Report on DLS Architecture and Deployment Strategy

FPA No MOVE/E2-2014-717/SESAR FPA

MOVE/E3/SUB/2018 - 412/SI2.810921/2019 - 362/SI2.810925

Deliverable 11.1.1

19th February 2020

History of the document

ID	Name	Date	Edition	Note
1	Report on DLS Architecture and Deployment Strategy (Internal draft)	13th December 2019	V0.1	SDM-DLS team final Draft
2	Report on DLS Architecture and Deployment Strategy (Draft for consultation)	19th December 2019	V0.2	Draft for SCP and CA Consultation
3	Report on DLS Architecture and Deployment Strategy (Issue after SCP and CA comments)	14th February 2020	V 1.0	Issued after SCP and CA comments
4	Report on DLS Architecture and Deployment Strategy (Issue after SGM)	19th February 2020	V1.1	Executive Summary updated and minor editorial changes

Control

Approved by	**Nicolas Warinsko** General Manager	Date 19/02/2019	Signature Signed
Reviewed by	**Mariagrazia La Piscopia** Chief Strategy and Programme	Date 19/02/2019	Signature Signed
Prepared by	**Davide Corinaldesi** DLS Implementation Project Manager **Cristian Pradera** Manager Deployment Programme and Planning	Date 19/02/2019	Signature Signed

Table of content

1. Executive Summary

Since the EC mandate received in 2016, **the SDM, acting as Datalink Service (DLS) Implementation Programme Manager,** elaborated a DLS Recovery Plan, defining concrete actions for all the involved stakeholders to achieve a full and synchronised Datalink Service Implementation in Europe.

The DLS Recovery Plan is structured in **two Frameworks:**

- implementation of the DLS Transitional solution (Path I Framework[1]) for the short term (focusing on the IR (EU) No 310/2015 needs). These activities have been successfully performed, leading to the achievement of important results.
- identification of the European Target solution (Path II Framework 2) for the medium - long term, focusing on the IR(EU) No 716/2014 AF6 needs. These activities have been performed thanks to the contributions and the outcomes of the following projects and study:
    - Path II Project [3] (CEF Transport Call 2016);
    - IP1 Project [4](CEF Transport Call 2017);
    - Capacity Assessment study (performed by the University of Salzburg).

Regarding the Path II Project, most of the activities have been completed in 2017 (e.g. Service Areas definition, identification of two DLS Architecture Proposals and a preliminary Business Case) while, the DLS governance definition and the "Transitional activities towards the target solution implementation" are still ongoing and they are expected to be completed by 2020. During the work performed in 2017, some technical and non – technical open points [5]arose. These open points have been addressed in 2019 thanks to the IP1 project finalisation and the Capacity Assessment study.

Hence, the so-called **IP1 project** has deeply analysed the two DLS Architecture Proposals from a technical and financial perspective, solving the mentioned open points, and at the same time has designed the Common European ATN Ground Network, representing the first relevant step towards the European Target solution full implementation.

Moreover, to support the open points resolution, a **DLS Capacity Assessment** (CAs) was considered necessary to evaluate the performances of both the Architecture Proposals and consequent identification of the best solution and strategy for the future. The University of Salzburg, responsible of this study, has provided a

1 Path I Framework: It includes the Model B (multiple VDL M2 Multi frequency RF networks operating on the same area) or Model C (single VDL M2 Multi frequency RF network implementing the Dual Language function operating in one area) and the Best in class avionics (BIC) which are the ones working well in a multi frequency environment.

2 Path II Framework: Activities needed to define all the aspects needed for the implementation of the DLS European target Architecture.

3 Path II Project - DLS Implementation Project (2016_159_AF6): it is a multistakeholders' project participated by: 21 ANSPs (ENAV, Austrocontrol, BULATSA, Croatia Control, DCA, DFS, DSNA, EANS, ENAIRE, Finavia, HungaroControl, LFV, LGS, LPS SR, MATS, MUAC, NATS, NAV Portugal, Oro Navigacija, PANSA, ESSP), 2 Service Providers (Collins, SITA), 3 Airspace Users (Lufthansa, Ryanair, TAP Portugal)

4 The so-called IP1 project: 2017_089_AF6 – "DLS European Target Solution assessment". 4 The IP1 stakeholders are: Airtel, ALTYS Technologies, Collins, Austrocontrol, BULATSA, Croatia Control, DFS, DSNA, ENAIRE, ENAV, ESSP, EUROCONTROL/ NM, Hungaro Control, Inmarsat, Leonardo – Finmeccanica, LFV, NATS, NAV Portugal, PANSA, SITA INC BV Canada, SITA INC BV Netherlands, SITA IT Services France, SITA OnAir SARL Switzerland, Thales, University of Salzburg

5 For more details Ref to Section 3.1.

detailed and complete picture on the VDL M2 lifespan, confirming the necessity of enlarging the overall Data Link capacity since the demand is constantly increasing in the future.

It is recognised that VDL M2 technology will have a limited lifetime, therefore, complementary technologies need to be identified and introduced as soon as possible in order to provide planning certainty to Airspace Users.

The SDM has continued cooperating with the **relevant stakeholders and EU Bodies**, including the Network Manager (NM), the European Aviation Safety Agency (EASA) and Eurocae, in order to facilitate the activities expected to be performed by each of them according to their related EC mandates.

On the basis of the projects' results and study mentioned above, the following **main recommendations** have been identified and **agreed with the operational Stakeholders** in the consultation process, through the thematic subgroup meeting and Steering Group meeting:

1. *To continue with a SDM strong Programme Management for the DLS implementation in Europe;*
2. *To deploy the Architecture Proposal 2 including the Common European ATN Backbone (CEAB) and, at the same time, introducing complementary communication technologies;*
3. *To follow the "DLS Deployment Strategy" roadmap:*
    - *Establish the DLS Governance not later than 2021;*
    - *Establish the Datalink Service Provider (DSP) by the early 2023;*
    - *Implement the Common European ATB Backbone (CEAB) before 2025;*
4. *To reinforce the performance monitoring by getting DLS data from all the mandated European ACCs to get the full situation by end 2020;*
5. *To establish an integrated air/ground platform to test/validate avionic upgrades and organise test/verification flights with stakeholders to validate new software versions (for both avionic and ground systems) in a real environment;*
6. *To confirm the operational use of the FMTP/OLDI messages between all the EUR ACCs to ensure an efficient transfer of the DLS flights.*

In order to implement the SDM DLS Strategy, it was recognised during the consultation process with stakeholders the need to start immediately the elaboration of a detailed programme. This will be done in close collaboration with NM and the relevant stakeholders.

In parallel, it is also needed to sustain the current VDL M2 DL system considering at least:

- *Adding more VDLM2 frequencies;*
- *Boosting the multifrequency (MF) avionics upgrade;*
- *Continuing to promote the upgrade of the bad performing VDLM2 avionics.*

EC support is needed to facilitate the implementation of the SDM DLS Strategy in due time.

For further details please see **Section 5 "Final Recommendations."**

2. Introduction

The main purpose of this document is to provide the final recommendations for the DLS implementation strategy in Europe (including AOC service), stemming from the outcomes of the activities performed so far.

The SDM has successfully concluded almost all the activities related to the ELSA recommendation[6] until today and will continue working and supporting the Bodies and Entities involved, managing the finalization of the activities still ongoing.

Therefore, the document is organised into content-oriented sections reflecting the key findings and processes reporting on the work performed so far by SDM to facilitate, coordinate and de-risk DLS implementation, enabling AF6 full deployment.

For a clarity purpose, here it is provided the organizational structure of the document:

- **Activities towards the target solution:** containing the main outcomes of the activities performed by SDM supported by Path II project, IP1 Project and the Capacity Assessment study (Ref. to Section 3);
- **Complementary activities:** this section outlines the main results stemming from the collaboration of the most relevant stakeholders and the EU Bodies and Organisations (EASA, NM, EUROCAE, ETSI, etc.)- (Ref. to Section 4);
- **The Final recommendations:** based on the main conclusions of the work done, this section recaps the main recommendations to be followed.

In addition, the Annex I - “ELSA recommendations current status” provides an overview of the ELSA recommendations, highlighting the current status of implementation.

Furthermore, the main results of the SDM monitoring exercise, regarding the airborne and ground domains, as well as the positive results obtained through the decrease of the number of provider aborts are outlined in the “Annex II” together with the activities performed in the past regarding the Path II Framework.

6 VDL Mode 2 Measurement, Analysis and Simulation Campaign, SJU project funded by EC in 2015

3. Activities towards the architecture definition

According to DLS Recovery Plan, the Path II Framework aims at identifying the steps towards the target solution, through the implementation of ELSA recommendations in order to grant the required performance needed to achieve full initial Trajectory Information Sharing (i4D) – ATM Functionality number 6 (AF6) in the Pilot Common Project (PCP) implementation (IR No 716/2014).

In this context, the SDM supporting the following activities:

- **Path II Project** (2016 CEF Transport Calls);
- **IP1 Project** (2017 CEF Transport Calls);
- **Capacity Assessment study** (CAs)**.**

The related activities are described in the following sections of the document.

3.1 Path II Framework (2016 CEF Transport Calls)

The "Path II Project" started with the 2016 CEF Transport Calls, with the specific objective to support the SDM in the activities needed for the DLS target solution implementation within the deadlines set by EU regulations and PCP, through the following five activities:

1. **Service Area Definition**: whose main aim was to design the European DLS Service Area. This activity was fully concluded by the end of 2017 and it represented a first step towards the target solution;
2. **European technical architecture definition**: it represented a high-level definition of the new European target architecture models based on the identified Service Areas. This activity is fully concluded in 2017 since two different Architecture Proposals have been defined. In performing this task several technical open points[7] have been identified requiring an additional work to fix them;
3. **Elaboration of a Business case for the target solution**: Business case production to evaluate the financial impact in implementing the European DLS target solution. This activity is concluded in 2017. In performing this task several non-technical open points have been identified requiring an additional work to fix them;
4. **Transitional Activities towards target solution**: identification of the future steps and activities that are required to ensure the transition from the current implementation to the target solution. In addition, the focus was also in guaranteeing a smooth transition from the current DL architecture to the new one. These activities are still ongoing, and they will be completed in 2020 (for details Ref. to Section 3.1.1);
5. **Ensuring consistency of activities related to the DLS Governance definition**: it aims at monitoring the effective European DLS Governance definition by the Path II project stakeholders. These identified activities will continue also in 2020 (for details Ref. to Section 3.1.2).

7 Ref. to note number 6

Hence, the full completion of the first three activities has been achieved by the end of 2017, identifying open points [8] to be further discussed and analysed, while the remaining activities (Transitional path and Governance) had been carried out during this year, but they are still ongoing and expected to be completed in 2020.

For a comprehensive purpose, the main output of the past activities can be found in the annex of this document but, for further details, refer to the deliverable documents (Ref. to Section 6).

3.1.1 "Transitional activities towards target solution" Path II Project (WP4)

The **Path II Project (WP4) – "Transitional Activities Towards Target Solution"** [9] analyses two tentative and different roadmaps depending on which Architecture will be implemented: Architecture Proposal 1 or Architecture Proposal 2.

In 2018, the WP4 work focused on the identification of the key transitional elements, risks and constraints, analysing several scenarios, regarding the two Architecture Proposals previously identified. Moreover, within the assessment of the transitional activities some points were identified and provided to the IP1 stakeholders for further and detailed analysis.

During 2019, the WP4 has focused its work on the consolidation and refinement of the most feasible Transitional Scenarios. In this framework, the following elements were considered: DLS Governance, Datalink Service Provider (DSP), Common European ATN backbone network (CEAB) and Radio Frequency (RF) Infrastructure.

The DLS Governance will select the DSP through a call for tender. The DSP will implement and manage the CEAB.

The "Transitional Plan" has been structured in the execution of three "Projects"[10]:

---

8 Regarding the open points, here some examples are briefly mentioned:

- **VME identification:** there are not enough technical details on how the VHF Management Entity (VME) should be designed and implemented (in terms of load balancing and geographical principles of VME functionalities), even if some cases of VME implementation are in place in other specific and different contexts and they could be considered as reference for the development of the required VME to cover both ATS and AOC service requirements;
- **IoP aspects like, for example, ATN routing ambiguity:** this is being addressed in Path I project, from which it appears that an agreement among ATN routers vendors (there are only 2 in the world) is expected to guarantee the global interoperability;
- **Lack of standardization** in the interfaces between VGS and ATN A/G Routers: the solution of this aspect could be helpful in order to facilitate the integration of the legacy systems in the new target architecture;
- **Support system layer** not fully addressed in the architecture proposals because of a lack of common understanding of the requirements defined in the IR (EU) 29/2009;
- **Frequency planning scheme not fully characterised**: considering that this topic has relevant impacts on the Data link system design, it was identified the need to work on it;
- **Business aspects:** it is necessary to study in depth the impact of the target architecture implementation in the current DLS business model

9 The WP4's leader is ENAIRE. The WP contributors are: ENAV, SITA, NAV PT, AUSTROCONTROL, PANSA, EANS, TAP PORTUGAL, ESSP

- "Project 1 – Build DLS governance structures and Datalink Service Provider": it explains how to setup a DLS governance structure and how to select a Datalink Service Provider (DSP) for ATS data communication;
- "Project 2 - Build the Common European ATN backbone (CEAB)": it shows a way to deploy the proposed Common European ATN backbone (CEAB) and being ready for operation;
- "Project 3 - Changes on RF Network": it describes how to introduce the necessary changes to improve the current radio frequency (RF) network.

