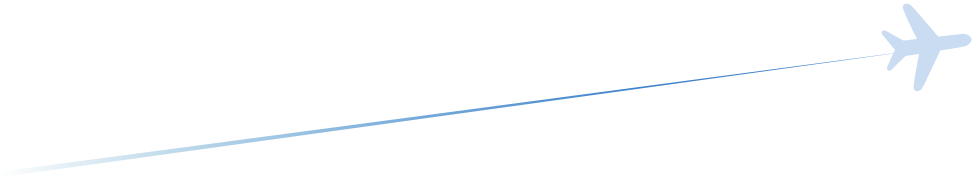

PJ.15-02 E-AMAN Service TRL6 High Level Architecture Description

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00.01.02	29.11.2019	Final Version	Markus Debusmann	Changes based on Gate Review comments

PJ.15 COSER

[PJ.15 COMMON SERVICES]

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Abstract

This document describes the High Level Architecture of the Extended Arrival Management (E-AMAN) Common Service for TRL6 maturity phase. It aims to reflect from the architecture perspective the deployment scenarios defined in the V3 Business Model, and at the same time provides the background for the ArrivalSequenceProvision service defined in PJ.15-02 for the TRL6 technical validation activities.

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1 Introduction

1.1 Purpose of the document

This document describes the High Level Architecture for the Extended Arrival Management (E-AMAN) Common Service. It follows the architecting approach defined in the Common Services Foundation Method [1] from SESAR 1 Project B.04.05 and uses the V2 Business Model [2] previously produced in PJ.15-02 to provide the description of operational, service and system architectures for E-AMAN Common Service.

It also provides the background in order to better contextualise the ArrivalSequenceProvision service (defined in [6]) in the overall architecture proposed by PJ.15-02.

1.2 Intended readership

The intended audience for this document is the SESAR Joint Undertaking, the partners in the SESAR 2020 Programme, the ATM stakeholders (e.g. Airspace Users, ANSPs, Airports, and manufacturing industry) with those third parties directly affected by its findings.

Other transversal projects, such as PJ19.03, and tasks within the SESAR 2020 Programme may also have an interest.

The document also provides inputs for work related to the service definition, prototyping and development activities in PJ.15-02.

1.3 Inputs from other Projects

The basic notions of the E-AMAN Common Service are described by PJ.15-02 in the V2 Business Model document [2], including the potential customers (stakeholders) of the service, the value propositions and the information flows needed between the stakeholders.

The concept of the E-AMAN operations was originally developed in SESAR 1 Programme, mainly by Projects P05.06.04 and P05.06.07.

The reference architecture, including its individual elements, are from the EATMA Repository, which is maintained by using the MEGA modelling tool [3] and can be accessed via the European ATM Portal [4].

1.4 Glossary of basic concepts

Term	Definition	Source
Arrival Manager	A planning system to improve arrival flows at one or more airports by calculating the optimised approach / landing sequence and Target Landing Times (TLDT) and, where	SESAR Lexicon

	needed, times for specific fixes for each flight, taking multiple constraints and preferences into account.	
Capability	The ability of one or more of the enterprise's resources to deliver a specified type of effect or a specified course of action to the enterprise stakeholders.	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0
Capability Configuration	A Capability Configuration is a combination of Roles and Technical Systems configured to provide a Capability derived from operational and/or business need(s) of a stakeholder type.	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0
Common Service	A service providing a capability in the same form to consumers that might otherwise have been undertaken by themselves.	SESAR B04.05 D02
Consumer	A user of a service	SESAR B04.05 D02
Customer	A consumer of a service under a specific contract.	SESAR B04.05 D02
Function	An activity which is specified in context of the resource (human or machine) that performs it.	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0
Node	A logical entity that performs activities. Note: nodes are specified independently of any physical realisation.	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0
Service	The contractual provision of something (a non-physical object), by one, for the use of one or more others. Services involve interactions between providers and consumers, which may be performed in a digital form (data exchanges) or through voice communication or written processes and procedures.	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0
Service contract (SLA)	A service contract represents an agreement between the stakeholders involved for how a service is to be provided and consumed. A service contract is specified through the service interface, the QoS and Service policies.	SESAR B.04.03 – Working method on service
Service instance	Service which has been implemented in accordance with its specification in the service catalogue (during the SESAR Development Phase, the service definitions are available in the ISRM) by a service provider (by itself or contracted to a third party).	SESAR B.04.03 – Working method on service
Service Provider	An organisation supplying services to one or more internal or external consumers.	SESAR B.04.05 – D02
Service taxonomy	The service taxonomy describes the categorisation of services provided between ATM stakeholders. It is used to organise the responsibilities of the service design as well as to provide a means of identifying services in the run-time environment.	SESAR B.04.03 – Working method on service
Stakeholder	A stakeholder is an individual, team, or organization (or classes thereof) with interest in, or concerns relative to, an enterprise (e.g. the European ATM). Concerns are those interests, which pertain to the enterprise's development, its	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0

	operation or any other aspect that is critical or otherwise important to one or more stakeholders.	
System Functionality Description (NSV-4)	Supports the development of system functional hierarchies and system functions.	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0
System Interface Description (NSV-1)	Links together the Operational View and the System View by depicting which systems and system connections realize which information exchanges. It is based on the definition of Capability Configurations and describes the assets, both technical and human which are required in order to provide capability.	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0

Table 1: Glossary of basic concepts

1.5 Acronyms and Terminology

Term	Definition
ACC	Area Control Centre
AMAN	Arrival Manager (Controller Support tool)
ANSP	Air Navigation Service Provider
APP	Approach
ATM	Air Traffic Management
ATS	Air Traffic Service
ATSU	Air Traffic Service Unit
CC	Capability Configuration
CTA	Controlled Time Of Arrival
DMAN	Departure Manager
ECAC	European Civil Aviation Conference
E-AMAN	Arrival Manager with Extended horizon
EATMA	European ATM Architecture
ER	En-Route
EPP	Extended Projected Profile
ETA	Estimated Time of Arrival
FAB	Functional Airspace Block
ICAO	International Civil Aviation Organization
IR	(European Commission) Implementation Regulation

