	Optional	n/a	TRL4	TRL4
SVC-032	Provision and Consumption of Time-based Separation Management Service	Optional	Optional	n/a	TRL4	TRL4
SVC-033	Provision and Consumption of Voice Comm Information Distribution Service	Optional	Optional	n/a	TRL6	TRL6
SVC-034	Provision and Consumption of Voice Comm Management Service	Optional	Optional	n/a	TRL6	TRL6
ER APP ATC 184	ATM Data Service Provider for ATC services in a Virtual Centre context	Required	Required	n/a	TRL6	TRL6

ER APP ATC 185	ATM Data Service Provider for Voice services in a Virtual Centre context	Required	Required	n/a	TRL6	TRL6
ER APP ATC 186	Virtual Centre ATSU	Required	Required	n/a	TRL6	TRL6
ER APP ATC 193	Management in the VC ATSU of a CWP preview mode during delegation of ATS Provision between ATUs	Required	Required	Optional	new	**TRL6**
ER APP ATC 194	Management in the ADSP of a CWP preview mode during delegation of ATS Provision between ATUs	Required	Required	Optional	new	**TRL6**
ER APP ATC 195	Management in the VC ATSU of Delegation of ATS Provision between ATSUs with Static AoRs for Y-Architecture	Required	n/a	n/a	new	**TRL6**
ER APP ATC 196	Management in the VC ATSU of Delegation of ATS provision between ATSUs with Dynamic AoRs for U-Architecture	n/a	n/a	Required	new	**TRL4**
ER APP ATC 197	Management in the ADSP of Delegation of ATS provision between ATSUs with Dynamic AoRs for U-Architecture	n/a	n/a	Required	new	**TRL4**
ER APP ATC 215	Management in the VC ATSU of Delegation of ATS Provision between ATUs with Static AoRs in a D-Architecture	n/a	Required	n/a	new	**TRL4**
ER APP ATC 216	Management in the ADSP of Delegation of ATS provision between ATUs with Static AoRs in a Y-Architecture	Required	n/a	n/a	new	**TRL6**
ER APP ATC 217	Management in the ADSP of Delegation of ATS provision between ATUs with Static AoRs in a D-Architecture	n/a	Required	n/a	new	**TRL4**
ER APP ATC 218	Management in the VC ATSU of Delegation of ATS provision between ATUs with Dynamic AoRs in a Y-Architecture	Optional	n/a	n/a	new	**TRL6**
ER APP ATC 209	Management in the ADSP of Delegation of ATS provision between ATUs with Dynamic AoRs in a Y-Architecture	Optional	n/a	n/a	new	**TRL6**
STD-097	EUROCAE ER for Taxonomy of Services between ATSU & ADSP(s), and between ADSP &ADSP	Optional	Optional	n/a	TRL4	TRL4

Table 1: Recap of SESAR Technological Solutions PJ.10-W2-93 related POIs, Enablers and maturities

The Table above shows the optional and required services applied for the "D" Architecture. It is deployed with the use of standard VC services in the first place, but it may be deployed with the use of proprietary interfaces common to the ADSPs, thus making the use of the standard VC services set as "optional". The use of proprietary interfaces within a 'D' Architecture is then referred as 'Legacy 'D' architecture' whenever there is the need to distinguish the two cases. The "Required" services are needed for the "D" Architectures in order to process the Delegation of ATS for the ADSP- ATSU services interface.

Below is reported the table on PJ10.W2-93B /POI-0075 "D" Architecture with the Functional Blocks/Roles &Enablers

SESAR Solution ID and Title	Functional Blocks/Role impacted by the SESAR Solution (from EATMA)	Enabler ID (from EATMA)	Enabler Title (from EATMA)	Initial Maturity	Target Maturity	Enabler Compulsory
PJ.10-W2-93B	Flight Planning - Lifecycle	SVC-008	Provision and Consumption of FlightDataDistribution Service in the context of Virtual Centres.	TRL6	TRL6	Optional