The transitional plan envisages that the DLS Governance, the Datalink Service provider (DSP) and the Common European ATN backbone network (CEAB) are common for both Architecture Proposals (as already defined in the high-level architecture proposals stemming from Path II Framework).

At the beginning and during the transitional period, some major decisions are expected to give clear guidance in which way to proceed (Ref. to Section 5).

For clarity purpose, the Implementation Proposal Programme is inserted below:

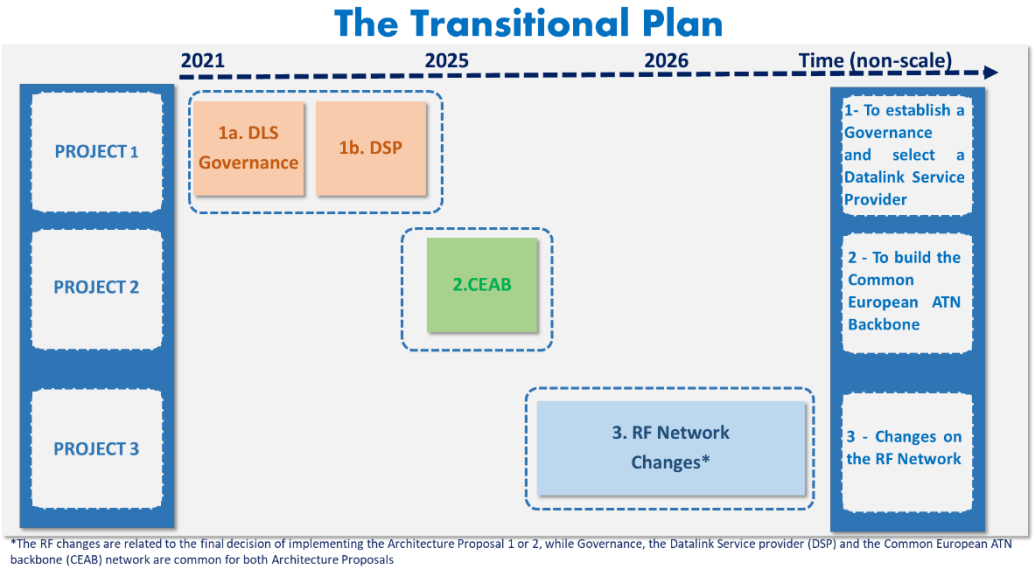


Figure 1 – Implementation Proposal Timeline

Stemming from the abovementioned WP 4 outcomes, the SDM has formulated a specific recommendation (Ref. to Section 5).

3.1.2 "Definition of a European Common DLS Governance" Path II Project (WP5)

Under the Path II Project WP5 "Definition of a European Common DLS Governance", the governance main roles and responsibilities have been defined, as well as the processes necessary to reach a common DLS deployment in support of the PCP[11] and in the procurement and setup of a European Datalink Service Provider. The establishment of a European Common DLS Governance has been considered by the SDM as fundamental in order to coordinate the activities of a full synchronized deployment of DLS in Europe preventing the future fragmentation. In fact, the need of a common governance was already identified in the DLS Recovery Plan.

During 2018, the WP5's stakeholders had defined a high-level structure of the initial organization breakdown, taking the existing models[12] as main inputs. The European Common DLS governance is proposed to be organised into two distinct levels.

During the 2019, thanks to the inputs provided by the IP1 work and considering the identified need to establish the Common European ATN Backbone (CEAB), the Governance's structure could be refined. The main output of this [13] contains a list of recommendations to be considered for the final DLS governance definition and establishment.

The figure below (Figure 2) shows the Governance organisational structure that has to be considered in order to guide the European Common DLS establishment. The structure comprehends the **Governance** and the **Governed** side.

11 IR (EU) No 716/2014

12 E.g New PENS and proposed SWIM governance

13 Path II Project / WP5: definition of a European Common DLS Governance. D.6.1.2- DLS governance structure report [second release]. The WP Leader is DFS and the edition date is 30.11.2018.

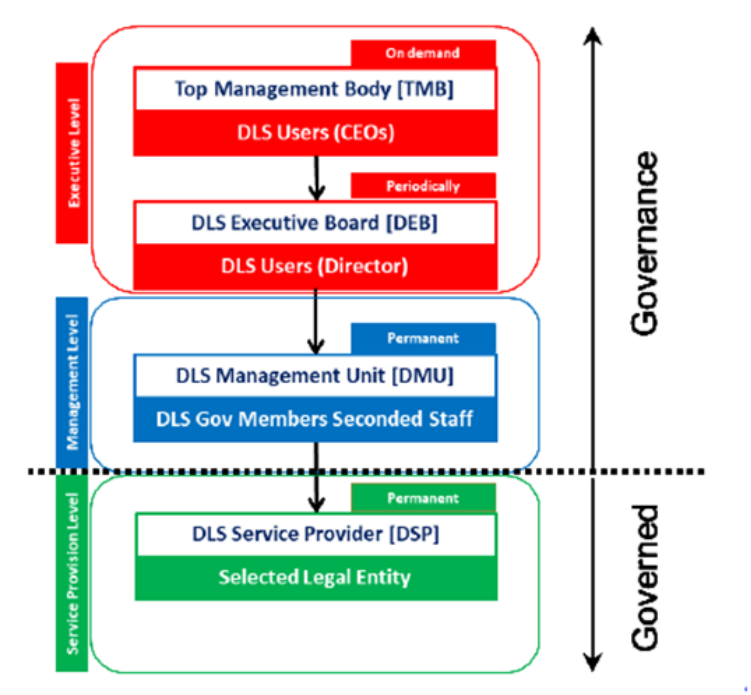


Figure 2 – Preliminary Governance organizational structure

The **Governance** shall be organised in two distinct levels:

- **Executive Level:** envisages the presence of the Top Management Body (TMB) and the DLS Governance Executive Board (DEB);
- **Management level:** oversees the DLS Service provider (DSP).

The Governance **executive and management bodies** are responsible of the DLS strategy management, the DLS Governance management, the DSP contract compliance monitoring as well as the DLS liaisons with DLS users, AUs and Regulators functions.

Regarding these Bodies, the related tasks and roles are briefly described below:

- **Executive Level - Top Management Body (TMB):** it is the final decision-making body regarding the political and strategic issues with deliberative powers;
- **Executive Level - DLS Governance Executive Board (DEB):** it is the strategic and formal decision-making Body; it is responsible of safeguarding the DLS Users interests**;**
- **Management level - DLS Management Unit (DMU):** it is composed by DLS user's seconded staff. It oversees the DSP daily management providing support to the DLS Governance.

Regarding the **Governed structure** which represents the Service provision level, it has been created to provide Datalink Services to all European Service Areas through the DLS Service provider.

The DSP **main functions are mainly related to the DSP technical service management and the DSP contract management.**

- **First function:** the DSP's technical service management14: oversees the management and technical issues related to the datalink service provision (i.e. Service catalogue management, Capacity Management, Service Performance Management, etc.);
- **Second function:** the DSP's contracts management 15 : supervises the delivery of appropriate processes (i.e. establishing new contracts and monitoring the existing ones, maintaining the contractual relationships set up by the DSP in order to assure the provision of the service).

It is worth noting that the Path II Project – WP5 is still ongoing and its completion date is expected by 2020 with the final Governance Release **D6.1.4**[16].

Stemming from the abovementioned points, the SDM has formulated a specific recommendation (Ref. Section 5).

3.2 IP1 Project (2017 CEF Transport Calls)

In order to solve the above-mentioned open points raised during the **Path II project** execution, an additional investigation has been requested to complete the **definition of the overall target technical architecture**. In this context, a specific **Implementation Project (IP1)**, has been submitted to the 2017 CEF Transport Calls by multiple stakeholders[17].

To address these needs, the IP1 has been structured in the following WPs:

- **WP1** - Design for a Common European ATN Ground Network**;**
- **WP2** - Further analysis and definition of the technical open points identified in Path II Project;
- **WP3** - Further analysis and definition of the non-technical open points identified in WP3 of the Path II.

The IP1 Project provides a clear view on both Architecture Proposals from a **Technical** (WP1 and WP2) and **Economic** (WP3) perspective. The **technical analysis** presents concrete functional and technical requirements, as well as the scenario definitions for the Capacity Study. The **economic analysis,** through the

14 The DSP Technical Service Management function oversees the management and technical issues related to the DSP service provision. It includes the following tasks: Service catalogue management, Capacity Management, Service Performance Management, Safety Management, Security Management, Transition management, Change Management, Asset/ Configuration Management, Release / Deployment Management, Service Validation & testing management, Knowledge management, Service Operation management, Access management, Service real time monitoring and reporting.

15 The DSP contracts' management function oversees the delivery of appropriate processes in order to establish new contracts and to monitor the old ones and to maintain the contractual relationships set up by the DSP in order to assure the provision of the service. The DSP contracts' management function is composed of the following activities: DLS users Contract management, CSP contract management, ATN backbone contract management.

16 D.6.1.4 DLS Governance structure Report – Final Release' due by 31th of December 2020

17 IP1 stakeholders are: Airtel, ALTYS Technologies, COLLINS, Austrocontrol, BULATSA, Croatia Control, DFS, DSNA, ENAIRE, ENAV, ESSP, EUROCONTROL/ NM, Hungaro Control, Inmarsat, Leonardo – Finmeccanica, LFV, NATS, NAV Portugal, PANSA, SITA INC BV Canada, SITA INC BV Netherlands, SITA IT Services France, SITA OnAir SARL Switzerland, Thales, University of Salzburg

elaboration of a Business Case, identified the main differences in costs and benefits of Architecture proposal 1 and Architecture proposal 2.

Stemming from the abovementioned points, the SDM has formulated a specific recommendation (Ref. Section 5).

3.2.1 "Design for a Common European ATN ground network" (IP1-WP1)

The IP1/WP1 aims at providing the technical design of the ATN G/G Network, the so-called **Common European ATN backbone** (CEAB), which has been identified in Path II project as the **common** part **for the two Architecture proposals**.

The WP1 is structured into seven sub-working packages completed during 2019, as outlined in the picture below:

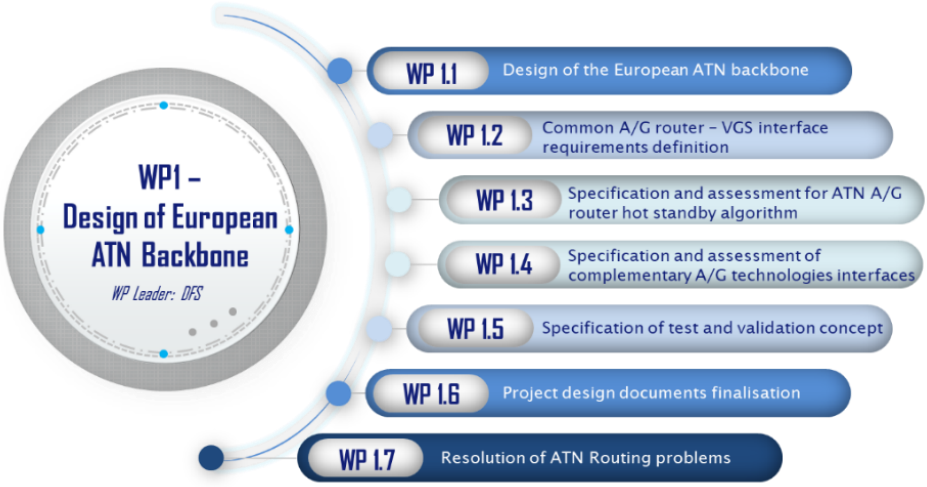


Figure 3 – WP1 Design of European ATN Backbone

As visible from the figure below (Figure 4), the CEAB will provide connectivity to:

- ATM systems (ANSPs);
- COM networks (CSPs):
  - VDL M2;
  - Complementary communication technologies (e.g. SatCOM, AeroMACS, LDACS,…);
- External routing domains like potential neighbouring Service Areas[18].