NAF	NATO Architecture Framework
NM	Network Manager
NOV	NAF Operational View
NSV	NAF System View
PCP	Pilot Common Project
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
TMA	Terminal Manoeuvring Area
TTO	Target Time Over
TWR	Tower (Capability Configuration in EATMA)
UAC	Upper Area Control Centre

Table 2: Acronyms and Terminology

2 Scope of the High Level Architecture Description

The main objective of this document is to describe the main architecture elements and their relationships across the different architecture layers for the E-AMAN Common Service. This description starts with the business needs, and goes down to the resources in the system layer that will need to collaborate with each other to meet these needs, supported by the services that enable the actual exchange of data.

2.1 E-AMAN Common Service

Following is the definition of the E-AMAN Common Service from the E-AMAN Business Model [2]:

'The E-AMAN Common Service provides functions necessary to operate Arrival Management with an extended horizon in an environment where multiple actors are involved e.g. multiple Airports, AMANs, ACCs, UACs and other interested parties, e.g. NM (i.e. Cross Boarder Arrival Management).

The level of capability considered here is matching basic E-AMAN requirements (excl. concepts of CTA, TTO, ETA min/max, EPP, coupled AMAN/DMAN). The mentioned advanced concepts are not validated up to a level of sufficient maturity to be used in the context of Extended Arrival Management.

These basic E-AMAN functions are:

- *Arrival Sequencing / Planning*
- *Arrival Management Information Distribution to all involved actors'*

The E-AMAN Common Service provides the "technical" capability necessary to operate Extended Arrival Management, while the operational responsibility for its approval and distribution to the end users of this information remains in the original ATSU's hands.

2.2 E-AMAN Common Service Scenarios

Two potential scenarios have been identified and developed as hypothetical deployment scenarios for the E-AMAN Common Service in [2]. In the next chapters of this document, the architecture description is provided for each of them.

Co-Location of E-AMAN on a local level

The capability provided by the Common Service here is the provision of a consolidated technical E-AMAN capability on a local (ANSP) level. The output of the Common Service is delivered to the end-users (e.g. adjacent ACCs / UACs) by the consolidated capability itself. No relocation or distribution of functions between stakeholders is performed, relocation and redistribution of functions is performed only at an ANSP scale.

This scenario describes an ANSP who may decide to provide the technical E-AMAN capabilities by a Common Service locally for the airports where he is in charge of. This Common Service would be realized by co-location of the E-AMAN systems at a single site. The operational processes executed around the E-AMAN technical capability are still executed by the original Approach Centre.

The architecture description is provided in Section 3.4.2.

Federation of E-AMAN

The capability provided by the Common Service here is the capability of harmonising the output of local E-AMAN technical capabilities on different geographic or organisational levels (ECAC, FAB), however any other scaling could be considered in principle. The output of the Common Service is delivered to the end-users (e.g. adjacent ACCs / UACs). By this, relocation of functions between stakeholders is performed

In this scenario, the Common Service provider receives arrival sequences from distinct ANSPs' current AMAN/E-AMAN systems and provides a Common Service that transforms these sequences into a harmonised data format, ready to be consumed by other ANSPs.

The architecture description is provided in Section 3.4.3.

2.3 High Level Architecture Assumptions

Based on the definition of the E-AMAN Common Service provided in section 2.1, the following assumptions have been made regarding the high-level architecture description presented in this document:

- Advanced conceptual aspects such as CTA, TTO, ETA min/max, EPP or coupled AMAN/DMAN have been explicitly excluded from the Business Model, and therefore not represented in the architecture description.
- For each of the scenarios, different options have been identified on how the information is actually exchanged and by which actors. In such cases, PJ.15-02 members have decided to describe only one of the options in this document. It should remain clear that the described option should not be seen as the preferred or recommended one, as there are other options which are equally valid.

3 High-Level Architecture Description

3.1 Introduction

This chapter provides the architecture description for three different scenarios. The first one could be considered as a reference scenario in order to show the nominal architecture where no Common Service is being provided; and the two following scenarios that were briefly described in section 2.2 (Co-Location and Federation). The description for Business and Operational layers are common and applicable to all of them, while for the System layer an individual description is presented for each scenario.

3.2 Business Architecture

Figure 1 below illustrates the latest version of the European ATM Capability Model (currently EATMA V10). It shows the hierarchical breakdown of the high-level abilities that the European ATM, as a global enterprise, needs to provide to its stakeholders. There are eight Capability areas (or Level 1 Capabilities) which are fully aligned with the components of the ICAO Global Operating Concept [5].

