# Final Project Report

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***Abstract***

This document is the Final Project Report for the 10.01.09 project.

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| None. |

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# Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

# Publishable Summary

SESAR stated the need for a service-oriented approach to meet the ATM Target Concept, i.e. the European scope interoperability in the ATM domain, aiming at striking out fragmentation among systems and countries, and at providing the holistic view of a single Pan-European ATM network whose services must be driven by stakeholders' needs. From the development perspective, a Service-Oriented Architecture (SOA) was the best candidate for enabling the ATM Target Concept, which allowed the orchestration of distributed resources and capabilities, even controlled by different ownership domains. SOA was in charge of decoupling ATM services from the underlying supporting systems and layers, and from the physical items to deploy as well. Information sharing and cooperation among different systems are the new fundamental concepts to be integrated into the next generation of ATM systems to achieve the ATM Target Concept.

The foreseen increasing of air transport demand, which should be three-fold by 2020 if compared to today's traffic, asks for an improvement of existing systems and infrastructures, resource planning and management processes. P10.01.09 addressed the problem of redefining ATC supervision systems in the new service-oriented perspective, in order to ensure that the provided services are always delivered with the required Quality of Service (QoS) levels.

In the ATC scenario, the task of supervision is crucial due to the strict dependability constraints. Systems to supervise are generally distributed and made up of several interacting components/services, thus complicating the task of system health monitoring and control.

In fact, supervision is system management, i.e. the ability of controlling the status of the monitored system, and of starting recovery and reconfiguration actions to prevent QoS degradation or as a reaction to anomalous and unexpected events also known as dependability threats, i.e. faults, errors and failures.

Traditional studies on dependability proposed fault diagnosis as an enabler to effective supervision management strategies. Diagnosis (fault location) aims to locate the root cause (fault) of a manifested failure, once it has been detected, in order to trigger the most proper recovery action. In a general perspective, supervision systems based on diagnosis can be thought as made up of (i) a failure detector, aiming to detect the presence of an error and to trigger alarms, (ii) a fault locator, aiming to go back to the root cause of the error/failure (i.e. the fault) and (iii) a recovery block, aiming to select and trigger the most proper recovery/reconfiguration action. These can be represented either by automatic systems or human operators.

Based on this underling idea, i.e. SOA based, and to address the aforementioned challenges, P10.01.09 proposed a technical supervision platform capable of meeting the aforementioned needs. Details on the proposed architecture are depicted in deliverable D05, whereas the requirements of the platform functionalities are detailed in deliverable D12.

In doing so, P10.01.09 tasks were structured as follows:

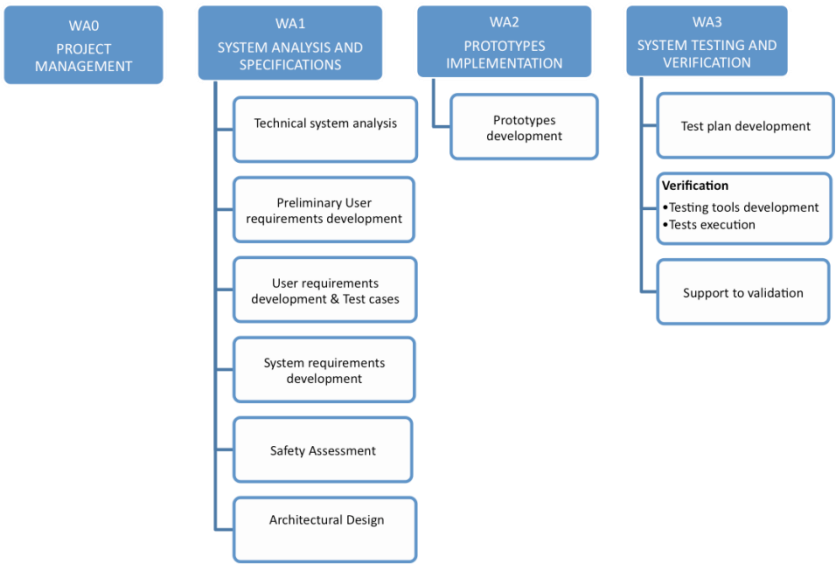


**Figure 1 Project structure**

Being the P10.01.09 with no operational counterpart, project was obliged to internally produce operational requirements, provided by deliverable D02 and D04, and use cases (listed into deliverable D54). On this background, the system requirements (available into deliverable D05) was produced, on which two prototypes in phase 1 were developed, one from Selex ES and the other from Thales. However, no validation activities have been possible because a not well-defined operational counterpart was identified. Prototypes were developed according with the new view for the Supervision Systems, in which the envisaged platform had to gather supervision key indicators by means of a standard interface to foresee by a “smart” engine systems failures and impact on the systems-network.

After this Phase, SJU informed, during the **Project Gate of 2013,** that no positive feedbacks towards the proposed concepts were received from the Operational Stakeholders.

Therefore, SJU identified a group (called Supervision Task Force, STF) of different transversal projects (i.e. B4.2, B4.3, 10.01.09, 12.01.09) were assigned the responsibility to analyse and identify the need for Supervision in a European ATM, tackling the different points of view (Operational, Systems and Infrastructure).

After one year of activity, STF has produced a report [3] on the supervision matter, in which STF identified some questions to be faced and postponed into the SESAR 2020 Programme, and others to be addressed into SESAR 1 programme. In this latter, STF stated that the Collaborative Decision Making area has to be the new target to be addressed from the 10.01.09 project.

After an activity for finding out the scope according with STF outcome and in performing a CR to make realistic the new start-up of the project, all partners have agreed to leave the project because the new identified aim/goal brought far from the expected and desirable outcomes.

# Acronyms

| Term | Definition |
|---|---|
| **ATC** | Air Traffic Controller |
| **ATM** | Air Traffic Management |
| **AOC** | Airport Operations Centre |
| **ConOps** | Concept of Operations |
| **COTS** | Commercial Off The Shelf |
| **EUROCAE** | European Organisation for Civil Aviation Equipment |
| **HMI** | Human Machine Interface |
| **HW** | Hardware |
| **ICAO** | International Civil Aviation Organization |
| **ICOG** | Interoperability Consultancy Group for the IOP Interface Specification |
| **MET** | Meteorological Information Provider |
| **PC** | Personal Computer |
| **PCG** | Programme Control Group |
| **RTCA** | Radio Technical Commission for Aeronautics |
| **SESAR** | Single European Sky ATM Research Programme |
| **SJU** | SESAR Joint Undertaking |
| **SLA** | Service Level Agreement |
| **SOA** | Services Oriented Architecture |
| **SPV** | Supervision |
| **SW** | Software |
| **SWIM** | System Wide Information Management |
| **SWIM-SUIT** | SWIM Supported by Innovative Technologies |
| **SWIM-TI** | SWIM Technical Infrastructure |
| **TAD** | Technical Architecture Document |
| **TS** | Technical Specification |
| **WA** | Working Activity |

# 1 Project progress and contribution

As long as the project has worked according with the PIR goal, the project designed and developed a first supervision platform based on SOA architecture, in which the supervised systems work as services. According with this goal, the services to be supervised has to be characterized by proper key performance indicator describing a well-defined quality of service (i.e. QoS). In turn, QoS is identified by the SLA (Service Level Agreement), which describes the admissible level of those key performance indicators.

The proposed supervision platform was implemented to expose standard interfaces, in turn provided out as services, to gather these key indicators and to be capable of elaborating those in order to detect the incoming failures and reacting to mitigate their impact.

In doing so, preliminary user requirements were auto-defined asking support to the other system projects. In particular a Requirements Definition Template was set-up and the flow shown in Figure 2 was followed to gather inputs. Details on the followed approach can be found into D02 deliverable.