18 e.g. Africa and Russia

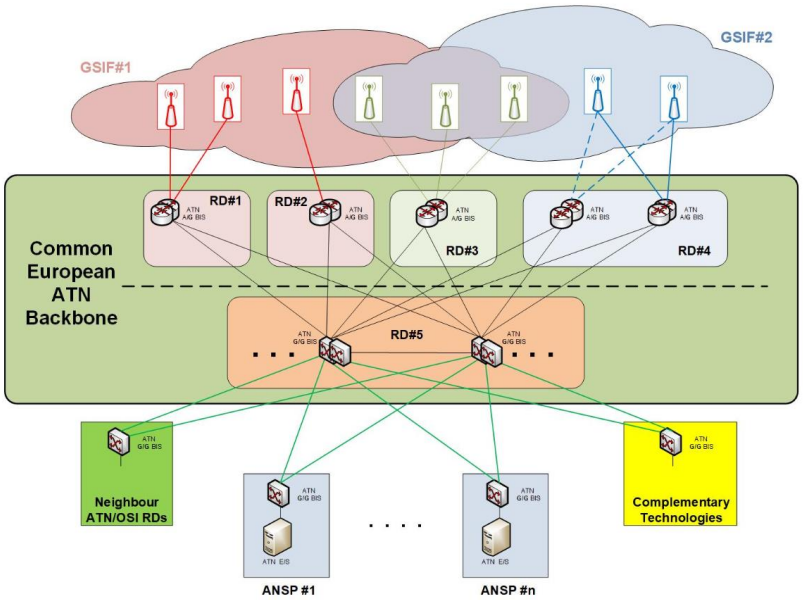


Figure 4 – WP1 Design of European ATN Backbone[19]

Stemming from the work performed, below are listed the main IP1/WP1 achievements:

IP1/WP1 Design for a Common European ATN backbone – Main achievements
• The CEAB design has been created; • The solutions for **some relevant interoperability (IoP) issues have been worked out as follows:** ○ **for the ATN routing ambiguity, the best solution has been identified, described and its implementation has been scheduled;** ○ **the most appropriate solutions for the ATN routing transitional domain issue has been identified and proposed to be implemented in the CEAB;** • The **WP1 outcomes (the design of the CEAB) have supported the Business Case, providing elements for the CEAB's cost estimation;** • **Furthermore, the WP1 outcomes (the design of the CEAB)** have supported the definition of the transitional activities towards the target solution, defining the schedule for the CEAB's implementation.

Table 1 – IP1/WP1 main achievements

Stemming from these activities, the following recommendations have been identified by the IP1-WP1 stakeholders:

- **The first recommendation** regards the introduction of the new alternative communication means. In order to use alternate technologies new avionics, have to be implemented[20]. Furthermore, the new avionics as well as the CEAB have to support a new mechanism able to switch the data connection from VDL M2 to alternative technologies (i.e Multilink capability);

19 For further details please refer to IP1- WP 1.1.

20 It should be noted, that the costs associated to alternate technologies avionics are not considered in the Business Case

- **The second recommendation** concerns the requirement for all ANSPs to be connected to the CEAB. It is assumed that all ANSPs must be connected to the CEAB in order to provide a seamless integration of the new communication technologies. If one of the ANSPs is connected to the CEAB but does not desire to contract the designed service provided then, the CEAB must provide a mechanism to prohibit the usage of the service.

Stemming from the abovementioned points, the SDM has formulated a specific recommendation (Ref. Section 5).

3.2.2 "Analysis and definition of the technical open points identified in Path II Project" (IP1 - WP2)

The IP1/WP2 "Analysis and definition of the technical open points identified in Path II Project" aims at analysing and identifying all the elements needed for solving the technical open points arisen during Path II project execution. To fulfil this purpose, WP2 has been structured in such a way to comprehend all technical elements needed to support a solid decision on the future target model.

The WP2 is structured into eight sub-WPs that have been completed during the year 2019, as outlined in the picture below:

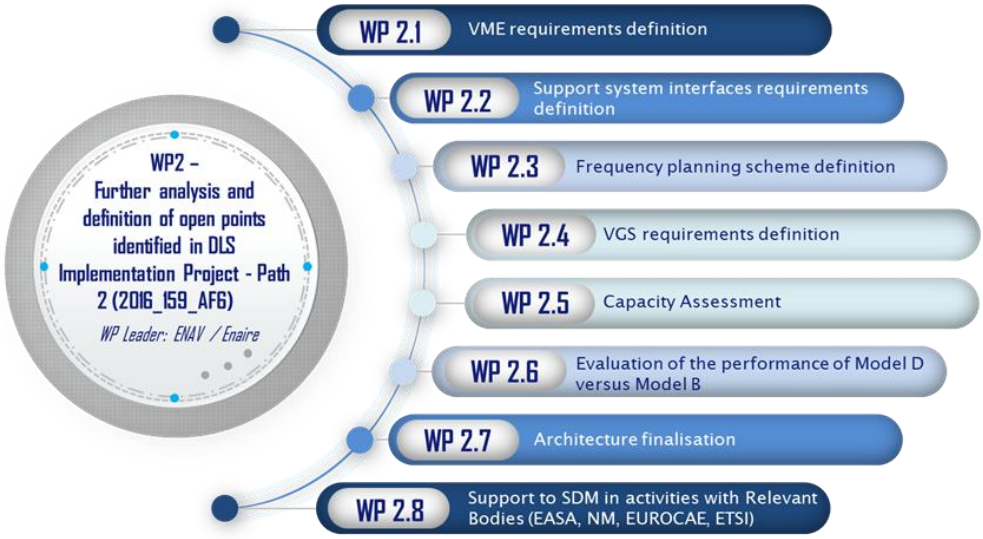


Figure 5 – (WP2) "Analysis and definition of the technical open points identified in Path II Project"

Besides, most of the activities that have been performed during the execution of IP1/WP2 have been influenced and interconnected to **the certification, standardization and testing process definition** and this is the reason why the SDM strictly collaborated with the specific EU relevant Bodies (Ref. to section 4.5)

The main IP1/WP2 achievements have been listed below:

IP1/WP2– Main achievements
• Definition of all relevant components of the two Architecture Proposals (including the VME and the VGS); • **Full design of the Architecture Proposal 1 and 2;** • **Definition of the DLS common monitoring system;** • **Definition of the input assumptions for the Capacity Assessment study;** • **Support to IP1 WP3 (the Business Case) for the definition of the Architecture Proposals' costs;** • **Support to CEF 2016 Path II WP4 (the definition of the transitional activities towards the target solution) for the creation of a timeline for the transitional project[21] ;** • Support to certification and standardisation activities.

Table 2 – IP1/WP2 main achievements

Stemming from the abovementioned points, the SDM has formulated a specific recommendation (Ref. Section 5).

3.2.3 "Analysis and definition of the non- technical open points identified in Path II Project" (IP1- WP3: Business Case)

The IP1/WP3 - "Analysis and definition of the non - technical open points identified in Path II project" aimed at defining and solve the non- technical points identified during the Path II project. In detail, the main purpose is to present a Cost Benefit Analysis (CBA) comparing architecture proposal 1 and 2.

The preconditions**,** which are part of the business case, are listed below:

- The AOC traffic will not be discriminated, and AOC services will not be impacted (e.g. no cost increase) whichever architecture proposal or model will be used in future;
- The Interoperability for today avionics, meaning no updates of avionics (software and/or hardware) is necessary;
- The Business case shall show a cost effectiveness, the cost of service will not increase due to the implementation of Architecture Proposal 1 or Architecture Proposal 2;
- The New Datalink Service Provider (DSP) will ensure the same Service Level Agreement as applied currently for the current communication service providers (CSPs).

The WP3 has been structured into two sub-WPs:

- SWP 3.1 "Consolidation of open points already identified" with the aim of solving the economic open points raised during the Path II project" provided required information' gaps to produce the business case analysis;
- SWP 3.2 "Business case finalisation" with the aim of presenting concreted costs and savings necessary to implement Architecture Proposal 1 or 2.

21 As mentioned before, the transition programme has been divided into three projects. In detail, the WP2 has supported the projects 3 "changes on RF Network".

Regarding the methodology, a modular approach has been followed, whose main points, are listed below:

- A "no-change" scenario, containing all the necessary costs to maintain the actual DLS infrastructure as it is nowadays; this scenario is the baseline against which the other two scenarios are assessed.
- **The "Common Change Blocks (CCB) and Architecture proposal 1"** scenario, representing the necessary changes to implement:
  - A common pan-European DLS Governance framework;
  - A Datalink Service Provider (DSP) providing a single ATN datalink connectivity for the ground users;
  - The Common European ATN backbone (CEAB) providing a single ATN ground network.
  - RF changes for Architecture 1, including the interfaces and functional changes, in order to migrate to the model D configuration.
- The "**Common Change Blocks (CCB) and Architecture proposal 2"** scenario, representing the necessary changes to implement:
  - A common pan- European DLS Governance framework;
  - A Pan- European Datalink Service Provider (DSP) providing a single ATN datalink connectivity;
  - The Common European ATN backbone (CEAB) providing a single ATN ground network;
  - **RF changes for Architecture 2,** maintaining the current Architecture, in which Model B and Model C networks coexist

The evolution of costs in the two changes scenarios, compared to the baseline scenario, has been calculated for the whole of the ECAC area over the period 2020-2040. Higher costs will be generated by both scenarios but, they will enhance the future communication services. It is worth considering that the tables and graphs that will follow present the costs as generally agreed by the WP3 working group. Deviations from this generally agreed costs are shown in the sensitivity analysis. A discount rate of 4% was used to calculate the Net Present Value (NPV). For the rationales behind the calculations please refer to the business case (IP1/WP3) (Ref. to Section 6)

Below the main IP1/WP3 achievements are listed:

IP1/WP3– Main achievements

- A precise net cost has been produced for all implemented scenarios (Ref. section 3.2.3 - SWP3.2 - Section 6) in addition, the cumulative costs have been calculated until 2040 for the ECAC Area;

The table below (Table 3) shows the discounted costs and costs savings for the Common Change Block (CCB) implementation (Governance, DSP and CEAB). These are common to both analysed scenarios.

Furthermore, it can be noted that re- using the existing New PENS interfaces represent a major opportunity for the CEAB implementation, enabling to maximize the cost efficiency of the investment. This opportunity is considered in the table below:

	€ million
Governance	- 13.5
DSP	- 35.4
CEAB	- 17.6
Costs Total	**- 66.5**
Governance	14.0
DSP	12.0
CEAB	11.8
Costs reductions Total	**37.8**
Net Present Value in 2040	**- 28.7**

Table 3: NPV for Common Change Blocks

The table below (Table 4) shows the **discounted costs and cost savings** for the **two architecture scenarios**:

€ million	CCB + Architecture Proposal 1	CCB + Architecture Proposal 2
Costs	-83.6	-70.2
Costs reductions	64.8	37.8
Net Present Value in 2040	**-18.8**	**-32.4**

Table 4: NPV for the two analysed scenarios (CCB+ Architecture Proposal 1 and CCB+ Architecture Proposal 2)

The figure below (

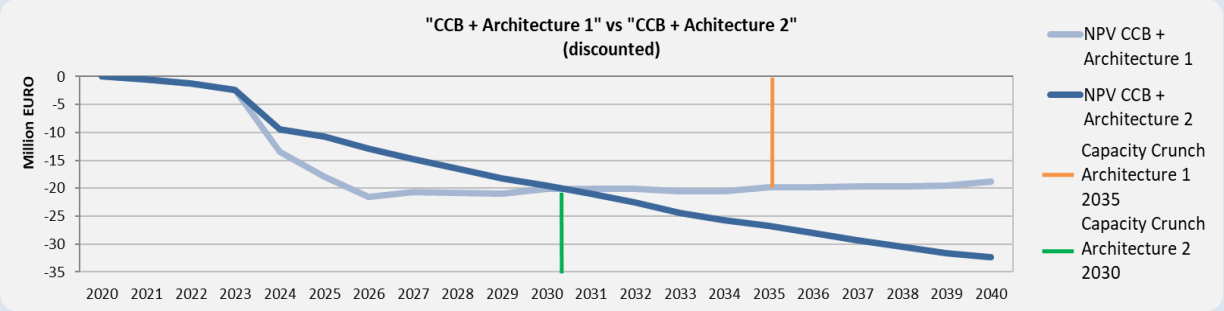


Figure 6) shows the **NPV evolution until 2040 of both analysed scenarios**:

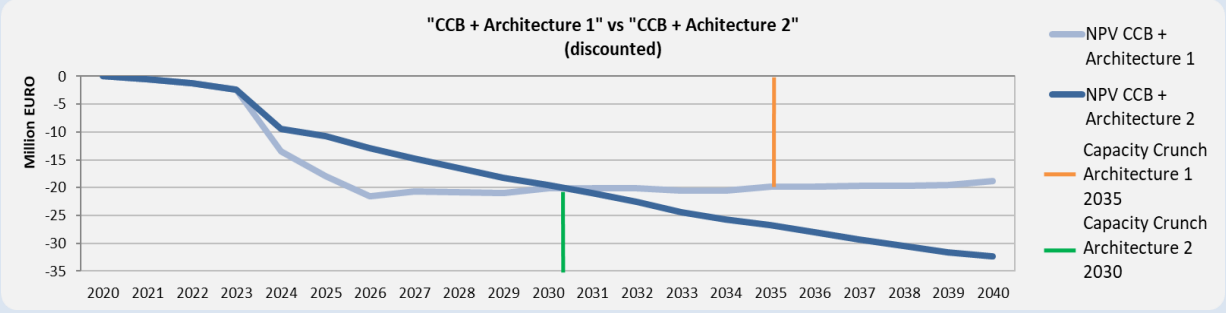


Figure 6 – NPV of Architecture Proposal 1 or 2

- Strategic benefits deriving from the Common Change Blocks (CCB) implementation, have been highlighted;

- The Architecture **Proposal 1 implementation shows a stronger cost advantage compared to Architecture Proposal 2 from 2030 onwards;**
- The presented outcomes are **sensitive to some key parameters considered** within the analysis, **which must be managed in further phases of the work** [22] ;
- Reflects an opinion from SITA and RC that the costs of the migration towards Architecture Proposal 1, especially in the RF network domain, may be significantly **under-estimated until further design work is undertaken;**
- **The key risks have been identified and initially assessed:** the **highest risks** are related to **Architecture Proposal 1 implementation**, specifically in the **RF network domain,** while the changes required for the governance, the DSP and the CEAB, present less risk (for additional details regarding the key risks please refer to D3.2 – Ref. Section 6)**;**
- **The key opportunities to maximize the cost efficiency have been identified.**