	Management - Data Distribution					
PJ.10-W2-93B	Flight Planning - Lifecycle Management - Data Distribution	SVC-009	Provision and Consumption of FlightDataManagement Service in the context of Virtual Centres	TRL6	TRL6	Optional
PJ.10-W2-93B	Coordination and Transfer	SVC-010	Provision and Consumption of CoordinationAndTransferManagement Service in the context of Virtual Centres	TRL6	TRL6	Optional
PJ.10-W2-93B	Support Functions	SVC-013	Provision and Consumption of Airspace Status Distribution Service	TRL6	TRL6	Optional
PJ.10-W2-93B	Arrival Management	SVC-014	Provision and Consumption of Arrival Sequence Distribution Service	TRL4	TRL4	Optional
PJ.10-W2-93B	Arrival Management	SVC-015	Provision and Consumption of Arrival Sequence Management Service	TRL4	TRL4	Optional
PJ.10-W2-93B	Correlation Management	SVC-016	Provision and Consumption of Correlation Distribution Service	TRL6	TRL6	Optional
PJ.10-W2-93B	Correlation Management	SVC-017	Provision and Consumption of Correlation Management Service	TRL6	TRL6	Optional
PJ.10-W2-93B	Conflict Management	SVC-018	Provision and Consumption of Medium Term Conflict Detection Distribution Service	TRL4	TRL4	Optional
PJ.10-W2-93B	Conflict Management	SVC-019	Provision and Consumption of Medium Term Conflict Management Service	TRL4	TRL4	Optional
PJ.10-W2-93B	Monitoring Aids	SVC-020	Provision and Consumption of Monitoring Aids Distribution Service	TRL4	TRL6	Optional
PJ.10-W2-93B	Operational Supervision	SVC-021	Provision and Consumption of Operational Configuration Distribution Service	TRL4	TRL6	Optional
PJ.10-W2-93B	Operational Supervision	SVC-049	Operational Configuration Distribution of Working Position Preview Mode, and Neighbouring ATSU Sector configuration for ATM Service Delegation	new	TRL6	Optional
PJ.10-W2-93B	Operational Supervision	SVC-022	Provision and Consumption of Operational Configuration Management Service	TRL4	TRL6	Optional
PJ.10-W2-93B	Operational Supervision	SVC-050	Operational Configuration Management of Working Position Preview Mode, and Neighbouring ATSU Sectors for ATM Service Delegation	new	TRL6	Optional
PJ.10-W2-93B	Safety Nets	SVC-023	Provision and Consumption of Safety Net (SNET) Alert Distribution Service	TRL4	TRL4	Optional
PJ.10-W2-93B	Code Management	SVC-024	Provision and Consumption of SSR Code Distribution Service	TRL4	TRL4	Optional
PJ.10-W2-93B	Code Management	SVC-025	Provision and Consumption of SSR Code Management Service	TRL4	TRL4	Optional
PJ.10-W2-93B	Support Functions	SVC-026	Provision and Consumption of Support Functions Distribution Service	TRL4	TRL4	Optional

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PJ.10-W2-93B	Support Functions	SVC-027	Provision and Consumption of Support Functions Management Service	TRL4	TRL4	Optional
PJ.10-W2-93B	Surveillance	SVC-028	Provision and Consumption of Surveillance Data Distribution Service	TRL4	TRL4	Optional
PJ.10-W2-93B	Technical Supervision	SVC-029	Provision and Consumption of Technical Supervision Distribution Service	TRL4	TRL6	Optional
PJ.10-W2-93B	Arrival Management, Monitoring Aids	SVC-031	Provision and Consumption of Time-based Separation Distribution Service	TRL4	TRL4	Optional
PJ.10-W2-93B	Arrival Management, Monitoring Aids	SVC-032	Provision and Consumption of Time-based Separation Management Service	TRL4	TRL4	Optional
PJ.10-W2-93B	A/G Voice Communication, G/G Voice Communication	SVC-033	Provision and Consumption of Voice Comm Information Distribution Service	TRL6	TRL6	Optional
PJ.10-W2-93B	A/G Voice Communication, G/G Voice Communication	SVC-034	Provision and Consumption of Voice Comm Management Service	TRL6	TRL6	Optional
PJ.10-W2-93B	ADSP ATC	ER APP ATC 184	ATM Data Service Provider for ATC services in a Virtual Centre context	TRL6	TRL6	Required
PJ.10-W2-93B	ADSP Voice	ER APP ATC 185	ATM Data Service Provider for Voice services in a Virtual Centre context	TRL6	TRL6	Required
PJ.10-W2-93B	VC ATSU ATC	ER APP ATC 186	Virtual Centre ATSU	TRL6	TRL6	Required
PJ.10-W2-93B	OPSUP HMI, CHMI	ER APP ATC 193	Management in the VC ATSU of a CWP preview mode during delegation of ATS Provision between ATUs	new	TRL6	Optional
PJ.10-W2-93B	OPSUP, TP&M	ER APP ATC 194	Management in the ADSP of a CWP preview mode during delegation of ATS Provision between ATUs	new	TRL6	Optional
PJ.10-W2-93B	CHMI, OPSUPHMI, Technical Supervision HMI	ER APP ATC 215	Management in the VC ATSU of Delegation of ATS Provision between ATUs with Static AoRs in a D-Architecture	new	TRL4	Required
PJ.10-W2-93B	ADSP Voice, ADSP ATC	ER APP ATC 217	Management in the ADSP of Delegation of ATS provision between ATUs with Static AoRs in a D-Architecture	new	TRL4	Required
PJ.10-W2-93A	Any Service	STD-097	EUROCAE ER for Taxonomy of Services between ATSU & ADSP(s), and between ADSP &ADSP	TRL4	TRL4	Optional