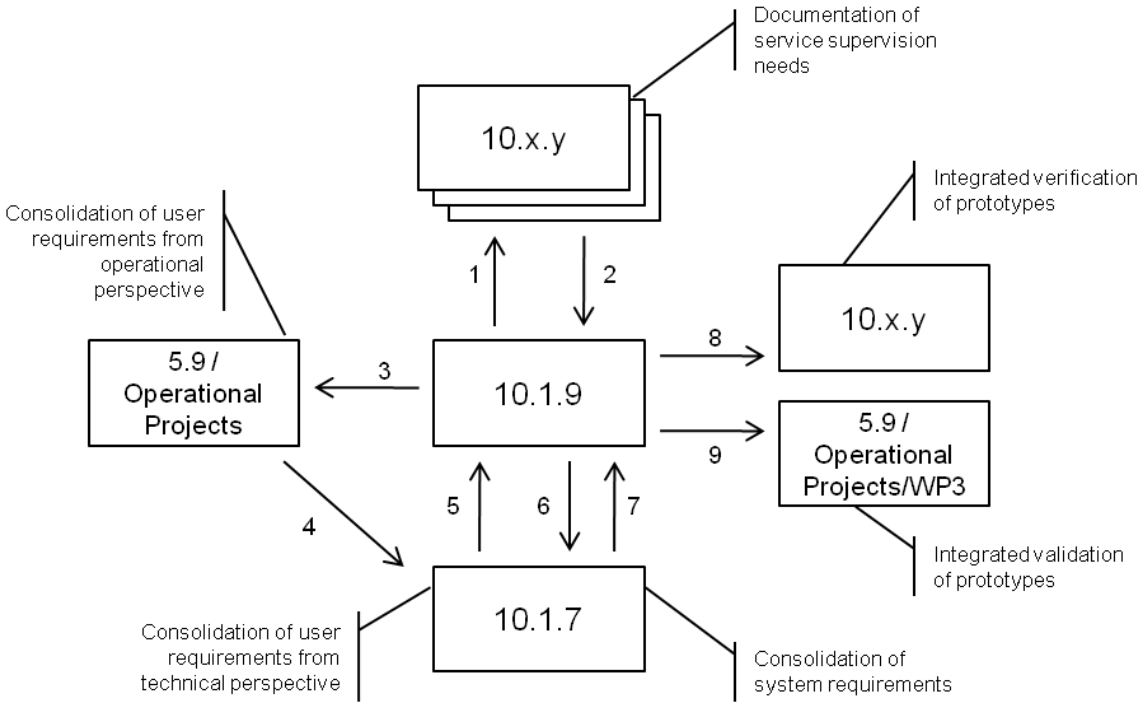


**Figure 2** ***Activities to be performed to collect and process the requirements needed to specify the 10.1.9 prototypes***

However, few answers were received but based on these and on further user requirements out-defined the project delivered a subset of user requirements useful for running the development chain.

The lack of a proper operative counterpart in the SESAR programme has not allowed performing validation activities, making very difficult to **identify and address by the project prototypes the OIs and related ENs**.

P10.01.09, in turn, was not capable of identifying a maturity level of its activity in context of SESAR Programme, with no possibility to quantitative assess the contribution to the SESAR Solutions, being not possible to link to those. Moreover, the continuous interruptions and the several changes suffered from the project have furthermore contributed to the actual project outcomes.

However, after the introduction of STF for driving the supervision approach into the SESAR Programme, the Project has supported the STF team in its activity. In this period the main contribution provided by the P10.01.09 has been related to the identification and description of suitable use cases to clarify the supervision goal. The progress of this activity was the STF final report provided in the 2014, which suggested, at the high level, the new goal of the project.