A sensitivity analysis has been performed, based upon different opinions provided by the expert stakeholders involved (especially coming from SITA and Collins, as mentioned before) this included variations in key parameters such as unit cost and possible cost reductions associated with the implementation of Architecture Proposal 1, focused on the RF network domains. The graph shows the impacts of those changes on both analysed Architecture Proposals.
For clarity purpose, the following table represents main analysed scenarios in the sensitivity analysis:

ID	Analysed Scenarios	Description
1	**The Base Case scenario**	Scenario applied in the business case (CCB+ Architecture Proposal 1 and CCB+ Architecture Proposal 2)
2	**The 30% Cost Increase**	An **30 % cost increase** due to possible cost increase of the transition activities (e.g. setting up of DSP and establishment of the associated systems) that could be delayed, or the transition period could be extended, with associated negative cost impacts on the implementation of the RF architectures
3	**The 50 % less VGS station reduction**	**Reductions in numbers of VGS's and radios under Architecture Proposal 1 compared to the Base Case cannot be achieved in full.** Since the infrastructure reductions constitute the source of the cost savings attributed to Architecture 1 in the base case, a sensitivity that assumes only 50% of those savings can be realized is considered here

Table 5 – Sensitivity analysis/Described scenario

22 e.g. The achievement of the projected reductions in VDL infrastructure

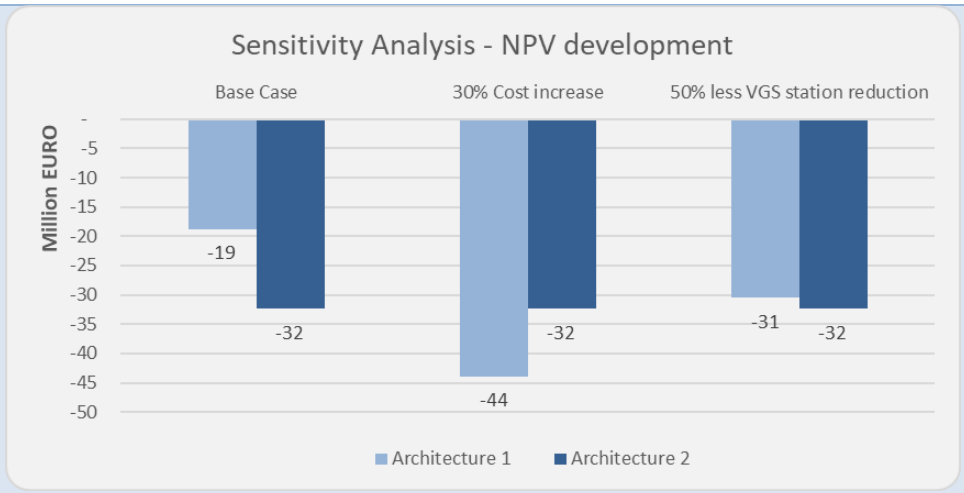


Figure 7 – NPV sensitivity for the analysed scenarios

Table 6 – IP1/WP3 main achievements

From the work performed the main IP1/WP3 stakeholders' recommendations have been listed below:

- Strategic benefits, stemming from the Common Change Block's implementation, have been considered and highlighted;
- The opportunities analysed such as reusing of the existing NewPens connections are included;
- The final decision will determine which architecture should be targeted; furthermore a "go or no-go" decision is expected by February 2021.

Stemming from the work performed, even if each scenario will bring higher costs compared to the reference (scenario 0 or "no change scenario"), strategic investments should be considered as urgently needed. In fact, today's VDL M2 data transmission is nearly outdated and substitutional means are urgently needed to enable future operational benefits stemming from DLS and AF6 implementation: these are mainly related to the Air Traffic Controllers (ATCOs) productivity improvements, support to other Air Traffic Management (ATM) functionalities and 4D trajectory savings (e.g. higher ATM predictability, reduced mileage resulting in reduced flight-time, fuel and CO_2 emissions).

The conclusion of the WP3 has represented a key step for the decision-making process regarding the evolution of the DLS deployment. Stemming from the abovementioned points, the SDM has formulated a specific recommendation (Ref. to Section 5).

3.3 Capacity Assessment study (CAs)

With the aim of comparing the performances of the two proposed Architectures and assessing the VDL M2 lifespan, a call for tender for a Capacity Assessment study was launched on July 2018 and awarded to the University of Salzburg (USBG).

As mentioned before, the main objective of this study was the identification of the time horizon by which VDL M2 will reach its operational limits as defined in ED120/ED228A in Europe, considering the need to support the implementation of new Datalink services and the increasing demand of data exchanges. The study has to be considered as an update of the VDL M2 Capacity and Performance Analysis performed by SJU in 2015.

In order to provide assumptions and requirements to be used as inputs for the simulations performed by USBG, the SDM has facilitated and promoted a work in close co-operation with IP1/SWP2.5: "Assumptions for scenarios for capacity analysis" where EUROCONTROL/NM (Leader), ANSPs, CSPs and manufacturing industries contributed.

The two **Architecture Proposals** have been analysed with regard to:

- The number of referenced years: start from 2018 until 2040;
- The "BASE/HIGH" air traffic growth: the "BASE" corresponding to a realistic scenario and "HIGH" to an optimistic air traffic increase over the years;
- The investigated areas: ECAC, Europe-CORE, Madrid, Europe-NW/NE/SE/SW;
- The number of VDL M2 channels: Common Signalling Channel (CSC) + up to 8 additional channels in the following configurations:
    - **Channel Use Base (CuB)** corresponding to the current implementation (data available until 2021);
    - **Channel Use 4 (C4A)** corresponding to the Common Signalling Channel (CSC) + 4 additional channels;
    - **Channel Use 6 (C6A)** corresponding to the Common Signalling Channel (CSC) + 6 additional channels (considered from 2021);
    - **Channel Use 8 (C8A)** corresponding to the Common Signalling Channel (CSC) + 8 additional channels (considered from 2024).

In detail, 8 scenarios have been defined depending from the use of channels:

The CAs scenarios for Architecture 1[23] depend on the use of En-route (ENR) and Ground (TMA) channels:

- Scenario E1 with channels used separately for En-route (ENR) and TMA data traffic;
- Scenario E2 with channels shared for En-route (ENR) and TMA data traffic;
- Scenario E3 with channels used separately for En-route (ENR) and TMA and without any AOC data traffic;
- Scenario E4 with channels shared for En-route (ENR) and TMA and without any AOC data traffic.

23 In the Architecture Proposal 1 all Communication Service Providers share all available VDL Mode 2 channels via common VDL Mode 2 Ground Stations (single RF network over Europe implementing the Dual Language function)

The CAs scenarios for Architecture 2 [24] are depending on the use of En-route (ENR) and Ground (TMA) channels:

- Scenario E5 with channels used separately for En-route (ENR) and TMA data traffic;
- Scenario E6 with channels shared for En-route (ENR) and TMA data traffic;
- Scenario E7 with channels used separately for En-route (ENR) and TMA and without any AOC data traffic;
- Scenario E8 with channels shared for En-route (ENR) and TMA and without any AOC data traffic.

For each year investigated, a baseline scenario was defined, considering reasonable assumptions about VDL M2 Multifrequency (MF), a MF- capable aircraft equipage rate, ATN/B1, ATS/B2 and AOC-Small, AOC-Medium and AOC-Large subscriptions, subscription share between Communication Service Providers (CSPs), ADS-C/EPP data profiles and many other assumptions (Ref. to Section 6).

These scenarios are the basis for the VDL M2 Capacity Assessment study (CAs) with the Architecture Proposals comparison and the analysis of the expected VDL M2 lifetime. They can be used as major source for future decisions on VDL M2 by the European Commission (EC) and by the stakeholders.

Furthermore, numerous variations of parameters in respect to the baseline, had been analysed in order to answer "what / if" questions, such as:

- What are the results if the multifrequency aircraft equipage rate cannot be reached for a specific reference year?
- What are the benefits to VDL M2 when efforts are made to move data traffic to other communication systems?
- What is the impact of altered periodic ADS-C data transmission parameters?
- What are the implications if the expected share between CSPs changes significantly in the future?

Considering the baseline scenarios and the numerous variations described above, the total number of simulations runs represented 1344 different scenarios analysed. Furthermore, for each one of them, for each VDL M2 Ground Sites within the ECAC Area and for each VDL M2 channel, a peak channel load value [25]was computed and used as the basis for the assessment of the results.

Specific threshold values were used to determine whether the Common Signalling Channel (CSC) or a specific additional VDL M2 channel had one of this three status: "PASSED", "BORDERLINE" or "FAILED"[26].

24 The Architecture Proposal 2 includes the VDLM2 system, as existing today, with specific assignment of VDLM2 frequencies to the existing Communication Service Providers (multiple Radio Frequencies networks in the same area as currently implemented in Europe)

25 Peak Channel Load value of 99th percentile of each minute over a period of 24 hours period

26 For details refer to Deliverable 3.0 – "VDL Mode 2 Capacity and Performance Analysis" – Chapter "2.5. Simulation and Assessment"

The figure below (Figure 8) provides an overview of the results of this study for the whole ECAC area, for the "realistic" air traffic growth assumption, so called "BASE" scenario, for the mixed ATS and AOC traffic, up to year 2040. It is worth noting that scenario E5 represents the current implementation (Ref. to Section 6).

BASE Air Traffic Growth Mixed ATS and AOC																				
Number of Channels	**CSC + 4 Additional Channels**							**CSC + 6 Additional Channels**						**CSC + 8 Additional Channels**				
Year	**2018**	**2021**	**2024**	**2027**	**2030**	**2035**	**2040**	**2021**	**2024**	**2027**	**2030**	**2035**	**2040**	**2024**	**2027**	**2030**	**2035**	**2040**
Baseline																		
Arch2 E5	PASS	PASS	BDRL	FAIL	FAIL	FAIL	FAIL	PASS	PASS	PASS	BRDL	BRDL	FAIL	PASS	PASS	BRDL	BRDL	FAIL
Arch1 E1	PASS	PASS	BDRL	BRDL	FAIL	FAIL	FAIL	PASS	PASS	PASS	BRDL	BRDL	BRDL	PASS	PASS	PASS	BRDL	BRDL
Arch2 E6	PASS	PASS	PASS	BRDL	BRDL	FAIL	FAIL	PASS	PASS	PASS	BRDL	BRDL	BRDL	PASS	PASS	PASS	BRDL	BRDL
Arch1 E2	PASS	PASS	PASS	BRDL	BRDL	BRDL	FAIL	PASS	PASS	PASS	PASS	BRDL	BRDL	PASS	PASS	PASS	PASS	PASS
MF Variations																		
MF1																		
Arch2 E5		PASS	BRDL	FAIL				PASS	PASS	PASS				PASS	PASS			
Arch1 E1		PASS	BRDL	BRDL				PASS	PASS	PASS				PASS	PASS			
Arch2 E6		PASS	PASS	BRDL				PASS	PASS	PASS				PASS	PASS			
Arch1 E2		PASS	PASS	PASS				PASS	PASS	PASS				PASS	PASS			
MF2																		
Arch2 E5		PASS	BRDL	BRDL				PASS	BRDL	BRDL				BRDL	BRDL			
Arch1 E1		PASS	BRDL	BRDL				PASS	BRDL	BRDL				BRDL	BRDL			
Arch2 E6		PASS	BRDL	BRDL				PASS	BRDL	BRDL				BRDL	BRDL			
Arch1 E2		PASS	BRDL	BRDL				PASS	BRDL	BRDL				BRDL	BRDL			
ADC-C Variations																		
ADSC-4C20W5M (2024) or ADSC-1C20W5M (2027)																		
Arch2 E5			FAIL	FAIL					PASS	BRDL				PASS	BRDL			
Arch1 E1			BRDL	FAIL					PASS	PASS				PASS	PASS			
Arch2 E6			BRDL	BRDL					PASS	PASS				PASS	PASS			
Arch1 E2			PASS	BRDL					PASS	PASS				PASS	PASS			
ADSC-4C10W3M (2024) or ADSC-1C10W3M (2027)																		
Arch2 E5			FAIL	FAIL					PASS	BRDL				PASS	BRDL			
Arch1 E1			BRDL	FAIL					PASS	PASS				PASS	PASS			
Arch2 E6			BRDL	BRDL					PASS	PASS				PASS	PASS			
Arch1 E2			PASS	BRDL					PASS	PASS				PASS	PASS			
ADSC-1C10W5M (2024)																		
Arch2 E5			BRDL						PASS					PASS				
Arch1 E1			PASS						PASS					PASS				
Arch2 E6			PASS						PASS					PASS				
Arch1 E2			PASS						PASS					PASS				
Offloading Variation																		
Arch2 E5			BRDL	FAIL	FAIL	FAIL	FAIL		PASS	PASS	BRDL	BRDL	BRDL	PASS	PASS	BRDL	BRDL	BRDL
Arch1 E1			BRDL	BRDL	FAIL	FAIL	FAIL		PASS	PASS	PASS	BRDL	BRDL	PASS	PASS	PASS	PASS	BRDL
Arch2 E6			PASS	BRDL	BRDL	BRDL	FAIL		PASS	PASS	PASS	BRDL	BRDL	PASS	PASS	PASS	PASS	PASS
Arch1 E2			PASS	PASS	BRDL	BRDL	BRDL		PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
CSP Variations																		
CSP5050																		
Arch2 E5				FAIL						PASS					PASS			
Arch1 E1				BRDL						PASS					PASS			
Arch2 E6				BRDL						PASS					PASS			
Arch1 E2				BRDL						PASS					PASS			
CSP7030																		
Arch2 E5				FAIL						BRDL					BRDL			
Arch1 E1				BRDL						PASS					PASS			
Arch2 E6				BRDL						PASS					PASS			
Arch1 E2				BRDL						PASS					PASS			