Table 2: Solution Related Functional Blocks/Roles &Enablers

4 Background and validation process

The PJ10.W2-93B is Solution targets a TRL4 maturity level.

A proper analysis was performed to be compliant with OSED Use Cases to process the Operational Requirements.

Delegation of services in a D architecture put constraints on HMI that shall be solved at standard level (CWP devoted for delegation that are of the same type for the delegating/receiving ATSUs or CWP using interoperable services).

The VC solution & design PJ10.W2-93B was assessed through different objectives:

- Its capability to support the delegation process of ATM services between two ATSUs connected to a same ADSP

- The number and maturity of existing or newly developed services between ADSP and ATSUs

- The interoperability aspects

- The performance of the global VC platform with regard to the operational acceptance of the overall delegation process

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5 Results and performance achievements

Several Technical objectives were validated for the Architecture "D" that took place for EXE 3 and EXE 6 .

The first objective is related to the status and the maturity of the VC Validation Platform based on the D architecture and on the Technical Supervision service put in place to monitor ATC ADSP and Voice ADSP.

In terms of the technological solution PJ10.93B for the "D" Architecture" the validation platforms - including distributed VC platforms - were well prepared and demonstrated a certain level of stability during the final runs, despite their complexity, leading to the following results:

- The VCS provided by FREQUENTIS and INDRA were highly mature and played a significant role in validating the delegation of ATM services on a VC platform with multiple ADSPs and ATSUs.

- Delegation of services in a "D" architecture can place constraints on the HMI, which need to be addressed at the standard level. One possible solution is to use a CWP that is dedicated for delegations of the same type for the delegating and receiving ATSUs, or to use interoperable services with an appropriate CWP.

Regarding the technical objective OBJ-PJ.10-W2-93b-V3-VALP-003 is covered by EXE#03, EXE#06. The obtained results demonstrated the ability of the Virtual Centre platform services to provide support in all steps of the delegation procedure.

Regarding the technical objective OBJ-PJ.10-W2-93b-V3-VALP-004, it is covered by EXE#03, EXE#06 and demonstrated a proper Interoperability of services with a special focus on the ability of ATC ADSP to provide its support to different users (ANSPs) and of Voice ADSP to enable A/G and G/G communication.

The technical objective OBJ-PJ.10-W2-93b-V3-VALP-005 is covered by EXE#03, EXE#06. This OBJ evaluated with a good quality of services the performance of the VC Validation Platform services from a technical point of view.

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6 Recommendations and Additional activities

Several recommendations will be used for the Next Phase:

- **VC architectures «D» Maturity:**

  - The use cases based on the Y or D architectures have provided a much better operational acceptance than the uses cases with the U architecture;

  - Although some new services were developed and validated at TRL6, some other defined by PJ16.03 were improved from TRL4 to TRL6 (mainly under the Y architecture);

  - Despite the improved maturity of some services from TRL4 to TRL6, there are a lot of others which are kept at TRL4. Future efforts should be concentrated on developing new services ADSP-ATSU and ADSP-ADSP, while increasing the maturity of the current VC services

However, further work shall be completed in next SESAR phases to ensure an appropriate delivery of ATS Services in the delegating and receiving ATSUs. This includes the validation of services presented so far as optional by the solution but appear as mandatory for the cases that still need to be validated.