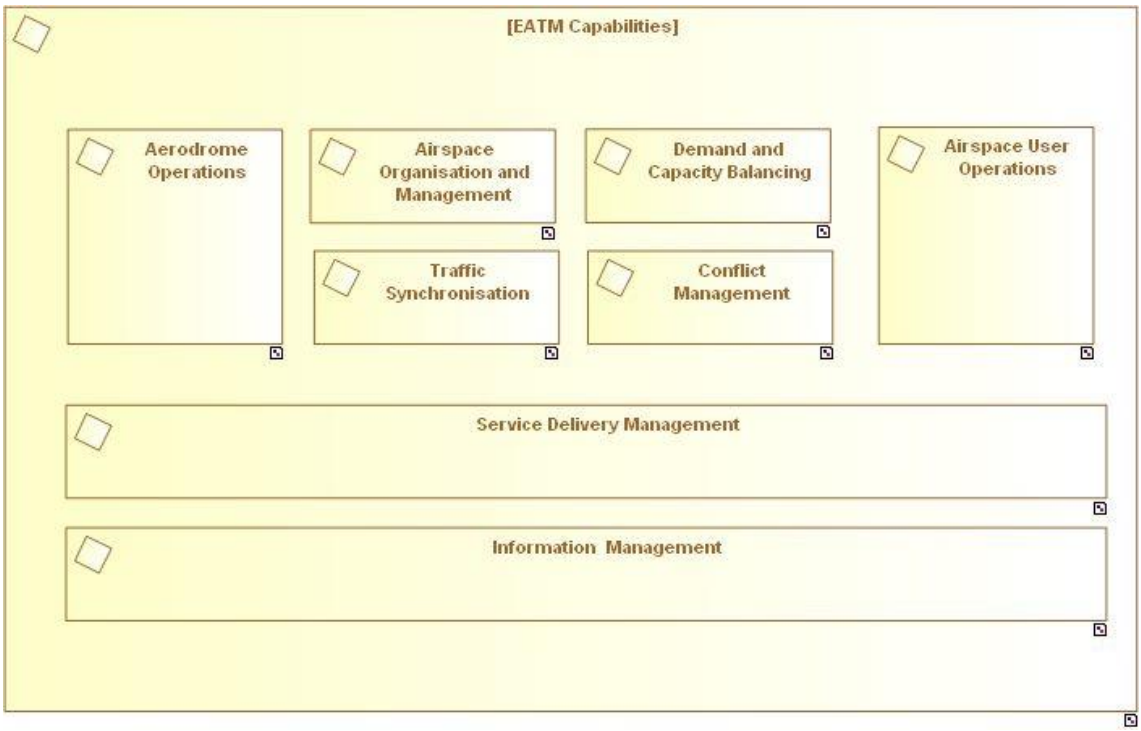

Figure 1: European ATM Capability Model in EATMA V10 (Level 1)

Following the method described in [1], it is proposed to use the Service Delivery Management area to define the Capabilities that the Common Services support, by putting the focus on the provision of services across the European ATM, rather than on improving any operational concept. Within this area,

there is an existing Level 3 Capability (created in SESAR 1 timeframe by Project B.04.05) that can be reused to fit the purpose of PJ.15-02: <<E-AMAN Common Service Provision>>.

Therefore the proposal is to reuse the abovementioned Level 3 Capability. The E-AMAN Common Service aims to achieve this Capability. This is illustrated below in Figure 2.

- [Level 1] Service Delivery Management
    - [Level 2] ATM Service Management
        - [Level 3] **E-AMAN Common Service Provision**

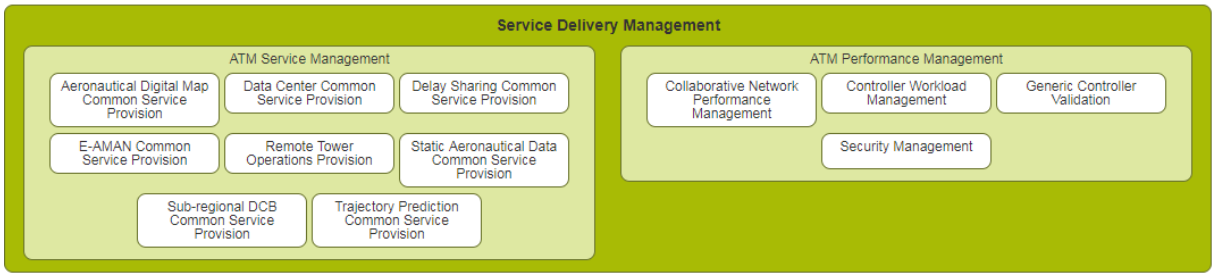

Figure 2: Service Delivery Management Capability area

3.3 Operational Architecture

As explained in Section 2.1, the scope of the E-AMAN Common Service according to the Business Model for V2 only covers the technical capability, and there is no impact expected on either the operational concept itself nor on the responsibility of the stakeholders involved in the concept. From the architecture perspective, it means that no alternative operational architecture description is required, as

- No new Nodes or Activities are deemed necessary;
- And no modifications on existing Nodes or Activities are deemed necessary

3.4 System Architecture

Table 3 below summarizes the Capability Configurations from EATMA that are used to represent the stakeholders (also known as users in the Business Model) in the system layer, along with the description for each of them.

User in the Business Model	Capability Configuration	Description
E-AMAN Common Service Provider	E-AMAN Common Service Provision	Implemented by a commercial entity that provide the functions necessary to generate an arrival sequence and related advisories for an extended horizon (e.g. up to 180-200 NM).
E-AMAN hosting ANSP E-AMAN mandated ANSP	APP ACC	Implemented by the Civil and Military ATS ANSP in an Air Traffic Control Centre (Approach).

Receivers of E-AMAN Service Data: ACC	ER ACC	Implemented by the Civil and Military ATS ANSP in an Air Traffic Control Centre (En-Route).
Receivers of E-AMAN Service Data: Airports	TWR (Destination Airport) TWR (Satellite Airport)	Implemented by the civil and military ATS ANSP in an Air Traffic Control Tower at an aerodrome.

Table 3: Capability Configurations used for the system architecture description

For the System architecture description, two diagrams are provided per each scenario, including:

- A Resource Connectivity Diagram (or Capability Configuration Context Diagram; NSV-1 in NAF) that describes from a static perspective who are the actors (represented as Capability Configurations at this stage) involved in the scenario and which are the main data exchanges between them.
- A System Process Diagram (or Function Context Diagram; NSV-4 in NAF) that aims to complement the NSV-1 by providing the dynamic view of the scenario. This is done by describing the order of the tasks (represented as Functions) performed by each CC and when should each data exchange actually occur. Overall, the actors and the data exchanges should be aligned with those from NSV-1. For the two E-AMAN Common Service scenarios, this context diagram aims to show how the introduction of the E-AMAN Common Service would impact on the process, how the new actor (in this case the provider of the Common Service) would fit into it, and which are the data exchanges involved him. It does not aim, by any means, to describe a real use case, as no operational use cases have been defined in PJ.15-02.

