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Contextual Note

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PJ10-W2 PROSA

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Abstract

The objective of the SESAR Solution PJ.10-W2-93 ATM Solution 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.

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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 SESAR Solution in terms of scope, main operational and performance benefits. The SESAR Solution object of the study, for which the initial maturity has been assessed as first V2, is related to the Delegation of Air Traffic Services (ATS) and Contingency.

PJ.10-Wave2 Solution 93 investigates Operational Uses Case for delegating the provision of Air Traffic Management services. Procedures are defined for normal and abnormal conditions. The operational concept is as technology-agnostic as possible and can be implemented by legacy systems as well as by systems supporting the Virtual Centre Model. The concept is applicable to En-Route and Terminal airspaces.

This Solution is dealing with the delegation of ATM services provision according to this definition of ATM services which comprises:

- Air Traffic Services
- Air Space Management
- Air Traffic Flow Management

The purpose of this contextual note is to introduce the initial Data Pack at V3 level.

2 Improvements in Air Traffic Management (ATM)

2.1 Challenges and Scope

To fulfil the future needs of the Air Traffic Management, a higher flexibility will be required compared to today, where Air Traffic Management is bound to national boundaries. In the future a more flexible use of resources is required and a high-level vision of this is depicted by the Airspace Architecture Study¹ of the European Commission.

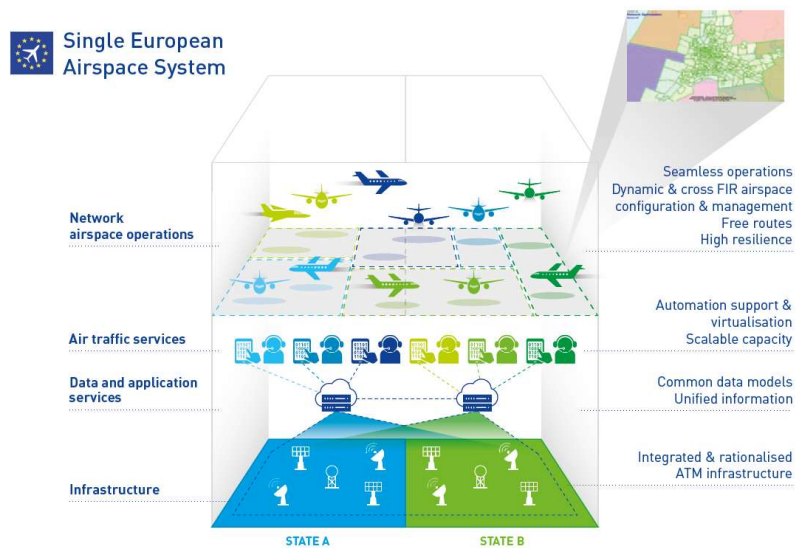


Figure 1: Airspace Architecture Studies

2.1.1 Introduction

PJ.10-W2-Solution 93 explored operational concepts of the delegation of ATM services provision amongst ATSUs. Delegations can be done either in normal conditions to improve the efficiency of ATM or it can be done in abnormal, i.e., contingency, conditions to improve resilience and minimise the impact of a failure.

¹ Airspace Architecture Study <https://www.sesarju.eu/node/3253>

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 investigated 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.

Based on the new operational opportunities offered by the Virtual Centre concept, a preliminary set of Delegation and Contingency Use Cases has been selected, with the aim to further investigate and develop dynamic airspace configuration and advanced ATFCM² capabilities. These will allow a completely new architecture to provide Air Traffic Services. These Use Cases considered the operational procedures and resource management to support static and dynamic delegation of ATS and have been identified before defining the Operational Requirements for different ATSU and ADSP configurations. The entire process of Delegation is described in the PJ.10-W2-93-V3 Final SPR-INTEROP/OSED.