In D architectures, harmonising ADSP behaviours along with standardised services will prove to be beneficial. This would involve making the functionality and adjustment of the HMI as similar as possible across both the delegating and the receiving ATSUs. Such an approach would ease the handover of traffic and increase safety, as all ATCOs involved would know what their counterparts have on their screens and how it is represented. This aspect should be taken into consideration in future validations.

7 Actors impacted by the SESAR Solution

The following stakeholders are impacted by PJ10.W2- Solution 93B in the Validation process:

- Air Navigation Service Providers (ANSPs);

- Air Data Service Provider (ADSP);

- Network Manager;

- Ground systems manufacturers;

- Airspace Users;

- Civil-Military coordination;

- Standardization Group EUROCAE WG-122;

- Regulatory for certification aspects.

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8 Impact on Aircraft System

None impact on Aircraft system.

9 Impact on Ground Systems

Some conclusions on the technical feasibility are reported in a general manner regarding several implementation to improve the Delegation process.

In addition, the impact only for the ADSPs are reported in the different Contextual note 93A, 93B and 93C according to different Architectures per validation exercises.

The impacted ground functionalities are reported below:

- **Preview mode**

- The preview mode is the main "technical enabler" of the overall delegation of ATS between ATSUs. It was successfully implemented in most exercises and the process resulted acceptable both at the CWPs and ADSPs levels.

- **Supervision & Monitoring**

- Monitoring tools were developed for each involved ATC ADSPs or involved ATSUs. If the supervision and monitoring of the systems is mainly performed by the various ATSEPs, this was done in close collaboration with the local SUPs and the decisions taken during the delegation process (e.g., switch of CWP modes) are performed together.

- **Technical:**

  - Use of Complex Virtual Centre Validation Platforms involving several ATC or voice ADSPs and several ATSUs
  - The ATCOs (in most of the EXE) were familiar with the HMI of the CWPs, as it is close to what they use in the OPS rooms
  - The tuning and testing conducted prior to the RTS (e.g., EXE3, EXE4 and EXE5) and the multiple Dry runs performed with ATCOs have considerably contributed to the stability of the technical platform(s)

10 Regulatory Framework Considerations

The National Supervisory Authorities (NSAs) of both the delegating and receiving ATSUs must work closely for following development (and the list is not exhaustive):

- EASA involvement for licencing and Certification aspects;

- Based on the Virtual Centre concept on "D" Architecture, it is recommended the Review of ATCO and ATSEP licensing schemes by providing them with new Certification means

- Review of eventual SLAs- Service Level Agreements put in place between the involved ATSUs

- Supervision of the implemented changes at each ATSU for the need for example of Cross-border delegation and this shall include those related to IOP- Interoperability

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11 Standardization Framework Considerations

The solution PJ10.93 is a follow up of the SESAR Wave 1 PJ16.03 which has defined a first list of services between ADSPs and ATSUs. The maturity of the services varies from TRL4 to TRL6 and our solution has increased the maturity of some services from TRL4 to TRL6 while new services (mainly those supporting the delegation process) have been created and validated at TRL6.

Furthermore, none of the listed services was standardized yet. As the European standardization body in ATM domain is EUROCAE, our recommendation to EUROCAE is to rapidly start the work of standardization of the VC services, especially those subject to validation under Solution 93. In a first step, one can focus on the most mature services, e.g., at TRL6. This recommendation is already a reality as we are aware that EUROCAE has already started the standardisation task in parallel with the SESAR research & development projects.

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12 Solution Data pack

D3.4 - PJ.10-W2-93B solution pack TRL4 (31st March 2023) including:

- D3.2.030 - PJ.10-W2-93-V3 Final SPR-INTEROP/OSED
- D3.2.180 - PJ.10-W2-93-V3 Final CBA
- D3.2.060 - PJ.10-W2-93-V3 Final TS/IRS
- D3.2.150 - PJ.10-W2-93-V3 Final VALR

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