3.4.1 Reference Scenario (with no Common Service)

In [1] it is mentioned that Common Services should be seen as alternative architecture options. In order to illustrate what changes is the E-AMAN Common Service is introducing, this section describes a scenario where no Common Service is provided so it can be used as a reference (or nominal architecture) for the Extended AMAN concept.

Specifically, an Approach Centre is generating an arrival sequence for an aerodrome within the TMA area that it is controlling. This sequence is distributed via legacy technologies to the rest of stakeholders interested in this information: the upstream En-Route ACC, the Tower at the destination Aerodrome, the Tower at the Satellite Aerodrome, and potentially, the Network Manager (not included in the diagram).

Figure 3 below shows the Capability Configurations used to represent these users of this scenario in the system layer, along with the relevant data exchanges between them from a static perspective.

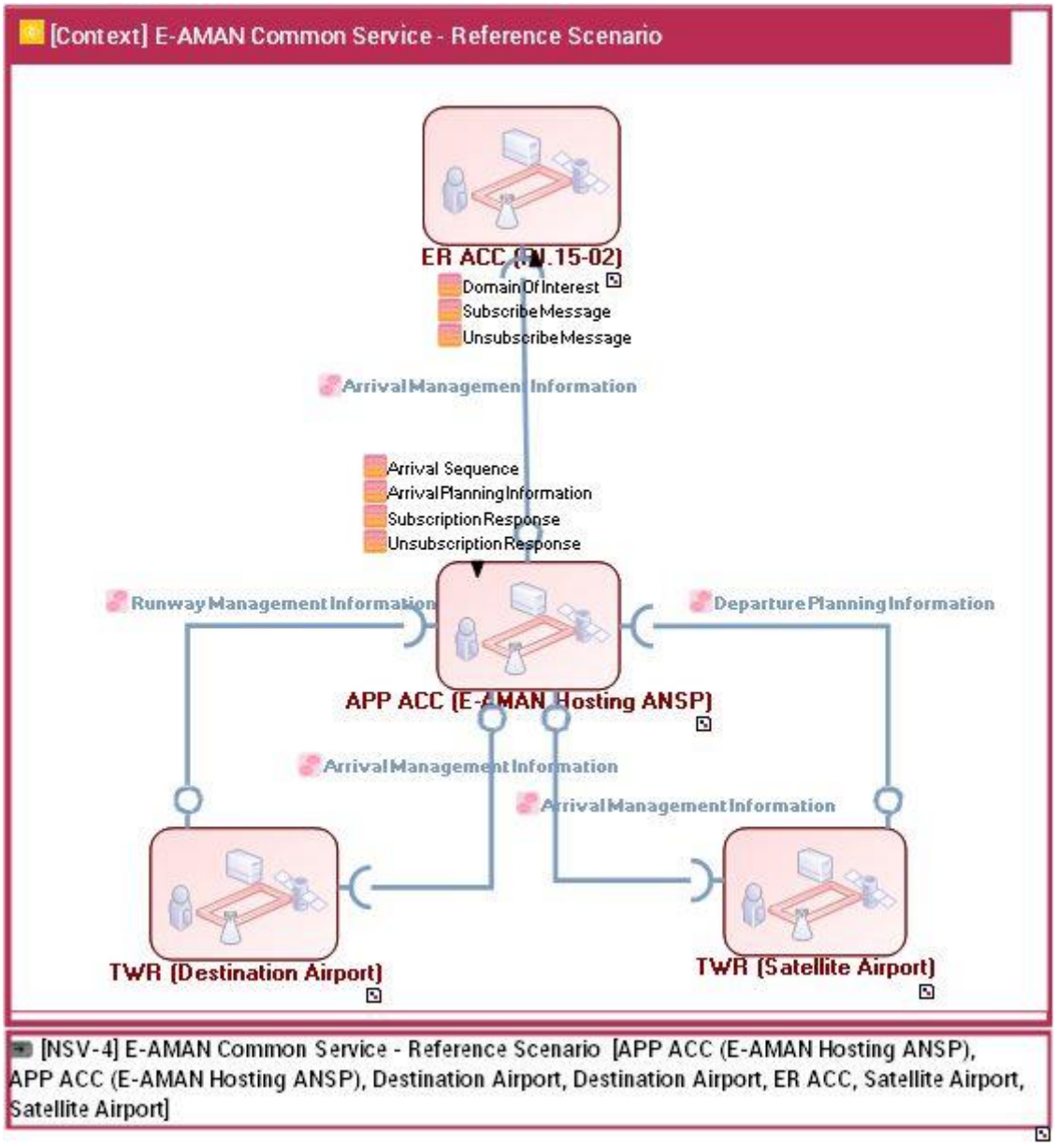

Figure 3: NSV-1 – Resource Connectivity Diagram for the Reference scenario

The NSV-4 dynamic sequence diagram of the Reference scenario is shown below in Figure 4.