The following use cases have been studied by the solution:

1. Delegation of ATM services provision at night;
2. Delegation of ATM services provision at fixed time;
3. Cross-border delegation of ATM services with dynamic AoR for an elementary sector;
4. Cross-border optimisation using delegation with static AoR;
5. Delegation of ATM services provision following abnormal conditions (ATSU contingency).

A close cooperation between the PJ.10-W2-WP3 and PJ.32-W3 complemented the following use cases:

1. Delegation of the ATFCM service and load-balancing between ATSUs;
2. Coordination process between Civil and Military ATSUs in case of Delegation³.

The OSED describes the necessary requirements for implementing the concept of delegation of ATM services among ATSUs. It includes the operational requirements as well as the performance, information exchange, safety, security, and human performance ones. The concept and procedures described in the document are independent from the different supporting architectures that are described in the TS/IRS of this Solution and reported in a separated Contextual Note to describe the Technical Architectures.

² ATFCM aspects of delegation of ATM services among ATSU have been researched in detail by PJ.32-W3

³ This use case describes the coordination process between civil and military ATSUs when there is an active TSA/TRA or there are multiple active TSAs/TRAs under the delegated airspace.

3 Operational Improvement Steps (OIs) & Enablers

The solution addresses the OI step SDM-0217 'Delegation of ATM Services provision between ATSUs'.

The following Table depicts the OI step SDM-0217 which is linked to the operational Solution PJ.10-W2-WP3. This operational solution is supported by three technical Solutions PJ.10-W2-93 A-B-C which have their own POIs and linked Enablers. These Technical Solutions are addressed in separated Contextual Notes.

SESAR Solution ID	SESAR Solution Title	OI Steps ID	OI Steps Title	Enabler ID	Enabler Title	OI Step/Enabler Coverage
PJ.10-W2-93	Delegation of ATM services provision between ATSUs	SDM-0217	Delegation of ATM Services between ATSUs			Fully
PJ.10-W2-93	Delegation of ATM services provision between ATSUs			REG-0546	Regulatory provisions for delegation of ATM services provision among ATSUs	n/a ⁴
PJ.10-W2-93	Delegation of ATM services provision between ATSUs			CR 07428 (PRO-267)	Procedure for Delegation of ATM Services provision between ATSUs	Fully
PJ.10-W2-93	Delegation of ATM services provision between ATSUs			CR 07429 (HUM-067)	Updated role/responsibilities for ATCOs in context of the delegation of ATS between ATSUs	Fully

⁴ The Solution didn't work on the area of regulation. This Enabler is created to indicate that for a deployment of the concept regulatory efforts are necessary. Thus, it is declared as n/a here. This OI step requires HUM and PROC enablers that must and will be defined in details and created according to validation results.

PJ.10-W2-93	Delegation of ATM services provision between ATSUs			CR 07430 (HUM-068)	Updated role/responsibilities for ACC/Approach/TMA Supervisor in context of the delegation of ATS between ATSUs	Partial
PJ.10-W2-93	Delegation of ATM services provision between ATSUs			CR 07431 (HUM-069)	Updated role/responsibilities for ATSEPs in context of the delegation of ATS between ATSUs	Partial
PJ.10-W2-93	Delegation of ATM services provision between ATSUs			CR 07432 (HUM-070)	Updated role/responsibilities for Technical Supervisor in context of the delegation of ATS between ATSUs	Partial

Table 1: SESAR Solution PJ.10-W2-WP3 Scope and related OI step

4 Background and validation process

The PJ10.W2-93 ATM Solution targets a V3 maturity level.

Starting from the results achieved in SESAR 2020 W2, PJ.10-W2-93 reached V2 phase by executing one validation exercise. It demonstrated the feasibility of the delegation of ATM services provision between Air Traffic Service Units (ATSUs) and was based on a Virtual Centre (VC) architecture, consisting of an ATM Data Service Provider (ADSP) which was geographically separated from the ATSUs.

After the V2 Maturity Gate, in coordination with PJ32 WP3, EUROCAE and SJU, it was agreed to split the solution in a different manner in order to cover the operational requirements for Delegation of ATS irrespective to the Architectures proposed in a Virtual Centre environment.