# 2 Project achievements

## 2.1 What are the results of the project? and Which R&D question has been answered?

Main P10.01.09 achievement has been the definition of a technical supervision system SOA oriented, with respect to the classic approach mainly based on SNMP protocol or internal middleware (i.e. system/equipment oriented). This attempt, as described in [1], was and is still a real challenge in the R&D context for the ATM/ATC environment. The proposed approach makes easier the integration of several systems/services to be supervised increasing the quality of supervision.

For doing so, the project defined the means for being able to perform (Figure 3):

- **Monitoring function**

  The monitoring function consists of three sub-functions: Application Monitoring sub function, Service Monitoring sub function and Hardware Monitoring sub-function. These sub functions monitor different supervised entities, but they all have some common functionality applicable to the monitoring of all supervised entities.
  Each supervised entity is monitored in a predefined way according to the Technical Supervision needs and the particular characteristics of the supervised entity. The configuration of each monitoring is managed by the Monitoring Configuration Management sub function. Excepting some particular exceptions that may appear, there is some functionality common to all the supervised entities independently from their nature, like the corrupted and erroneous messages detection, the detection of uncommon or out the ordinary status changes or the diagnostic message management

- **Control function**

  The Control Function consists of three sub functions: Hardware Control sub function, Application Lifecycle Control sub function and Service Lifecycle Control sub function. These sub functions perform the manual and automatic actions on the supervised entities and control their lifecycle. Each supervised entity will accept a set of control actions according to its particular characteristics. The Control function will acknowledge these particular characteristics via the Control Configuration Management sub function.

- **Failure Management function**

  The Failure Management function consists of two sub functions: Failure Detection sub function and Failure Response sub function.

  - **Failure Detection sub function**

    This sub function is in charge of seeking for failures in the information generated by the monitoring of the supervised entities. Detectable failures are described in the SPV Configuration. If some monitoring information matches a predefined failure, the associated alarm is generated, and the Failure Response sub function is called.

  - **Failure Response sub function**

    Once a failure is detected by the Failure Detection sub function and notified to the Failure Response sub function, this sub function process the failure and depending on the failure nature. It launches an automatic recovery action sequence in case these actions are defined in the Failure Management Configuration sub function, if there is no automatic recovery actions defined, the Operator will be responsible of taking the necessary actions to mitigate the failure.

- **Alarm function**

  The Alarming function consists of two sub functions: Alarm Rising sub function and Warning Generation sub function. The aim of this function is to inform the user about the unusual

behaviour of the supervised entities. The alarms and warnings displayed to the user will depend on the user role and access rights

- **Statistic function**

  The Statistics function provides three sub functions: Metrics Computing sub function, Statistical Analysis sub function and Report Generation sub function. This function provides the means to analyse the Technical Supervision and the supervised entities performance, generating and providing metrics and reports both "offline" (from stored data) and "online" (from data directly obtained from other functions). Metrics and reports are generated according to the configuration information provided by the Statistics Configuration Management sub function

- **Service Provision function**

  The Service Provision function provides five sub functions: Supervised Hardware Status Service Provision sub function, Supervised Applications Status Service Provision sub function, Supervised Services Status Service Provision sub function, Diagnostic Message Management Service Provision sub function and Statistical Data Analysis Service Provision sub function. These sub functions interface with the rest of the functions to provide and maintain the services associated to each sub function.

It's worth noting that these functionalities have been allocated to the Technical Supervision Functional Block described into the 10.01.07 TAD.

Details on the above functionalities can be obtained into deliverable D08, in which the overall architecture was described. Based on this, two prototypes (described into D10 and D12) were developed and also verified according with a proper verification plans (i.e. details are provided into D19 and D16); no validation was performed because no operation counterpart was identified.