Figure 8 – BASE air traffic growth mixed ATS and AOC[27]

The table below (Table 7) provides an overview of CAs main outcomes:

CAs main outcomes
Which is the expected lifetime of VDL M2 with regard to the European Core Area, assuming that the targeted baseline scenarios can be reached? • With CSC + 4 additional channels: in year 2027 at the latest the VDL M2 will become critical ("BORDERLINE" or "FAIL") with any architecture. If remaining with the current Architecture Proposal 2 (scenario E5) or migrating to Architecture Proposal 1 (scenario E1) VDL M2 will become critical not later than year 2024; • The Multifrequency equipment rate, had to be at least 70% in year 2021, otherwise, the use of VDL M2 would become critical already in year 2021; • When remaining with Architecture Proposal 2 (Scenario E5), for baseline scenarios, an extension to CSC + 8 channels will not improve the situation below these assumptions and VDL M2 reaches its critical situation in year 2030 at the latest with Channel Use Scheme C6A (CSC + 6 additional channels); • By migrating to Architecture 1 (scenario E2), which allows a more flexible channel assignment mechanism, with a channel use scheme of C6A (= CSC + 6 additional channels) the lifetime of VDL M2 can be extended up to the year 2035 at the latest, and with C8A (= CSC + 8 additional channels), even up to (and beyond) the year 2040; • The main conclusion and recommendation are to put efforts in order to make Channel Use Scheme C6A (CSC + 6 additional channels) available before the year 2024 at least for the European Core Area, thus extending the lifetime of VDL M2 by a maximum of 6 years, up to year 2030 at the latest.
Which Channel Scheme would be best suited to expand the expected lifetime of VDL M2? Using scenario 2 by migrating to Architecture Proposal 1 (scenario E2), with the channel use scheme C6A (CSC + 6 additional channels) the lifetime of VDL M2 can be extended up to the year 2035 at the latest, and with C8A (CSC + 8 additional channels), even up to (and beyond) the year 2040.
What are the expected benefits / drawbacks when moving to Architecture Proposal 1? The advantages of Architecture Proposal 1 over Architecture Proposal 2 are mainly related to the better load balance, shown in several scenarios, extending the lifetime of VDL M2 by at least 3 years. By migrating to Architecture Proposal 1 (scenario E2), with the channel use scheme C6A (CSC + 6 additional channels) the lifetime of VDL M2 can be extended up to the year 2035 at the latest, and with C8A (CSC + 8 additional channels), even up to (and beyond) to the year 2040. **Otherwise, when remaining with current Architecture 2 (scenario E5) the lifetime of VDL M2, even with CSC + 6 (or 8) additional channels, is expected to "end" already 10 years earlier in year 2030 at the latest. Applying Architecture 2, with a**

27 It is worth considering that Arch2- E5 is the evolution of the current implementation

more flexible channel assignment mechanism (scenario E6) with CSC + 8 additional channels, the lifetime of VDL M2 can be extended up to year 2035 at the latest." Therefore, regarding the long-term VDL M2 capacity aspects the following guidelines are suggested: • In case that it is envisaged to keep the lifetime of VDL M2 well beyond the year 2030, it is suggested to consider Architecture Proposal 1 (scenario E2) with most flexible Channel Scheme 2 as the most appropriate solution with the best performance. It should be able to extend the lifetime of VDL M2, even with "mixed ATS and AOC" data traffic, with CSC + 6 additional channels (C6A) up to year 2035 at the latest and with CSC + 8 additional channels (C8A) up to (or even beyond) the year 2040. • Otherwise, if it can be expected that *other digital aeronautical communication systems* (e.g. ***LDACS***, satellite communication **system *ESA/Iris*, AeroMACS etc.) will be able to take over and replace VDL M2, at least from year 2027/year 2030 onwards, then it is suggested** to consider to *remain* with the current *Architecture Proposal 2*, but *migrate* to the more flexible channel scheme (scenario E6).
How can the offloading of the data to alternate communication technologies, help to expand the lifetime of VDL M2? Offloading Data (ATS and/or AOC) to other means of Air/Ground Communication will extend the respective lifetime for all scenarios; **Only when** it is reasonable to assume that *all AOC traffic,* from *year 2027 onwards,* can be moved from VDL M2 to other future digital aeronautical communication systems (e.g. *LDACS*, SatCOM *ESA/Iris*, AeroMACS etc.) the following can be concluded: • By migrating either to Architecture Proposal 2 (scenario E8) or to Architecture proposal 1 (both E3 and E4 scenarios are suitable), the channel use scheme C6A (CSC + 6 additional channels) would be sufficient to extend the lifetime of VDL M2 significantly up to (and beyond) the year 2040; Furthermore, it is worth considering that Architecture proposal 1 (scenario E2) is the only CAS scenario, when applying data Offloading, which would extend the lifetime of VDL M2 up to (and beyond) year 2040, with no more than CSC + 6 additional channels. The Architecture Proposal 2 (scenario E6) shows the same result but with CSC + 8 additional channels.

Table 7 – CAs main outcomes

For further details regarding the CAs outcomes, please refer to the Capacity Assessment Study.

Below, the main SDM considerations on CAs main outcomes are listed:

CAs– SDM considerations
• **Modelling and Assumptions:** the results are very sensitive to the variation of the input parameters, in fact, a small input variation could cause big deviation in the simulation results; • **Architecture Proposal 1 vs Architecture Proposal 2:** Architecture Proposal 1 is always more efficient than Architecture Proposal 2;

- **VDL M2 lifetime:** the simulations have demonstrated that additional frequencies will be required as soon as possible. Furthermore, the decisions of adding frequencies have to be taken in due time considering the time needed for the deployment;
- **A more flexible use of the Frequencies:** the lifetime of both architecture proposal can be extended by some years when implementing a more flexible use of the available frequencies, i.e. use available frequencies for both Ground and en-route data (Scenario E2/E6) provides a better utilisation of the RF spectrum for both Architectures;
- **Multifrequency avionics:** the simulations have shown that the common signalling channel (CSC) will become soon the bottleneck, if there will not be a reasonable percentage of multi frequency capable aircraft (i.e additional channels have a limited impact if several aircraft could not use it);
- **ADS-C/EPP:** considering ADS-C/EPP as an application that is very demanding, the simulations have demonstrated that there is an urgent need for more capacity (i.e. additional channels) to support the foreseen ADS-C/EPP implementation. Stemming from the results of the comparison of the different ADS-C scenarios, it is crystal clear that less consuming ADS-C solutions are the preferred combinations.
- **Offloading of the data:** the study outlined that the offloading of the data can alleviate both architectures extending their respective lifetimes;
- **Network subscriber rates for Communication Service Providers (CSPs)**: the study has demonstrated that those different combinations (mainly driven by the AOC market evolution) of network subscription rate will impact the VDL M2 network performances of all Architecture Proposal 2 scenarios.

Table 8 – CAs main achievements

Stemming from the abovementioned points, the SDM has formulated specific recommendations (Ref. Section 5).

4. Cooperation activities

According to European Commission DLS related mandates and based on the outcomes stemming from a successful cooperation, the SDM together with all the other mandated organisations is continuing working to oversee all the next steps related to the Datalink Implementation in Europe.

During the current year, based on each organisation's specific tasks, a wide process of detailed analysis and deep work has continued in order to clarify and to address all the technical and non-technical aspects related to all the mentioned topics.

In this view, the SDM has continued to promote a transversal cooperation among all the relevant Bodies, through Coordination Meetings, held via Face-to-Face or Webex on a periodic basis, with the aim of sharing results and arranging proper initiatives for the achievement of the expected goals.

Hereinafter, an overview of the specific activities carried out by SDM in cooperation with EASA, Network Manager/ECUROCONTROL, EUROCAE, ETSI and other relevant Bodies (SJU, EDA, NSAs).

4.1 Cooperation with EASA

According to the European Commission mandate, EASA is expected to perform the following activities:

- a short-term review of the Regulation (EC) No 29/2009 (DLS IR);
- the initiation of a rule making activity on datalink services (DLS) as planned in the EASA Rulemaking and Safety Promotion Program 2017-2021.

Since the beginning of its mandate, the SDM is facilitating the cooperation with EASA, through the definition of common and updated objectives for a mutual support, participating to all the most relevant meetings. In detail, during 2019, EASA has requested a specific and direct support of SDM during the Rule Making Group (RMG) meetings. The SDM has continuously:

- Provided an updated picture on the status of Path I Framework (status of the DLS implementation), Path II Project, as well as IP1 activities, with the aim of aligning the RMG activities with the results achieved so far;
- Provided technical opinion in clarifying and guiding the stakeholder's through the right understanding of the implementing rule IR (EU) No 29/2009.

More in general, the SDM and EASA have closely handled several technical matters, allowing the continuation of the core DLS activities that will grant a successful DLS implementation in Europe. In specific, following the work started in 2017, the main topics that had been addressed have been the following ones:

- Strict cooperation on the evaluation of specific ELSA recommendations, focusing on the transversal topics envisaging consistent corrections in ATM European scene, both in the airborne and ground domains;

- Shared definition of Capacity Assessment objectives and requirements, in fact, EASA contributed to the review and definition of the contents, supporting the SDM work;
- Coordinating and discussing the interoperability (IoP) issues affecting the DLS provision, through RMG meetings;
- Supporting the analysis and discussion of the non- airline operational control (AOC) related issues, through the analysis of the current DLS regulation, identifying the key points to be analysed in detail, providing assumptions and identifying the potential alternative technical solutions.

4.2 Cooperation with Network Manager

The Network Manager is performing the following activities:

- Supporting the DLS implementation reinforcing the Radio Frequency Function (RFF) contribution, by enhancing the VDL M2 monitoring campaigns (e.g. through live measurements);
- Performing the pan-European ATN/VDL2 performance monitoring and spectrum coordination function as identified in the ELSA recommendations (NetworkOversight-02);
- Supporting the implementation of the DLS Recovery Plan, in coordination with SDM and EASA, by maintaining on the behalf of the ANSPs a list of aircraft that have an acceptable performance enabling them to use the network ('logon list' former white list) and a list of avionics with performance concerns. Other possible contributions are on the architecture and governance definition and to the testing and validation for both air and ground systems (cf. Interop testing);
- Reporting all findings stemming from previously mentioned actions (RFF, performance monitoring, etc..) to the Commission, EASA, SDM and interested stakeholders (cf. Monthly performance reports and Datalink Performance Monitoring Group (DPMG).

A strong cooperation, based on common objectives, has been continued between the SDM, NM and EASA. As a result of this fruitful cooperation, the "**Datalink Support Group (DSG)**" has been set up in July 2019.

Regarding the DSG group, it has been established as a joint effort of EUROCONTROL, SDM and EASA supported by multiple stakeholders. The aim of the group is to evaluate the operational and technical emerged problems regarding the operational use of DLS, assigning priorities, and solving the issues found. As a matter of fact, thanks to the collaborative work that has been done during the current year, some issues have been already agreed and fixed.

The work has been organized is several coordination meetings between the Network manager and the SDM with the involvement and support of other relevant stakeholders, with the aim of sharing results and arranging proper initiatives for the achievement of the expected goals.

Within the framework described so far, the SDM and NM have continued to jointly deal with several technical topics, which have been identified as key points for a successful DLS implementation, here below are listed the most relevant:

- Active support within the DLS Performance Monitoring Function (DPMF) Framework, contributing in a practical and operational way on the questions raised in 2018. Furthermore, the SDM is supporting

the NM with the real-time monitoring definition, through the identification of the main differences between real - time and periodic monitoring. SDM and NM support, the IP1 stakeholders with the resolution of technical open points and with the design, of a detailed workflow to be followed by the ANSPs for the real-time monitoring process;
- Coordination and joint evaluation of DLS implementation status and performance monitoring.

This year, the SDM has actively supported the performance monitoring and the detailed analysis of the results and issues emerged through the performance monitoring outcomes.

4.3 Cooperation with EUROCAE

The EUROCAE, together with the SDM executed the main activities related to the EC mandate, which are briefly outlined below:

- Identification and development of the main required standards necessary for the “end-to end certification” process;
- Adaptation of the ED-92B standard based on the current need, complementing it through the necessary clarifications in order to support the overall standard and certification material;
- Collaboration with the SDM, EASA and the NM, in order to support the activities established in the DLS Recovery Plan.