A gap analysis was performed by the Solution 93 partners to address these requirements in line with the target of the Solution. This analysis supported the preparation of the validation exercises and the definition of related validation objectives.

Most of V3 Exercises are based on Virtual Centre architectures.

The following table shows the list of the Validation exercises under Solution PJ.10-W2- 93 executed at V3 level:

EXE ID	High Level Objectives	Geographical Environment	Technical Environment
EXE-002 (ENAIRE)	To validate the operational feasibility and acceptability and evaluate impact of ATS delegation in En-Route environment, through three use cases: ATS delegation by night, at fixed time and on-demand	The airspace of the exercise covers the following units: <ul style="list-style-type: none"> - LECM (Madrid ACC) - LECS (Sevilla ACC) - LECB (Barcelona ACC) - LECP (Palma TACC) 	Single ADSP with local CWPs
EXE-003 (Skyguide)	To validate the operational feasibility and acceptability and evaluate impact of ATS delegation in En-Route environment, through two main use cases: ATS delegation by night and in Contingency	The airspace of the exercise covers the Upper Sectors of southern part of Germany (Karlsruhe UAC) and Switzerland.	Virtual Centre distributed environment with two involved ATC ADSPs: CCS from DSNA and iTEC from INDRA; CWPs from different vendors Skyguide, INDRA and DFS SH; and two Voice ADSPs from FREQUENTIS and INDRA, all platforms connected

			through a central AMQP broker provided by FREQUENTIS
EXE-004 (ENAV)	To validate the operational feasibility and acceptability and evaluate impact of ATS delegation in En-Route environment, through three main use cases: ATS delegation involving Civil-Military cooperation, on-demand and in Contingency	The airspace of the exercise covers the Upper Sectors LIRR (Rome ACC) and LIBB (Brindisi ACC).	Virtual Centre distributed environment with CCS ATC ADSP from ENAV and DSNA; CWP from LEONARDO; Voice ADSPs from SITTI. All platforms connected through a central AMQP broker provided by ENAV and DSNA.
EXE-005 (COOPANS)	To validate the operational feasibility and acceptability and evaluate impact of ATS delegation in En-Route environment, through two main use cases: ATS delegation on-demand and in Contingency	The airspace of the exercise covers the Upper Sectors belonging to Copenhagen and to Malmoe ACCs	Distributed platform with a THALES TopSky ADSP, situated at Rungis (FR) while the CWPs are based in Copenhagen (DAN) & Malmoe (SWE)
EXE-006 (PANSA)	To validate the operational feasibility and acceptability and evaluate impact of ATS delegation in En-Route environment, through two main use cases: ATS delegation by night and on-demand	The airspace of the exercise covers the Upper Sectors belonging to Warsaw and to Vilnius ACCs	Distributed platform with two iTEC ADSPs providing services to two ATSU: Warsaw (PL) and Vilnius (LIT)

Table 2: PJ.10-W2-93 Validation environment for V3 exercises

5 Results and performance achievements

The V3 validation exercises proved the maturity of the delegation of ATM services concept with respect to the different experienced scenarios and traffic conditions. During the validation exercises data was gathered by means of questionnaires and debriefings providing a good level of results.

For each of the addressed KPAs the following results have been obtained:

- Safety** was addressed and confirmed to be maintained during validation of both nominal and abnormal situations (except for the On Demand use case). It was not negatively impacted according to the validation results. Due to the amount of traffic experienced, controllers were able to easily perform their task and safely manage the traffic. The general consensus was that the working method used during the delegation process would not adversely impact on safety in nominal conditions. Overall, although the global level of safety was felt as quite good and no real losses of separations were detected, the controllers expressed some safety concerns. However, these concerns were more linked to specific situations in which controllers experienced difficulties and technical issues related to the validation rather than attributable to the delegation process itself. In fact, ATCOs, SUP and Technical Staff (ATSEP) highlighted that appropriate support tools are required for executing a safe delegation ATS procedure. Supporting tools to enable the Delegation are considered of great importance, e.g., for conflict detection and resolution, flight conformance monitoring, geographical information, technical supervision, etc.
- Human Performance** received mostly (except for the On Demand use case) positive feedback from controllers in all exercises. The delegation process did not negatively affect controllers during operations in both nominal and contingency conditions. Overall, both situational awareness and workload level in tested scenarios was considered tolerable or acceptable. Therefore, the delegation of ATM services might create an extra workload for the ATCO especially for High traffic situation and requires special attention to manage it safely. This can only be fulfilled when ATCOs are not too busy with the management of their sectors. Thus, the traffic density and complexity need to be at a manageable level allowing to face with possible extra workload caused from delegation on board. Finally, no specific risk of increase of human error with relation to the delegation process was observed or reported with during the exercises. Operating methods and procedures were found acceptable, in both nominal and abnormal cases.
- A performance assessment was done for a set of KPIs and summarised in below Table. The **ATCO Productivity KPI (CEF2)** was particularly increased (>25%) by the delegation process while the **Airspace Capacity KPIs (CAP1 for TMA and CAP2 for en-route)** are also increased with more than 10%. The **Fuel Efficiency KPI (FEEF1)** observes an improvement about (>10%). And based on the assessment of the sole EXE4, the **Technology Costs (CEF3)** have been assessed and compared between a "Do Nothing" scenario (the today legacy infrastructure) and the VC infrastructure at ENAV, the conclusion was a cost reduction of about 5% is foreseen at the end of transition period (by 2043).
- Resilience** aspects demonstrated that the loss of airspace capacity generated by the contingency situation is reduced. Also, the time to recover from non-nominal to nominal situations is significantly reduced with the delegation procedure (the validation exercises have

shown that the delegation process takes from 1 to 3 min depending on the use case). In case of contingency, thanks to the delegation, it is possible to reduce the number of cancellation or the possibility of delays occurrence.

- **Regarding the Economical Benefits**, the principal KPAs of the CBA are CEF and Technology cost, that represent the highly fragmented structures of the European ATM system. Results from the economic impact on the CEF2 have shown significant yearly maximum potential saving especially for the specific architecture analysed with the service interface network in order to be able to connect the ADPS with a different instances during the Delegation of ATS. The potential saving depend largely on the services adopted and needed for the Delegation process.

The following tables summarises the assessment outcomes per KPI.

KPI	Validation Targets – Network Level (ECAC Wide)	Performance Benefits at Network Level (ECAC Wide or Local depending on the KPI)	Confidence in Results
SAF1: Safety - Total number of estimated accidents with ATM Contribution per year	Yes	Yes	Low
FEFF1: Fuel Efficiency - Actual average fuel burn per flight	High	- 6.5 kg / flight (positive impact)	Low
CAP1: TMA Airspace Capacity - TMA throughput, in challenging airspace, per unit time.	High	+ 12.30 %	Low
CAP2: En-Route Airspace Capacity - En-route throughput, in challenging airspace, per unit time	High	+ 10.4 %	Low
CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode).	N/A	N/A	N/A
TEFF1: Gate-to-gate flight time	N/A	- 0.13 min / flight (positive impact)	Low

PRD1: Predictability – Average of Difference in actual & Flight Plan or RBT durations	Medium	PRD1 extrapolation at ECAC level not available, see Section 4.10.	N/A
PUN1: Punctuality – Average departure delay per flight	N/A	N/A	N/A
CEF2: ATCO Productivity – Flights per ATCO -Hour on duty	High	+ 5.9 % flights/ATCo-hour	Low
CEF3: Technology Cost – Cost per flight	High	-1.56% (positive impact)	Low

Table 3: Results of the EXEs per KPAs

There are three cases:

1. An assessment result of 0 with confidence level other level High, Medium or Low indicates that the Solution is expected to impact in a marginal way the KPI or mandatory PI.
2. An assessment result (positive or negative) different than 0 with confidence level High, Medium or Low indicates that the Solution is expected to impact the KPI or mandatory PI.
3. An assessment result of N/A (Not Applicable) with confidence level N/A indicates that the Solution is not expected to impact at all the KPI or mandatory PI consistently with the Benefit Mechanism.