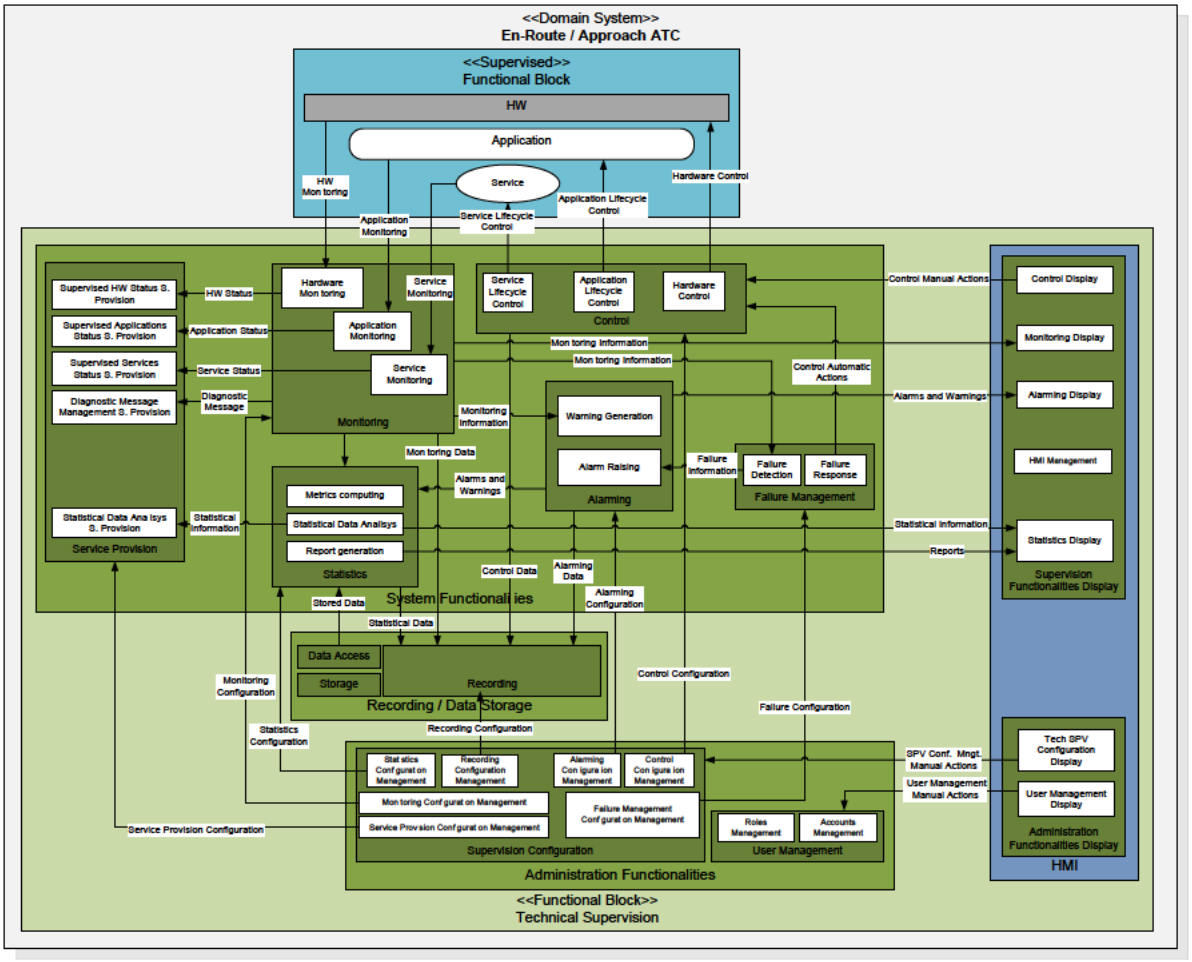


**Figure 3 Proposed functional block**

## 2.2 Which agreement has been reached?

In terms of **Technical Solution**, P10.01.09 project has agreed that supervision solution has implemented the concepts described before and hereafter listed:

- **Monitoring function**
- **Control function**
- **Failure Management function**
- **Alarm function**
- **Statistic Function**
- **Legal recording**

## 2.3 What contribution has been made to the ATM performance targets?

Project 10.01.09 has suffered, as the others SESAR projects working on supervision matter, of the difficulty in having a clear and well-defined operational counterpart capable of providing the targets to be addressed. This, along with the SJU request to change the project scope with respect to the submitted PIR [1], has not permitted a real contribution to the ATM performance.