Since the SDM started its coordination work with the most relevant Bodies, it cooperated with EUROCAE, reviewing the standards and identifying the new technical updates regarding the most relevant ones (i.e. ED92 standard).
In fact, regarding the previously mentioned standard, the SDM supported EUROCAE as follows:

- Involving the most relevant stakeholder who were willing to acquire new information about the latest technical and operational topics;
- Working on ensuring the overall interoperability of the VDL M2 system through dedicated test cases which will be finally collected in an independent document called “ED92 companion document”.

4.4 Cooperation with ETSI

During the past years, a strong cooperation has been achieved between the SDM and ETSI for the revision and **definition of the standardization/regulatory processes and activities**, facilitating and increasing the implementation of technical standards, maximizing interoperability, safety and quality.

In detail, following the work started in 2017, the main topics addressed during the previous years have been partially covered during 2019. Below the short description:

- Joint analysis of ETSI standards, focusing and giving attention on aspects related to interoperability (IoP);
- support in the definition of ETSI work plan to address the interoperability (IoP) aspects and in standard updates according to IP1 outcomes;

- continuous alignment and uniformity between the mentioned work plan and the IP1 project activities.
- During 2019, the SDM together with ETSI has finalised a new version of EN 303 214 that is in line with the revised EASA baseline regulation. The subsequent discussions with the IP1/WP2.8 partners have concluded that for further updates the necessary resources were not available at the moment. On one hand, ETSI has already experienced lack of available expertise on VDL M2 in Technical Group AERO, on the other hand, EUROCAE is looking for expertise on VDL M2 systems.

In conclusion as main consequence the ETSI is experiencing a lack of expertise to support update of VDL M2 standards as identified in the ELSA study supporting regulation and providing guidance to implementers and service providers. This is an important issue that SDM hereby is making the EASA RMG 0254 aware of.

4.5 Cooperation with Other Relevant Bodies

Based on the second letter mandate, during the current year, the SDM continued engaging the most relevant stakeholders and provides a pro-active steering to them. In fact, following the path started in 2017, the SDM has continued to engage also other relevant Bodies in the implementation management of the DLS Recovery Plan. In detail, the SDM has constantly informed and consulted, on a bilateral basis, the following Bodies:

- **The SESAR Joint Undertaking (SJU)**, who provided its full support during the overall activities carried out during the IP1 and will continue offering its full support to the Path II Project activities that are still open and that will end by 2020.
- **The European Defence Agency (EDA)**, considered as a relevant Military authority, during the current year, collaborated with the SDM, in order to avoid any possible conflict and acted as a facilitator coordinating of the military point of view in the Single European Sky.
- **National Supervisory Authorities (NSAs),** during the year, the National Supervisory Authorities, with the aim of supporting the SDM, oversaw the ANSPs and helped the coordination of the DLS implementation. In addition, the SDM helped the NSAs in the safety oversights.

4.6 Additional activities with DLS Stakeholders

In addition to the mentioned activities, the SDM has collaborated actively with other DLS stakeholders in the following activities:

- Regarding the DLS implementation, continuous monitoring sessions and meetings have been performed by SDM with the ANSPs and AUs. In detail, regarding the **Ground Domain** and considering the expiration of the deadline imposed by the IR (EU) No 310/2015, the SDM has been working with all the ANSPs who did not respect the target date, organizing specific sessions and dedicated meetings aimed at solving and/or facilitating the recovery of the DLS implementation. Concerning the **Airborne Domain** whose deadline imposed by the IR (EU) No 310/2015 is 5th February 2020, the SDM has been working on specific activities to monitor the airborne implementation status.

- The activities towards an early deployment of AF6 aimed at supporting the potential issues and organising the overall necessary work able to grant a complete deployment of AF6. They could be divided into two main phases: the first one whose main purpose was to provide an ATM full support

to the ATS B2 aircraft while, the second one will be aimed at assisting the ANSPs and SJU stakeholders in the next months. In more details:

- 1st phase: thanks to the coordination activities with the manufacturing industries, ANSPs and EASA, it was possible to solve issues related to some specific CPDLC messages, that were not supporting the ATS B2 standards permitting in addition the update of the related guidance material[28]. Consequently, the aircraft supporting the ADS- C/EPP started flying in Europe in 2019.
- 2nd phase: in the next months the SDM, collaborating with the stakeholders, will give a full support to the ANSPS and SJU project members, solving the above-mentioned issues and will continue working on the deployment of AF6.

- **Coordination activities with relevant Manufacturing industries** (i.e. Airbus, Inmarsat, Honeywell, etc.): with the aim of ensuring alignment and awareness of the results stemming from SDM activities on DLS implementation.
- **European Space Agency (ESA)** and SESAR Deployment Manager have collaborated in several activities towards the utilisation of Satellite - based communication systems (such as Iris), that have led to the official signing of the Memorandum of Cooperation (MOC) in July 2019. A specific focus of the cooperation is on the use of satellite as a first complementary datalink air-ground communication technology. The collaboration between the SDM and the European Space agency has allowed the drafting of a roadmap as a reference for the future satellite communication (SatCOM) implementation.
- **FAA coordination activity:** the FAA, together with the SDM, coordinated the air-ground datalink implementations in their respective geographical scope, sharing experiences and lessons learned in order to facilitate the harmonization and the interoperability of datalink usage between the United States and Europe.

  In detail, this cooperation aims at:

  - Assuring a stronger stakeholder's commitment regarding the controller pilot data link communications (CPDLC);
  - Granting a stronger coordination in specific areas[29];
  - Allowing an effective exchange of information regarding the timelines and actual status of implementation for both: the tower and the en-route operations.

  In order to further improve these coordination and collaboration activities, a specific DLS technical interchange meeting took place in October 2019. In addition, thanks to it, an agreement regarding the air/ground communication interoperability issues on VDLM2 networks has been reached.

28 EUROCAE ED-120 (Change 3) and ETSI standard EN 303 214

29 These specific areas include the cooperation among programmatic, operational and systemic features

5. Final Recommendations

This section provides a list of final recommendations based on the outcomes of the work described in this document.

5.1 SDM Recommendations

Based on the outcomes of the work described in previous sections, a set of recommendations is listed below:

1. **To continue with a SDM strong Programme Management for the DLS implementation in Europe** considering the good results achieved in the past years;
2. **To deploy the Architecture Proposal 2 including the Common European ATN backbone (CEAB) and, at the same time, introducing complementary communication technologies.** Regarding this, the following points have to be considered:
    - Even if Architecture Proposal 1 brings advantages at Radio Frequency layer, its implementation presents higher risks[30] (technical, economical and transitional) compared to Architecture Proposal 2. Furthermore, the Architecture1/Model D was not recommended due to the high risks related to its implementation (identified risk n. 5) as well as the lack of the necessary support from relevant stakeholders including AUs and Collins / SITA (identified risk n. 3);
    - The need to maintain the required minimum investments in the VDL M2 in order to guarantee the DLS provision for the expected remaining VDL M2 lifetime;
    - The need to support the implementation of the complementary communication technologies as soon as possible, offloading the VDL M2 channels to safeguard investment made on VDL M2;
    - In order to obtain the strategic benefit in reducing the fragmentation and facilitating the seamless integration of complementary communication technologies all ANSPs shall be connected to the Common European ATN Backbone (CEAB);
    - To define and develop the multilink operational concept, supporting the complementary communication technologies (e.g. SATCOM, LDACS, AeroMACS), taking also into account the R&D work done by SJU;
    - To ensure that airborne (avionics) and ground (CEAB) systems will be interoperable supporting multilink operations;
    - **To enhance the VDL M2 system:**
        - **Boosting the multifrequency (MF)** in the airborne implementation. In fact, considering the current status, it is recommended to speed up the MF implementation in order to reach at least the 70% of VDL M2 equipment rate by 2021, 80 % by 2024 and 85% or higher by 2027;
        - **Continuing to promote the upgrade and facilitate the resolution of the issues for the bad performing VDL M2 avionics.** Current statistics are showing that a large proportion of aircraft equipped with bad performing avionics (+/- 50% of the flights, according to the NM provided figures) are jeopardising the overall network performances;

30The risks are described in the D3.2. For further details, please refer to it, in particular the risks R3 and R5 should be considered (Ref to Section 6)

- **Adding more frequencies**: it may be possible to extend the VDL M2 lifespan adding more VDL M2 frequencies (especially in core Europe with a limited number of frequencies as considered in the CAs) coping with the expected future data traffic increase;
- To consider an **optimisation of the current frequency's allocation mechanism** (managed also at European datalink governance level) supporting a more flexible use of the available spectrum in order to expand the lifetime of VDL M2 by some years (e.g. considering a different number of frequency assignments for the En- Route and for the TMA data traffic)[31]
- To investigate **bandwidth saving technology** (e.g. non-use of IDRP and optimised AOC messages);

o To ensure the appropriate resources to continue supporting the required improvements of the current and future DLS standards (involving ETSI and EUROCAE as needed);

o All relevant Stakeholders to continue supporting the Data Link Support Group (DSG) in evaluating the operational and technical problems emerged from the DLS operations, assigning priorities and resolving the issues found.

3. **To follow the** "**DLS Deployment Strategy" roadmap presented below** (Figure 9), considering the following recommendations:
   - o To establish the DLS Governance at the beginning of 2021 or earlier if possible;
   - o To establish the Datalink Service Provider (DSP) by the early 2023 and start operations in 2025 or earlier if possible;
   - o To implement the Common European ATN Backbone (CEAB) beginning of 2025 or earlier if possible;
   - o To fully deploy the DLS Architecture proposal 2 by early 2026 or earlier if possible;
   - o To introduce the complementary communication technologies (e.g. SATCOM, AeroMACS, LDACS) by 2025 or earlier if possible (for example SATCOM and AeroMACS could be ready for the service provision by the beginning of 2022). At least 5% of the aircraft operating within the airspace of European Civil Aviation Conference (ECAC) countries in the ICAO EUR region should be equipped by 2027 with complementary air ground communications technologies.
   - o To pave the way for the future DLS infrastructure evolution considering the introduction of new Datalink services (e.g. B2 and TBO) as early as possible to complement the legacy VDL M2 technology (from 2026 on)

31 For further details please refer to the Capacity Study (CAs)

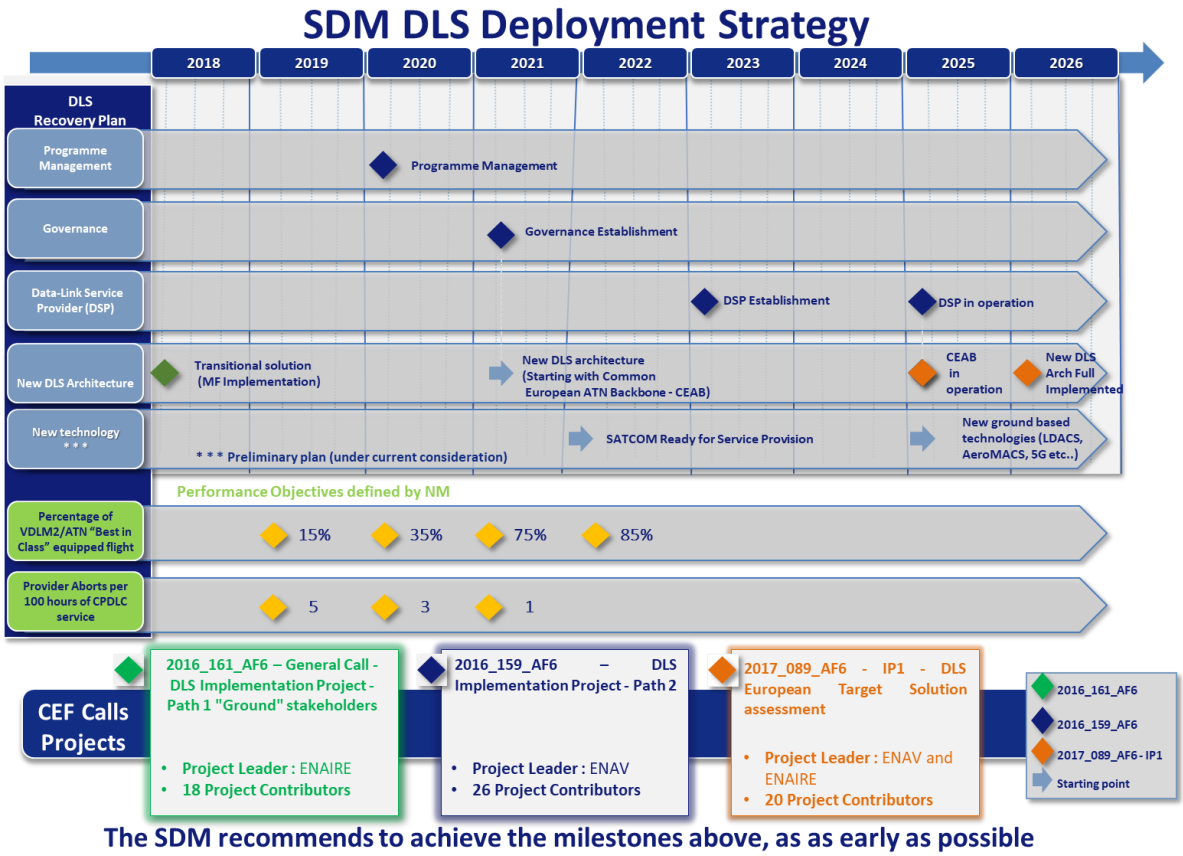


Figure 9 – SDM DLS Deployment Strategy

5.2 Operational Recommendations

This section provides additional operational recommendations based on the outcomes of the work performed by SDM and EUROCONTROL/NM:

1. **To reinforce the performance monitoring by getting DLS data from all the mandated European ACCs to get the full situation by end 2020** (only 30% are received today) and working closer with operations to measure the capacity gains. If needed, the delivery of these data to the Network Manager should become mandatory;
2. **To establish an integrated air/ground platform to test/validate avionic upgrades and organise test/verification flights with stakeholders to validate new software versions (for both avionic and ground systems) in a real environment.** The test and validation platform should be operational by end 2020;
3. **To confirm the operational use of the FMTP/OLDI messages between all the EUR ACCs to ensure an efficient transfer of the DLS flights.** The implementation of these automatic transfers impacts the DLS operational benefit.