6 Recommendations and Additional activities

The validation exercises targeting at V3 were successfully validated in a different environment and different Technologies adopted. However there are many recommendations covered in the VREP as a whole results. These recommendations are reported in the following list:

- **Delegation Procedure, Concept and Training**

Due to limited ATCO resources, in some exercises, the SUP role was played by a Planner ATCO. It is recommended to perform a validation of the concept with specific SUP roles, at different ATSU while providing them with the necessary support tools (Supervision, Monitoring, VCS).

During the Delegation ATS phase, it is recommended that the environment of the Delegating ATSU has the same level of complexity or, if possible, lower compared to the receiving ATSU (i.e., compatible sub-OEs).

Training aspects is a mandatory element when dealing with Delegation of ATS, where most of the Actors suggest to be fully trained on the Checklist of the procedures in order to be well processed by the Human involved in the Simulation. Also, ATCOs recurrent training is needed in order to guarantee an optimal maintenance of competence by reinforcing and broadening the knowledge necessary to perform effectively in their role.

- **Preview Mode Functionalities**

Develop further support tools for ATCOs and SUPs to improve Situation Awareness during the Preview Mode. As examples: pointing traffic from the delegating to the receiving during the exchange of traffic situation (i.e., during the preview mode).

Supporting tools to enable the Delegation are considered of great importance, e.g., for conflict detection and resolution, flight conformance monitoring, geographical information, for the rationalization of infrastructures. However, it is suggested to develop additional supervision/monitoring supporting tools (e.g. Command and Control) to improve situation awareness of the SUPs and ATSEPs at the delegating and receiving ATSU.

Finally, according to the conclusion reported in the VREP of PJ10.W2 SOL 93, it could be summarized that:

- Generally, although experienced in some exercises, the delegation of ATM services would not be feasible in High to very High traffic densities but was demonstrated as feasible in Low to Medium traffic densities for all Uses Cases considered.
- About the delegation environment, it is recommended that the environment of the delegating ATSU has the same level of complexity or, if possible, lower compared to the receiving ATSU (i.e., compatible sub-OEs).

- Furthermore, the concept has been demonstrated as operationally feasible for the following use cases valid for TMA and En-Route Phase of Flight:
 - Night use case
 - Fixed time use case
 - Contingency Use Case

Considering the On-Demand use case only, (Cross-border, Civil Military and ATFCM), the operational feasibility results are not as almost positive as in the previous Use cases.

For all use Cases validated, the Supporting tools for ATCOs such as Conflict Detection and Resolution, Flight Conformance Monitoring, Geo environment information and Technical Supervision are key enablers for the solution deployment and needed for the concept of Delegation of ATS.

However further work needs to be carried out for High to very High traffic densities but was demonstrated as feasible in Low to Medium traffic densities for all Use Cases considered.

In fact, the high level of traffic complexity and traffic demand did not allow the compliance of the ATC procedures for the Delegation ATS process, due to their complexity and, therefore, leading to a higher number of conflicts, non-optimal trajectories, and lower levels of situational awareness.

In addition, and with the aim to integrate what above stated, for the “cross-border scenario” the results indicate a mix between positive, neutral and negative outputs, without a well-defined conclusion; instead of, the “ATFCM scenario” has been demonstrated as non-feasible Use case due to the high traffic load and high complexity scenario.

In both cases, the quality of the ATC Service has been proven as “highly negatively impacted

These outcomes are different with respect what is reported in the CBA Deliverable. In fact, limitations noted in the CBA deliverable about the level of confidence for the benefit results. They include aspects of crew rostering licensing and social aspects. There is a need consider that CBA presents benefits associated with traffic levels scenarios, which, as stated in the recommendations, require further evaluation and can only be foreseen in a future scenario.