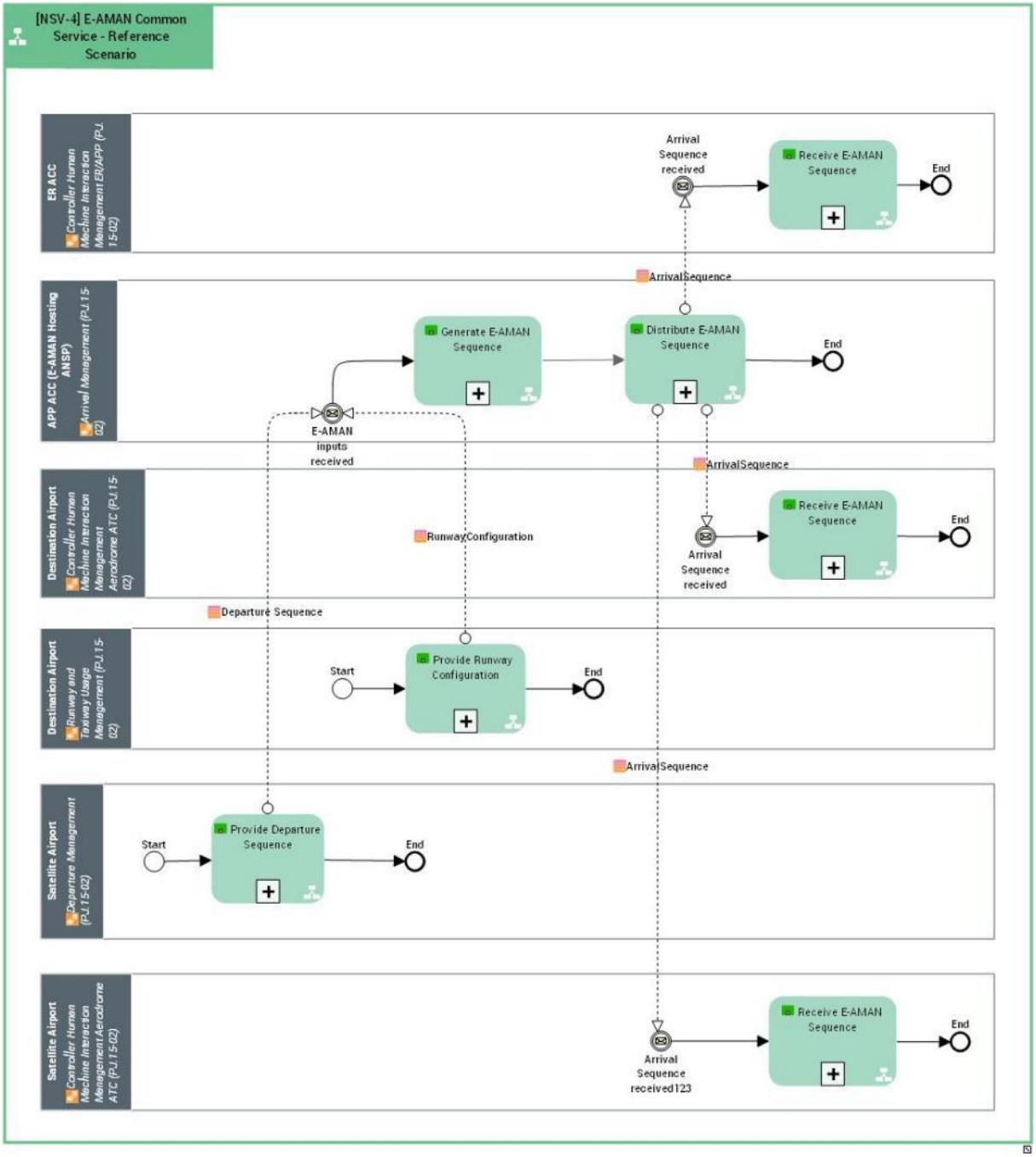

Figure 4: NSV-4 – System Process Diagram for the Reference scenario

3.4.2 Co-Location of E-AMAN on a local level

This scenario follows the Common Service Pattern of “Consolidation” and might apply mainly to ANSPs, which already have AMAN or E-AMAN systems in place.

It describes an ANSP who may decide to provide the technical E-AMAN capabilities by a Common Service locally for the airports where he is in charge of. This Common Service would be realized by co-location of the E-AMAN systems at a single site. The operational processes executed around the E-AMAN technical capability are still executed by the original Approach Centre.

The main rationale behind this scenario is the “Economy of scale” effect which should allow reducing maintenance costs by centralising system management, requirements engineering and product management.

In terms of data exchanges, the Approach Centre will first collect the runway configuration from the destination Airport and the departure information from the Satellite Airport. These will be provided to the E-AMAN Common Service provider along with other data necessary for the calculation of AMAN-related information, such as flight, trajectory, surveillance data, etc. The E-AMAN Common Service provider will then generate the arrival sequence and send it back to all the actors that need such information, including the Approach Centre, the upstream En-Route Centre, the destination and the satellite Airports.

Figure 5 below shows the Capability Configurations used to represent these users of this scenario in the system layer, along with the relevant data exchanges between them from a static perspective.