6. References

List of Reference			
ID	**Title of the document/ Deliverable**	**Edition / Date**	**Owner**
1	Datalink Services (DLS) Recovery Plan	Edition: FPA MOVE/E2/2014-717/SESAR FPA SGA MOVE/E2/SUB/2015-467/SI2.724359 Milestone M1.3 Date: 17/10/2016	SDM
	PATH II PROJECT		
2	D5.1 Coordination with DLS IP Path I – Transition scenarios	Edition: V.0.19 Date: 28/12/2019	DLS IP Path II/ WP4 Consortium (lead by ENAIRE)
3	D6.1.2 - DLS Governance Structure Report' (Second Release)	Edition: V.2.0 Date: 01/03/2017	DLS IP Path II/ WP5 Consortium (lead by DFS)
IP1 - DLS EUROPEAN TARGET SOLUTION ASSESSMENT			
	IP/WP1/SWP 1.6 WP1.6: Common European ATN backbone Specification	Edition: V. 1.0 Date:30/09/2019	DLS Path II / IP1 / WP1 Consortium
	IP1/WP2/SWP2.5 Assumption for Scenarios for the SDM VDL2 Capacity Assessment Study	Edition: V1.1 Date: 28/06/2019	DLS IP Path II/ WP2 Consortium
	IP1/WP2/SWP 2.7 WP2.7: Architecture finalization	Edition: V.0.5 Date: 30-10-2019	DLS Path II / IP1 / WP2 Consortium
4	WP3 - Business Case Report (SWP 3.2)	Edition: V.2.0 Date: 09/12/2019	DLS Path II / IP1 / WP3 Consortium (lead by NATS)
5	D11. VDL M2 Measurement, Analysis and Simulation Campaign – ELSA Final Report	Edition: V00.01.03 Date: 30/06/2016	NATS

7. List of acronyms

Acronym	Definition
ACC	Air Traffic Control Centre
AF6	ATM Functionality #6
A/G	Air/Ground
AGR	(ATN-) Air Ground Router
AOC	Airline Operational Control
ANSP	Air Navigation Service Provider
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Service
AU	Airspace User
BB	(ATN-)Backbone
BIC	Best in Class (from the ELSA study)
C4A	Channel Use 4
C6A	Channel Use 6
C8A	Channel Use 8
CAs	Capacity Assessment
CCB	Common Change Block
CEAB	Common European ATN backbone
CEF	Connected Europe Facility
CPDLC	Controller/Pilot Datalink Communications
CSC	Common Signalling Channel
CSP	Communications Service Provider
CuB	Channel Use Base
DEB	DLS Executive Board
DGSIFs	Dual Ground Station Information Frame
DL	Datalink
DLS	Datalink Services
DMU	DLS management unit
DSP	Data-link Service Provider
EASA	European Aviation Safety Agency
EC	European Commission
ECAC	European Civil Aviation Conference
ECTL	EUROCONTROL
EDA	European Defence Agency
ELSA	Enhanced Large Scale ATN deployment
ENR	En Route (ICAO)

ESA	European Space Agency
ESSP	European Satellite Service Provider
ETSI	European Telecommunication Standardization Institute
Eurocae	European Organization for Civil Aviation Equipment
FAA	Federal Aviation Administration (US)
FMTP/OLDI	Flight Message Transfer Protocol / OnLine Data Interchange
G/G	Ground/ Ground
GSIFs	Ground Station Information Frames
i4D	initial 4-Dimensional (Trajectory Exchange)
ICAO	International Civil Aviation Organization
IoP	Interoperability
IP	Implementation project
LDACS	L-band Digital Aeronautical Communication System
MF	Multi-Frequency
MOC	Memorandum of Cooperation
NM	Network Manager (EUROCONTROL)
NPV	Net Present Value
NSA	National Supervisory Authority
PA	Provider Abort
PCP	Pilot Common Project
PENS	Pan European Network Services
RF	Radio Frequency
RMG	(EASA-) Rule Making Group
SATCOM	Satellite Communications
SDM	SESAR Deployment Manager
SESAR	Single European sky ATM researches
SGA	Specific Grant Agreement
SJU	SESAR JU
TMA	Terminal Manoeuvring Area
TMB	Top Management Body
USBG	University of Salzburg
VDL	VHF Datalink
VDL M2	VHF Data-Link Mode 2
VDL2	VHF Digital Link (VDL) Mode 2
VHF	Very High Frequency
VGS	VDL Ground Stations
VME	VHF Management Entity
WP	Work Package

ANNEX I
ELSA Recommendations Current Status

In the light of above, this section provides an overview of the ELSA recommendations, divided in four domains: “Ground (network)”, “Avionics”, “Standards” and “Network Implementation and Oversight” and their current status. The table below shows the current status of the ELSA’s recommendations:

ID	DOMAIN	RECOMMENDATION ID	STATUS
		Ground	
1	**Ground 01**	Use a dedicated channel for transmissions at the airport in areas with high traffic levels in en-route.	Done in Path I
2	**Ground-02**	Progressively implement additional VDL2 frequencies in accordance with the traffic level.	Done in Path I
3	**Ground-03**	Optimise the en-route VGS network coverage	Already analysed and its implementation depends upon the deployment of the target architecture (Path II project/ IP1/ CAs)
4	**Ground-04**	Use the CSC as common control channel only, unless traffic level is very low	Ground segment done in Path I[32]
5	**Ground-05**	Implement ELSA recommended protocol optimisation: limit the AVLC frame size	Ground segment started in Path I[33]
6	**Ground-06**	Ensure the availability of a fifth VDL2 frequency (at a minimum)	Done (ICAO Frequency Management Group)
7	**Ground-07**	Favour alternative communications means for Airline Operational Control (AOC), with a priority to the airport domain	Under current analysis to be further worked out. The SDM has already involved the alternative communication means in its roadmap.
8	**Ground-08**	Implement the MF VDL2 target technical solution: in each Service area, one single RF network that operates reserved VDL frequencies supporting two-GSIF channels;	Based on the Path II project/ IP1/ CAs outcomes the SDM recommends the Architecture Proposal 2 implementation and at the same time the introduction of complementary technologies.
9	**Ground-09**	Fix the unbounded retry issue in certain VGSs	Done (Path I)
10	**Ground-10**	Fix the Clear Request issues	Done (Path I)
11	**Ground-11**	Optimise the Disconnect Mode management	The SDM is supporting the Network Manager (Data-link Support Group action)

32 This point has been done in Path I for the ground segment but, in order to improve the use of the Common Signaling Channel it is necessary to continue implementing MF capable aircraft. Multifrequency is deployed at the Ground where needed, i.e. Core Europe. However, there is still quite a number of DLS certified Aircrafts that are not Multifrequency capable. DPMF is monitoring this situation and will escalate this issue to the relevant Bodies when required.

33 This point has been addressed in Path I for the VGSs but, in order to optimise the use of the VDLM2 channels it is necessary to adapt the avionics as well. Further steps for some ground components and most of the avionic are required

ID	DOMAIN	RECOMMENDATION ID	STATUS
		Avionics	
12	**Avionics-01**	Upgrade of avionics to the "best in class" performance	In progress, even if a considerable number of avionic upgrades have been achieved in Path I[34]
13	**Avionics-02**	Update the pilot procedures to avoid unnecessary avionics reset	Almost done (Path I)
		Standards	
14	**Standards-01**	Define and implement an effective datalink end-to-end system certification process (including both ground and air components) and reference material for the ground network infrastructure (MOPS-like)	The SDM supporting EASA (action to be further worked out by EASA)
15	**Standards-02**	Include the selected interoperability improvements and clarifications in the relevant standards, and implement the resulting changes	The SDM is supporting EUROCAE and ETSI
16	**Standards-03**	Include updates for MF interoperability in the relevant standards	The SDM supporting EUROCAE and ETSI
		Network Oversight	
17	**NetworkOversight-01**	Establish/empower a pan-European air/ground datalink implementing function having appropriate steering responsibilities	The European Commission gave the mandate to SDM
18	**NetworkOversight-02**	Establish/empower a pan-European ATN/VDL2 performance monitoring and spectrum coordination function	The European Commission gave the mandate to NM
19	**NetworkOversight-03**	Establish/empower a pan-European ATN/VDL2 end-to end certification and oversight function for validating (ground and airborne) sub-systems' acceptability	The European Commission gave the mandate to EASA

Table 9 – ELSA Recommendations at their current status

34It is recommended to continue implementing the Multi Frequency capabilities and optimising the block size of the avionics, considering that the size has been reduced

ANNEX II

Path I Framework (Background) and Path II Framework (Outcomes)

Path I Framework - Background

Introduction

Since its mandate, the SDM performed several activities to safeguard the implementation of the DLS transitional solution, in the ground and airborne domains. These activities aimed at ensuring the synchronization of the implementation projects carried out at Country level, as well the enhancement of the stakeholders' awareness regarding scope, timeline and framework of the overall DLS implementation process.

In the monitoring framework, continuous monitoring sessions have been performed by SDM during 2019, through the submission of specific questionnaires to the Air Navigation Service Providers (hereinafter ANSPs) and to the Airspace Users (hereinafter AUs) with the aim of providing an updated status of the DLS implementation in Europe and identifying specific needs and risks.

Regarding the **Ground Domain** and considering the expiration of the deadline imposed by the IR (EU) No 310/2015, the SDM has been working with the ANSPs that did not respect the target date organizing specific sessions and dedicated meetings aimed at solving and/or facilitating the recovery of the DLS implementation.

Concerning the **Airborne Domain** whose deadline imposed by the IR (EU) No 310/2015 is 5th February 2020, the SDM has been working on specific activities to monitor the airborne status. Due to the imminent deadline, the SDM is expected to organize specific workshops and dedicated meetings as well as to continue the monitoring exercise in order to make feasible for the AUs the achievement of the capability increase[35] imposed by the regulation.

Ground domain

Considering the past deadline of February 2018 imposed by IR (EU) No 310/2015, the SDM acted as a coordinator and facilitator, constantly supporting all the ground stakeholders and monitoring of the late implementers, thanks to the actions described below:

1. The European ANSPs answered to the questionnaire submitted by the SDM, providing updated information regarding the DLS implementation status, including the upgrade to ATS-B2 services.
2. Further interactions have been carried out, in order to refine the preliminary picture of the DLS implementation status, and to provide support, if needed.
3. Based on the data gathered through all surveys and monitoring activities, ad-hoc bilateral meetings have been performed. In fact, during the current year, specific meetings and sessions between the SDM and the ANSPs which are considered DLS late implementers, took place in order to support them solving their current issues.

Based on the last monitoring exercise, which took place in May 2019 and further refined thanks to additional investigations in September and December 2019, the SDM provided an updated picture of the DLS Implementation in the European Airspace according to the division by Area Control Centers (ACCs).

35 IR (EU) No 29/2009 preface point number 8.

The following legend has been adopted:

- **Green:** DLS provided in compliance with the Commission Implementing Regulation IR (EU) No 310/2015 to all airspace users (AUs) using the datalink service provision (hereinafter DSP)-ID ARINC and the DSP-ID SITA;
- **Yellow:** DLS provided, but not in compliance with the Commission Implementing Regulation IR (EU) No 310/2015, including the following cases:
  - ANSPs not providing all ATN B1 Services;
  - ANSPs providing all ATN B1 Services but only to AUs using the DSP-ID ARINC;
  - ANSPs providing all ATN B1 Services but only to AUs using the DSP-ID SITA;
- **Red:** DLS is not provided.