For the Next phase, SESAR 3 Project ISLAND “Solution D” will investigate on technical support like MTCD and MONA services is highly recommended for the use case on cross-border delegation and ATSUs contingency with more use cases to be validated. Even the PJ10.W2 Sol 93 ATM solution considered the MONA and MTCD set as an optional Services in a Low Medium Traffic density for the Delegation of ATS, these functionalities are mandatory in a High /Very High Traffic density during the Delegation process. Additionally, this Solution will be able to complement these recommendations focused on cross-border delegation and ATSUs contingency with more use cases to be validated.

In conclusion, requirements linked for training / Airspace Familiarization aspects (including or not regulatory adaptation) and ATSEP requirements including regulatory adaptations shall be further worked.

7 Actors impacted by the SESAR Solution

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

- Air Navigation Service Providers (ANSPs);
- Air Data Service Provider (ADSP);
- Network Manager;
- Ground systems manufacturers;
- Standardization Group EUROCAE WG-122;
- Airspace Users;
- Civil-Military authorities;
- Regulatory and certification authorities

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 Sol A, SOL B and Sol C 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 ATSU. 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 ATSU. 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.
- **Supporting Tool for the delegation of ATS**
 - The acceptance of the solution was somehow altered by the lack of controller support tools (such as Safety Nets, MTCDS) while this should not be considered as an element of the delegation procedure

10 Regulatory Framework Considerations

Licensing and regulatory aspects are considered as a synchronization activity with PJ.10-W2 Solution 73 (IFAV- Increased Flexibility of ATCO Validation). Solution PJ.10-73 and PJ33 FALCO worked to identify and validate Controller needs, which may allow for a more flexible ATCO validation regime, enabling a Controller to operate in any airspace classified as a particular type. This would mean that the ATCO would rely more heavily on the tools to decrease the requirements of geo-specific knowledge. Solution PJ.10-73 IFAV and PJ33 FALCO is perceived as fundamental when introducing the Virtual Centres concept, delegation of airspace and supporting contingency and resilient services.

The following Regulation are considered as a Recommendations:

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;
- 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.

11 Standardisation Framework

Considerations

The work carried out within PJ.10-W2-93 solution is well-aligned with the standardisation activities performed by EUROCAE WG-122. The alignment is performed in both directions: on the one hand, the working group is taking the results of the solution and previous background as input, while on the other hand the solution is considering WG-122 outputs to complement both the operational and technical threads.

Standardisation provides clarity around the technical architecture for enabling virtual centres, including developing the interoperability blueprint for suppliers of ADSP services.

However, the EUROCAE WG-122 pointed what would be the impact of introducing or not a standard. It concluded that:

- a lack of standard would reduce potential efficiency in the discussion with NSA and may lead to long delay prior to implementation,
- The most compelling reason for standardization of Virtual Centres is to enable multilateral use cases and ensure a more efficient implementation. This cannot happen in isolation and is dependent on the regulatory and licencing regime also changing,
- The highest ranked benefits for standard are seen to be the enabling of operational benefits (flexible use of airspace between ATSU's), interoperability and the potential use of future flexibility, and the enabling of further innovation,

Prior to any standardization activity, a need is expressed for a clear and operational concept and uses cases as it was recognized that standards may also inhibits innovation. Finally, it was admitted that the wider regulatory and licensing regime would be aligned to the virtual centre service-based use cases - just because the possibility to provide operations from a third-party ATSP exists, does not mean it is permissible in the local regulatory regime.

12 Solution Data pack

D3.2 - PJ.10-W2-93: V3 solution pack V3 (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
- D3.2.090 - PJ.10-W2-93-V3 Final VALP
- D3.2.060 - PJ.10-W2-93-V3 Final TS/IRS
- D3.2.150 - PJ.10-W2-93-V3 Final VREP