## 2.4 Difference between initial and final scope (If relevant, how achievements differ from the initial scope, summarising why the scope has evolved?)

The project suffered a change of scope during its activity, moving from an initial one, identified in the submitted PIR [1] and those come out from the report issued by the STF [3]. In fact, the project was stopped after the first iteration, not being able to reach the whole set of initially fixed objectives. To overcome this difficulty, a group of different transversal projects (grouped into a Supervision Task Force, i.e. STF) were assigned from the SJU the responsibility to analyse and identify the need for Supervision in a European ATM, tackling the different points of view (Operational, Systems and Infrastructure).

STF produced a report [3] providing recommendations on the supervision identifying some aspects to be faced and postponed into the SESAR 2020 Programme, and others to be addressed into SESAR 1 programme.

One this latter, the report identified the Collaborative Decision Making area as those to be faced into the 10.01.09 project as the new project scope.

After an re-arrangement of the project to address the new identified scope, submitting also a CR to make realistic the new start-up of the project, all partners have agreed to leave the project because the new identified scope/goal was far from the expected and desirable outcomes described and agreed in [1].

## 2.5 Project deliverables

A summary of the project deliverables is presented in the Table 1.

**Table 1 10.01.09 deliverables list**

| Del. code | Del. Name | Description | Assessment Decision |
|---|---|---|---|
| D02 | Preliminary User Requirements Development Report | The preliminary User requirements are provided. A proper user-form was created to gather those from the external project. | No reservation (P) |
| D03 | Technical System Analysis Report S2 | Technical architecture description for the S2 prototype | No reservation (P) |
| D04 | User Requirements Development Report V2S2 | Description of the User Requirements stemming from the D02 deliverable. | Reservation/s requiring clarification/s |
| D08 | Architecture Design Report V2S2 | Description of the architecture principles to be provided by the Supervision platform | No reservation (P) |
| D12 | THALES prototype development delivery v2.0.0 | A description of THALES prototype according with the D04 and D05 deliverables. | No reservation (P) |
| D10 | Selex prototype development delivery sheet v2.0.0 | A description of Selex ES prototype according with the D04 and D05 deliverables. | No reservation (P) |
| D14 | Selex verification plan v2.0.0 | Description of the verification plan to run in the Selex ES prototype. | No reservation (P) |
| D16 | THALES verification plan v2.0.0 | Description of the verification plan to run in the THALES prototype. | No reservation (P) |
| D19 | Selex verification report v2.0.0 | A details report on the verification activity accomplished by the Selex ES prototype | No reservation (P) |
| D53 | Activity report on supervision | Report providing an activities description performed into the STF group. | |
| D54 | Use cases and scenarios definition report | Definition and description of the scenarios on which to verify the prototypes. | |
| D05 | System Requirements V2S2 | System requirements definition based on the D04 deliverable, as well as D03. | No reservation |
| D21 | THALES verification report v2.0.0 | A details report on the verification activity accomplished by the THALES prototype | No reservation (P) |

## 2.6 Contribution to standardization

P10.01.09 did not contribute to standardization activities.