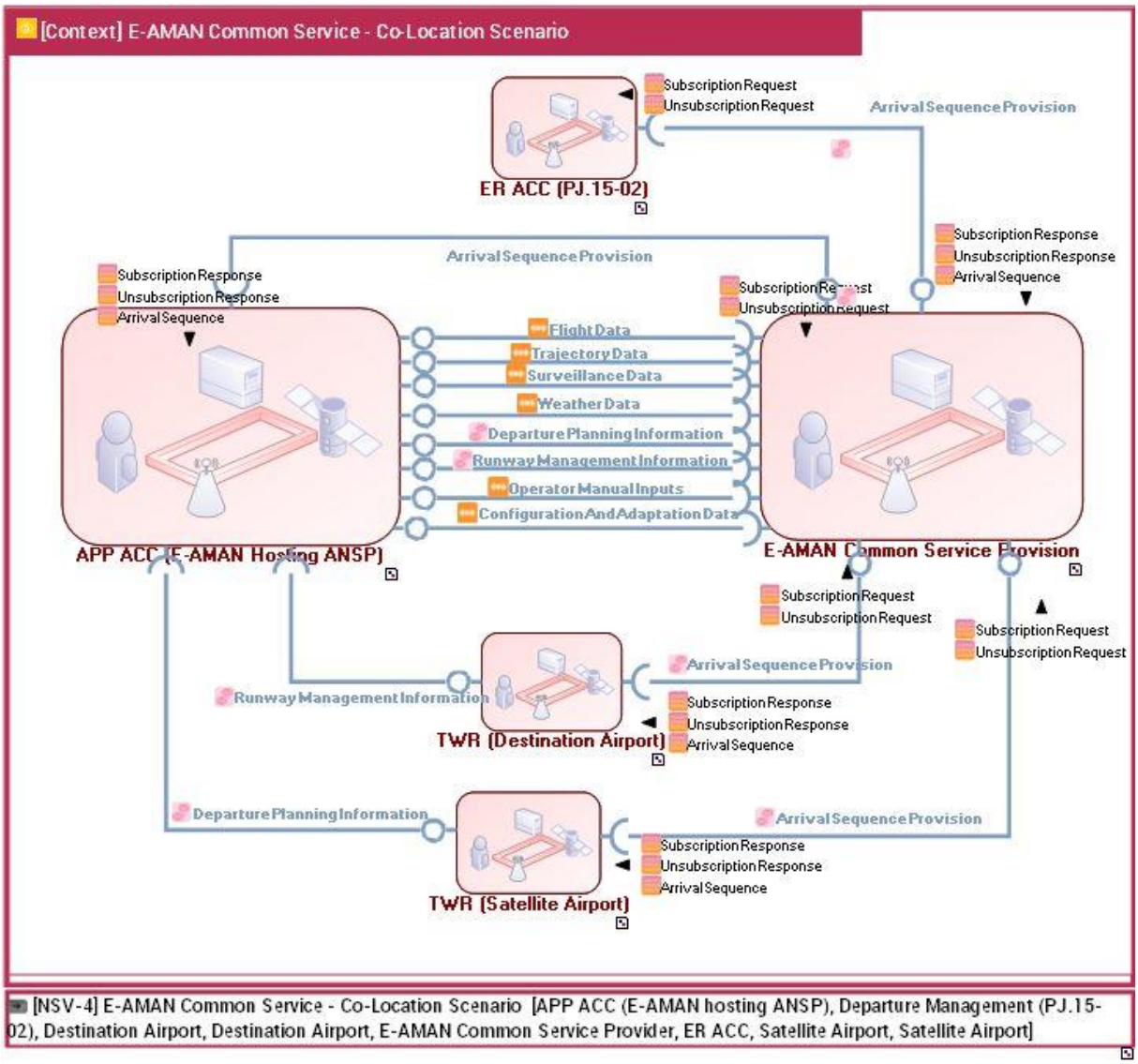

Figure 5: NSV-1 – Resource Connectivity Diagram for the Co-Location scenario

In addition, a NSV-4 is also produced to describe the dynamic aspects of an example process and can be seen in the Figure 6 below.

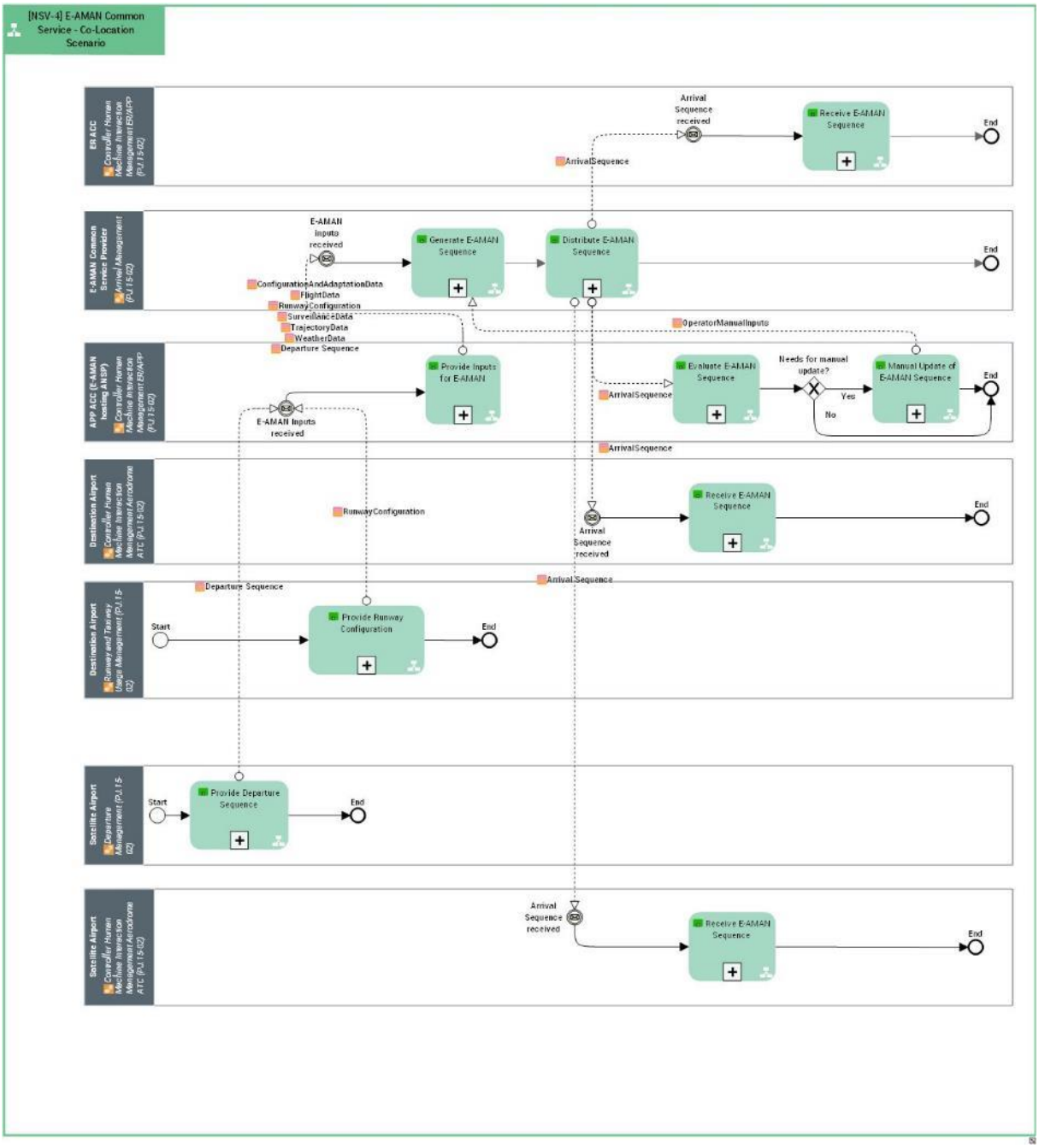

Figure 6: NSV-4 – System Process Diagram for the Co-Location scenario

3.4.3 Federation of E-AMAN

This scenario follows the Common Service Pattern of 'Federation' and applies mainly to ANSPs that have AMAN/E-AMAN systems in place.