## 2.7 Project Conclusions and Recommendations

Main recommendation coming from the final report provided in the Supervision Task Force that can be summarized as:

In what regards to the content and scope, the recommendations coming from this project are aligned with the recommendations/observations provided in the Supervision Task Force Final report (ref. [3]), that can be described as:

There is an identified need for achieving/providing Supervision in:

- **Local Technical Supervision** (to detect the technical cause of operational disruption).
- Local CDM (to assess the operational impact of the technical failure).
- Network Management Function CDM (to share the local operational impact).
- Supervision for:
    - SWIM – NM_B2B profile status.
    - SWIM – ATC_ATC_Coordination profile status (already defined in ED133).
    - Satellite signal (e.g. GPS, EGNOS, etch) at local and regional levels.

In addition, current regulations (e.g. EASA 1034/1035) imply the use of supervision as a means to meet the safety goals.

It needs to be studied the need for Supervision at the following ATM operation businesses:

a) **As is (local?) situation**: each stakeholder remains individual and sole responsibility for its own resources and service provision with the responsibility to provide local contingency only;

b) **Extension of the Area of Responsibility (sub-regional? FAB?)**: adjacent stakeholder may be able to ensure resources and service provision on behalf stakeholder facing difficulties to provide its own resources and service provision.

c) **Fully integrated ATM European organization** with resources shared among B.4.4 & B.4.5): stakeholder will provide to and consume service from other European stakeholders.

In which the following considerations are to be handled:

For each of these potential European ATM organizations, nominal and non-nominal scenarios shall be defined and might lead to new supervision requirements. Fundamental questions will rise such as:

- Which operational capability (resource, service provision) needs to be supervised in order to identify the operational impact?

- Which information to disseminate? Cause of the failure apart for legal matter? Impact of the failure?
- Shall this be a full automated process or will it rely on a support of human for the decision making (e.g. NOTAM)?
- Does this change imply new roles/responsibilities or a change/extension of the existing ones (institutional issue)?

Moving from ATM operational business expectation a) to b) and c), there will be a growing need for security mechanisms and strategies which could lead to some supervision needs.

But, the key issue will be where responsibilities will lie in the future, and if/how technical capabilities and service provision will meet the need for stakeholder internal and external 'situational awareness' and the retention or devolution of their specific responsibilities. Especially, if these are to be conducted on more collaborative ('committee') based processes, and if/where final intervention can be implemented.

**Moreover, for cost-effectiveness reasons, the development of common best practices for procedures in cases of failure and technical supervision standards can be considered (including CDM aspects).**

That recommendation can be summarized as follows:

1. align 10.1.9 project plan starting from existing material (e.g. Community Specification on airport CDM);
2. consider the evolution of the technical supervision towards service-orientation interface. This can be initiated by the SESAR Common Services project (either B.4.5 or SESAR2020 Common Services project);
3. consider the extent of SESAR 2020 R&D activities on technical supervision supporting operational supervision/processes and related decision-making activities to address Step2 needs. This has especially to be put in the context of RPAS and cyber-security aspects of Step2.

Stemming from the above first recommendation, 10.01.09 has identified as further ones to reach the required targets:

- the need of involved, with high commitment, operational stakeholders into the project, which has to support technical project partners in identifying clear operational objectives and scenarios in the CDM context;
- balance the effort among technical and operational partners in order to face and overcome the challenge of supervision identified by the STF recommendation.

# References

**[1]** PIR Project 10.01.09 https://extranet.sesarju.eu/WP_10/Project_10.01.09/Project%20Management/10.01.09%20PIR%20_Part%201.doc

**[2]** Project baseline - https://extranet.sesarju.eu/WP_10/Project_10.01.09/Latest/REP_10.01.09_LATEST_PROJECT_BASELINE.pdf

**[3]** Supervision Task Force Report - https://extranet.sesarju.eu/intraprogman/Assessment Library/Supervision Final Report.doc

**[4]** SESAR Programme Management Plan, Edition 03.00.01

**[5]** European ATM Master Plan, Edition 2

**[6]** Multilateral Framework Agreement ("MFA") signed between the SJU, EUROCONTROL and its 15 selected members on August 11, 2009, amended on 14 June 2010, 19 October 2010 and 2 July 2012

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