In this scenario, the Common Service provider receives arrival sequences from distinct ANSPs' current AMAN/E-AMAN systems and provides a Common Service that transforms these sequences into a harmonised data format, ready to be consumed by other ANSPs. From the consumer perspective (e.g. an En-Route ATSU), the main benefit is that it is not necessary to implement different interfaces to receive the AMAN information (e.g. from several Approach ATSU) that might come in different formats. By doing this, the Common Service allows current consumer systems to be transitioned to new standardised interfaces in a controlled way at minimal cost.

The Approach Centre will generate its own arrival sequence based on own data and inputs received from the Airports. This arrival sequence uses an own data format and will be sent to the E-AMAN Common Service provider. The E-AMAN Common Service provider will then convert the sequences into a harmonised format for their distribution to all the end users of AMAN-related information, including the upstream En-Route Centre, the destination and the satellite Airports.

Figure 7 below depicts the Capability Configurations used to represent these users in the system layer, along with the relevant data exchanges between them from a static perspective.

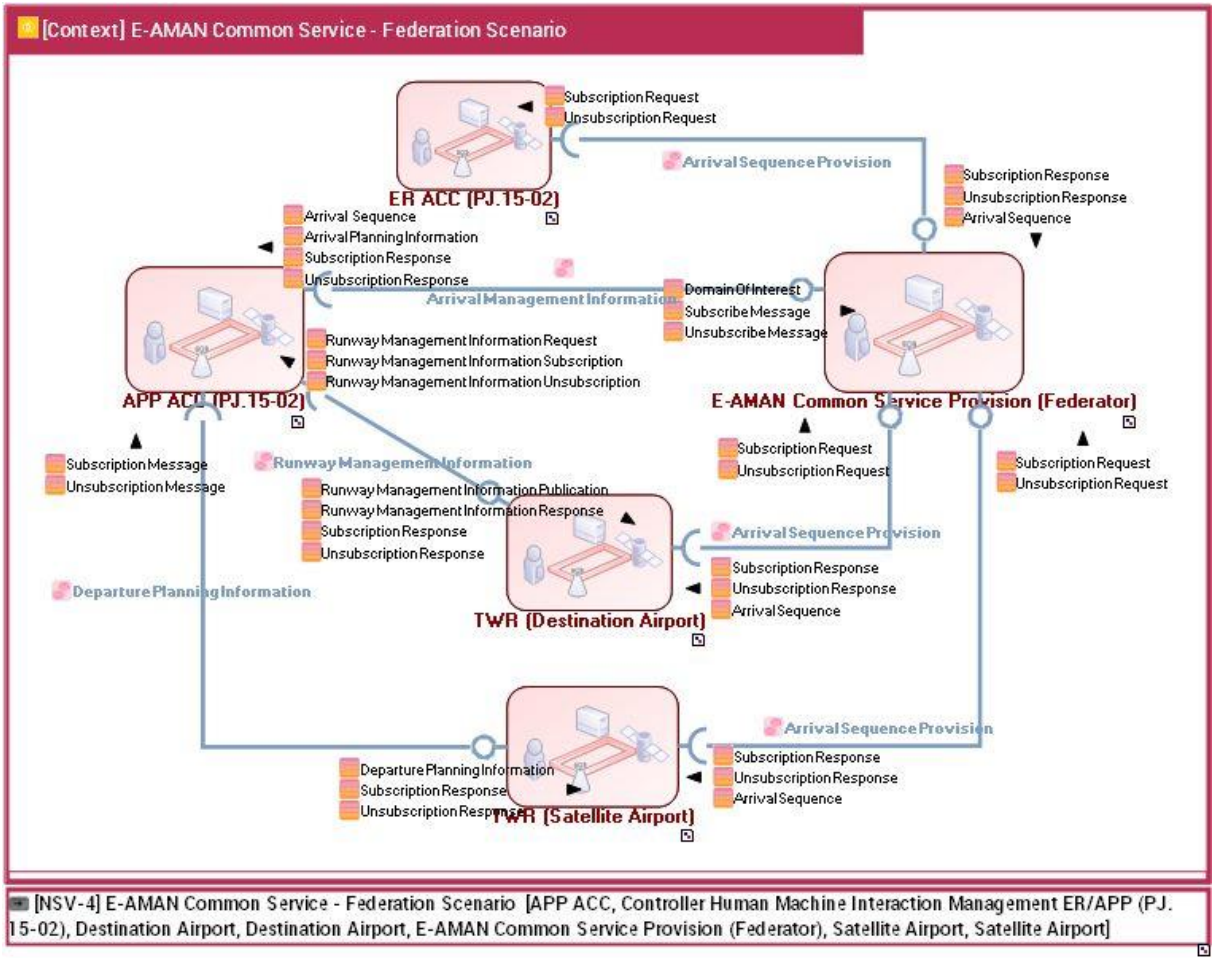

Figure 7: NSV-1 – Resource Connectivity Diagram for the Federation scenario

The dynamic perspective is provided by the NSV-4 in the Figure 8.

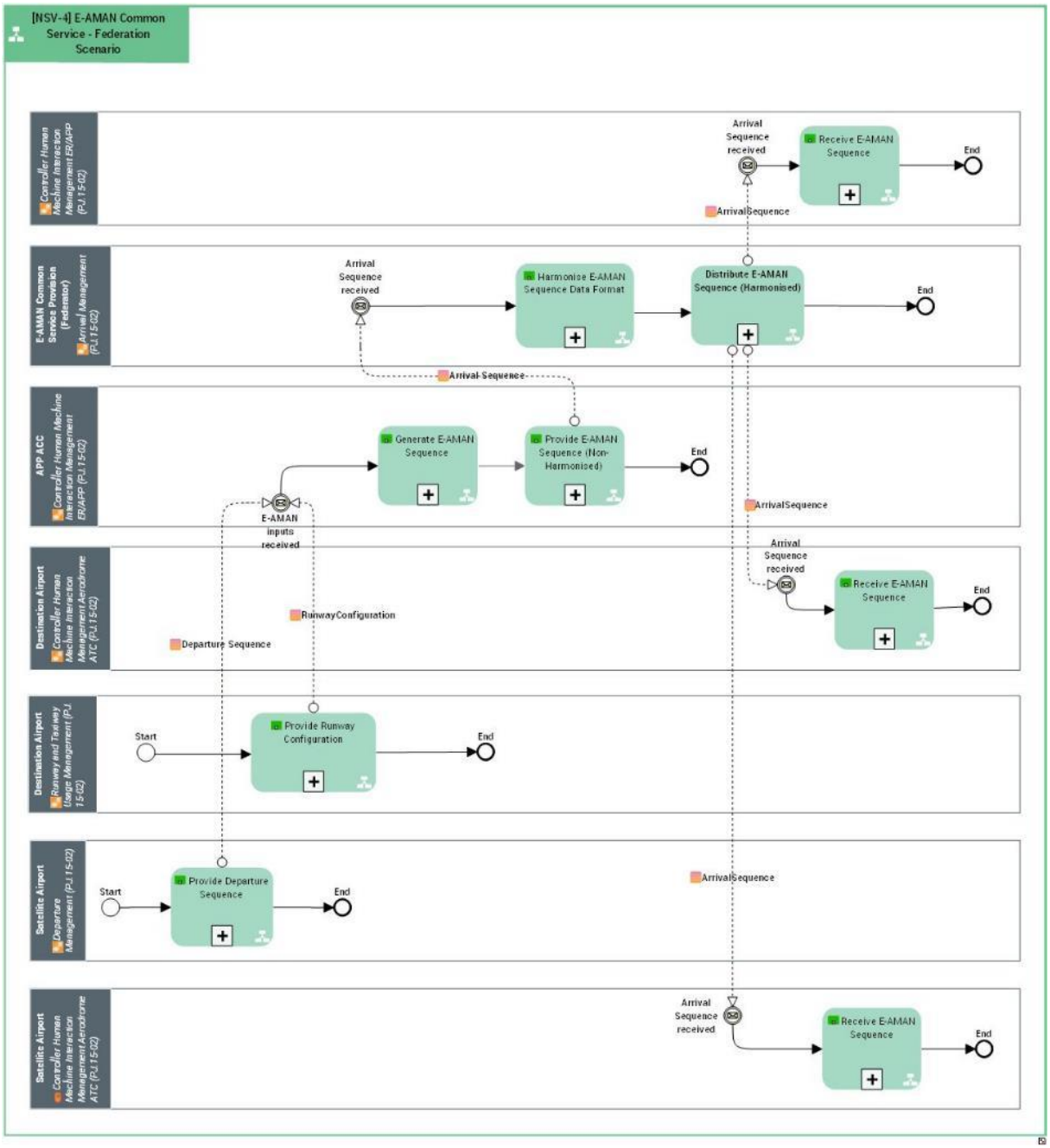

Figure 8: NSV-4 – System Process Diagram for the Federation scenario

3.5 Standardisation and Regulatory Needs

The solution uses existing standards for the implementation of the prototypes being validated in the technical validation exercises:

1. EUROCAE ED-254: Arrival Sequence Service Performance Standard
2. XML over Transport Secured AMQP

There is no need to update these standards nor to define additional standards. Also no need for a regulation is foreseen.

4 References and Applicable documents

[1] SESAR1 B.04.05 D15 Common Service Foundation Methodology, Edition 00.02.01

[2] SESAR2020 PJ.15-02 Business Model of the E-AMAN Common Service TRL6/V3, Edition 00.01.01

[3] MEGA Web Access:
https://www.srvs.nm.eurocontrol.int/mega_prod/hopex/megaauthentication.aspx

[4] eATM Portal Working Version:

https://www.eatmportal.eu/working/signin

[5] ICAO Doc 9854, Global Air Traffic Management Operational Concept, First Edition – 2005

[6] SESAR2020 PJ.15-02 ArrivalSequenceProvision Service Description Document TRL6 v00.01.01

Appendix A Requirement “Harmonisation of different Data Formats“

The Solution PJ.15-02 validated two different deployment options for an E-AMAN Common Service: the Co-location scenario and the Federation scenario. In both deployment options, the existing functionality of the Arrival Management Functional Block was used without modifications. For the Federation scenario described in section 3.4.3, the contextual function ‘Harmonise E-AMAN Sequence Data Format’ was modelled in the NSV-4 diagram (see Figure 8 on page 13) in order to provide more clarity for the reader.

The following requirement describes the function “Harmonise E-AMAN Sequence Data Format” in more detail.

[REQ]

Identifier	REQ-15-02-HLA-FED.0001
Title	Harmonisation of different Data Formats
Requirement	In a Federation scenario, the E-AMAN Common Service shall harmonise different formats of arrival sequences as provided by AMAN systems into a harmonised format as described in EUROCAE ED-254.
Status	<validated>
Rationale	The Federator enables the provision of Arrival Sequence Information of multiple E-AMAN system that might use different data formats for the arrival sequences. To foster interoperability and harmonisation resulting in cost savings, the Federator harmonises the different formats into a harmonised format as described in EUROCAE ED-254.
Category	<Functional>