It is worth mentioning that these charts do not consider the ownership of the infrastructure but only service provision using the DSP-ID of ARINC and/or SITA. The figure below outlines the results declared by the **ANSPs.**

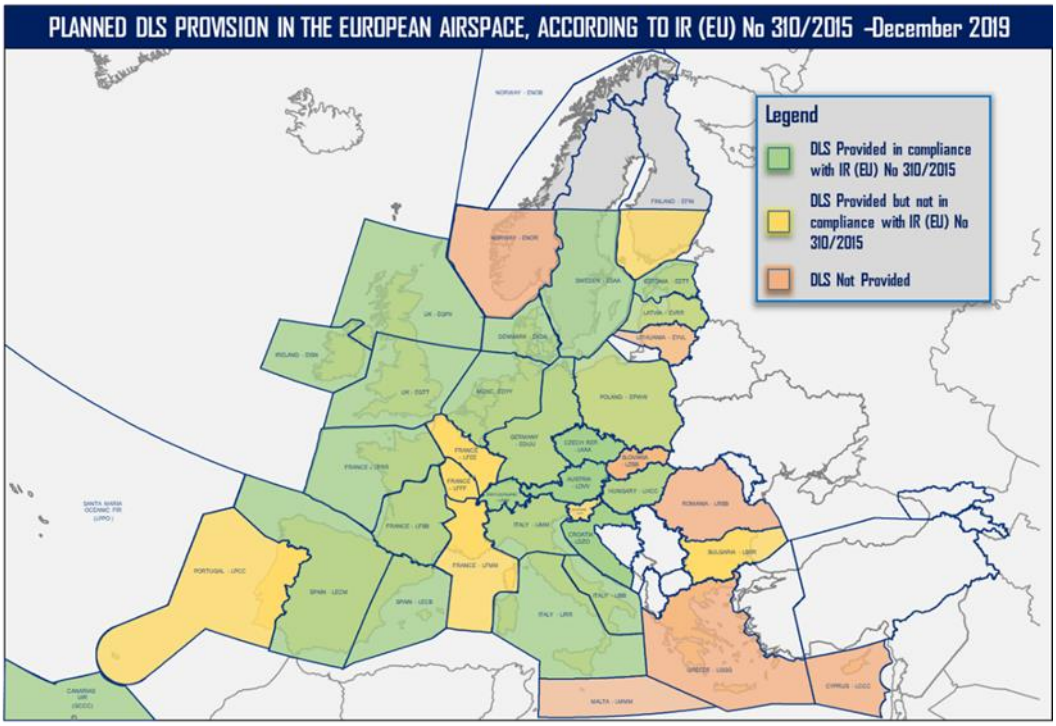


Figure 10 – Current DLS Implementation Status - Ground (December 2019)

According to the above chart, 18 States declare the "green" status meaning that they do provide DLS in compliance with IR (EU) No 310/2015:

1. Austria;
2. Belgium;
3. Croatia;
4. Czech Republic;
5. Denmark;
6. Estonia;

7. Germany;
8. Hungary;
9. Ireland;
10. Italy;
11. Latvia
12. Luxembourg;
13. Netherlands;
14. Poland;
15. Spain;
16. Sweden;
17. Switzerland;
18. UK.

Moreover, 5 States declare the "yellow" status meaning that they currently provide DLS but not in fully compliance with IR (EU) No 310/2015:

1. Bulgaria;
2. Finland;
3. France;
4. Portugal;
5. Slovenia.

Finally, 7 States declare the "red" status meaning that they currently do not provide DLS:

1. Cyprus;
2. Greece;
3. Lithuania;
4. Malta;
5. Norway;
6. Romania;
7. Slovak Republic.

The SDM has been continuously asking updates about the DLS implementation to the ANSPs and the latest update is from December 2019. In addition, a second map is depicted below (Figure 11)highlighting which States are expected to provide DLS by December 2020.

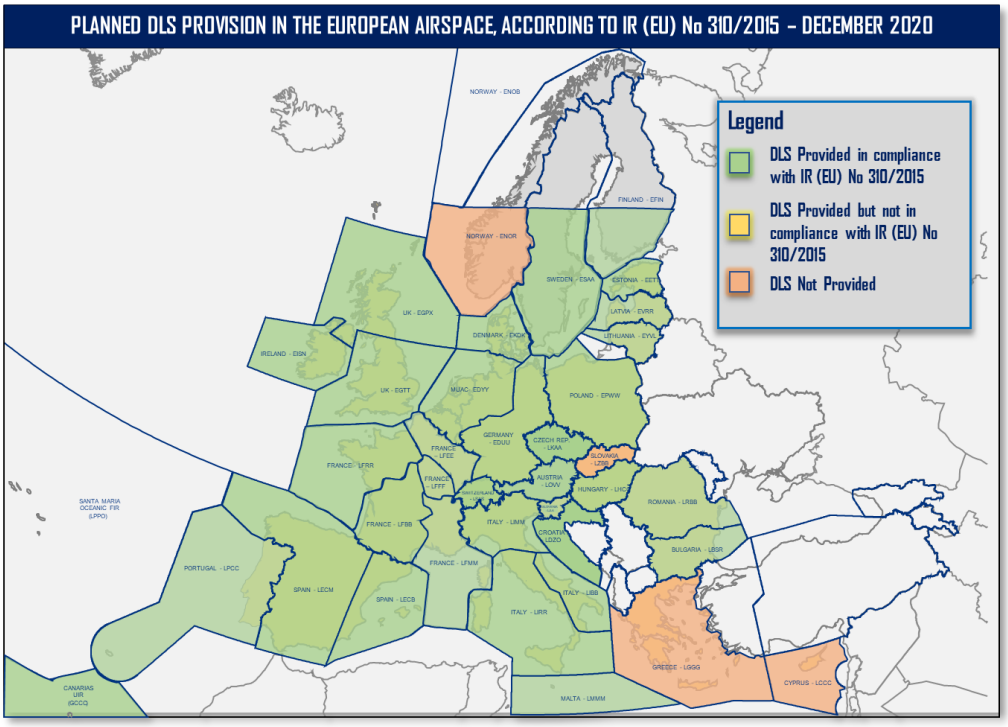


Figure 11 - Planned DLS Implementation – Ground (December 2020)

Airborne domain

Regarding the airborne domain, considering the main elements of the regulatory framework, it is important to mention the following elements:

- all the aircraft considered "equipped" means that they are compliant with the Mode 2 performance expectations in a Single-Frequency (SF) or/and a Multi-Frequency (MF) environment;
- a significant percentage of flight - not less than 75% - should be equipped with datalink services in order to have an efficient service, in line with the IR (EU) No 29/2009 [36];
- the installation and implementation of avionics, including "Best In Class" (BIC), lead to an improvement of the overall performances;

Regarding these, the SDM has monitored, the current and planned DLS implementation status in terms of aircraft equipage, operational approval and flight crew trained.

36 IR (EU) No 29/2009 preface point number 8

DLS Implementation status in the airborne domain: overall results

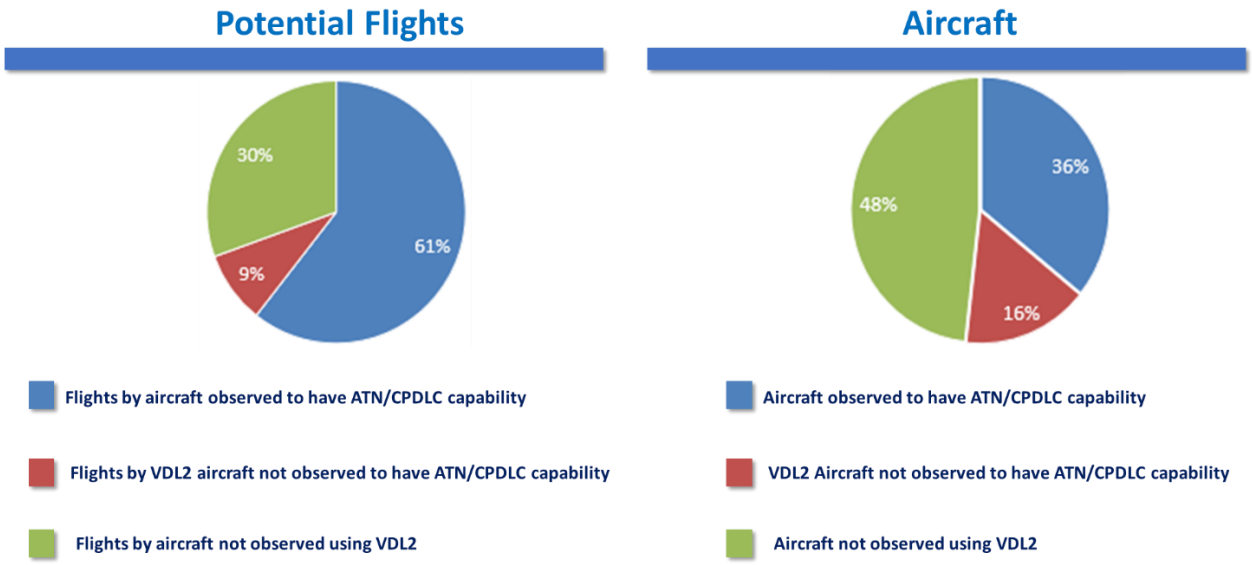


Figure 12 - DLS Implementation status in the airborne domain: overall results

From the previous picture is possible to read that approximately 36% of the 18,829 current aircraft in Europe are observed to be connecting to the ATN and these aircraft made 61% of flights in datalink airspace.

In the light of above, it appears that there have been improvements over the years and from the forecast in 2020, showing the results in the figure below:

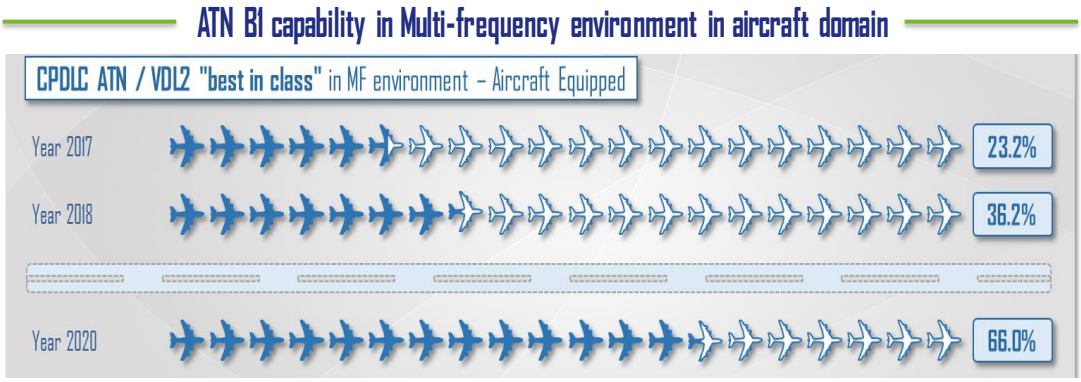


Figure 13 - Trend of ATN B1 capability in MF environment aircraft domain

The SDM, therefore, will continue to highly push the continuation of the avionics installation already started by Implementation Projects submitted within 2016 and 2017 CEF Transport Calls, with the aim of achieving the requested percentage of equipped aircraft according to the deadlines set by the afore mentioned IR.

Regarding these projects submitted within the 2016 and 2017 CEF Transport Calls, here it is provided a brief recap of the expected completion date, highlighting in red those with an end date beyond the IR deadline of 5th February 2020.

PROJECT NUMBER	PROJECT LEADER	ACTUAL END DATE
CIVIL PROJECTS		
Air France Group Datalink upgrade to best in class avionics - Lot2		
2017_008_AF6_AIR	Société Air France (Air France)	31.12.2019
Deployment of ATN B1 capability within TAP Group (AIR & GND)		
2016_061_AF6_AIR	Transportes aereos portugueses sa (TAP)	31.01.2020
Lufthansa Group & Air France Group Datalink upgrade to "best in class" avionics		
2016_165_AF6_AIR	Deutsche Lufthansa Aktiengesellschaft (Lufthansa)	31.12.2020
Portugalia E195 - Deployment of ATN B1 capability		
2017_083_AF6_AIR	portugália – companhia portuguesa de transportes aéreos s.a. (PORTUGÁLIA)	15.12.2019
RYR Upgrade to ATN B1 to "best in class"		
2016_164_AF6	Ryanair DAC (RYANAIR)	06.02.2020
Airbus A310 ATN VDL2 Compliance (AIR& GROUND)		
2016_125_AF6_AIR	Spanish air force (ES AF)	31.10.2020
MILITARY PROJECTS		
FALCON 900 compliance with Air Ground ATN VDL2 Data Link (AIR)		
2016_126_AF6_AIR	Spanish air force (ES AF)	19.10.2020

Table 10 - Projects expected end date - Overview

Performance Boosting

The SDM synchronised approach has brought to the achievement of important improvements in terms of overall datalink performances. Specifically, a decrease of the provider aborts has been demonstrated, with also an increase of the use of DLS. At the same time, also better DLS technical performances had been obtained and outlined in the following sections.

Overall Provider Abort Rate

The provider abort rate means a sustained loss of ATN end to end connectivity for at least 6 minutes leading to a service loss. Consequently, in order to increase the DLS performances, the provider abort rates need to decrease over time. In addition, the rate has to remain constant, or better needs to decrease even when the CPDLC usage increases. During the current year, a decrease of the PA rate has been visible, together with an increase of the CPDLC usage. So, the overall trend is positive.

The following graphs, coming from the Datalink Performance monitoring provided by EUROCONTROL/ NM, illustrate the decrease overall provider abort rate (PA rate) aggregated for all ANSPs [37]reporting figures to EUROCONTROL /NM[38].

38 At the time of this report only 6 ANSPs provided LISAT data to EUROCONTROL/NM

Below two graphs are outlined: the first one (Figure 14) illustrates a long-term view, starting from January 2013 until December 2019. The second one (Figure 15) shows a short- term view from December 2018 until December 2019.

From the graph below, the demand dramatically increased over time, while the PA's rate was decreasing mainly due to the additional capacity that has been added.

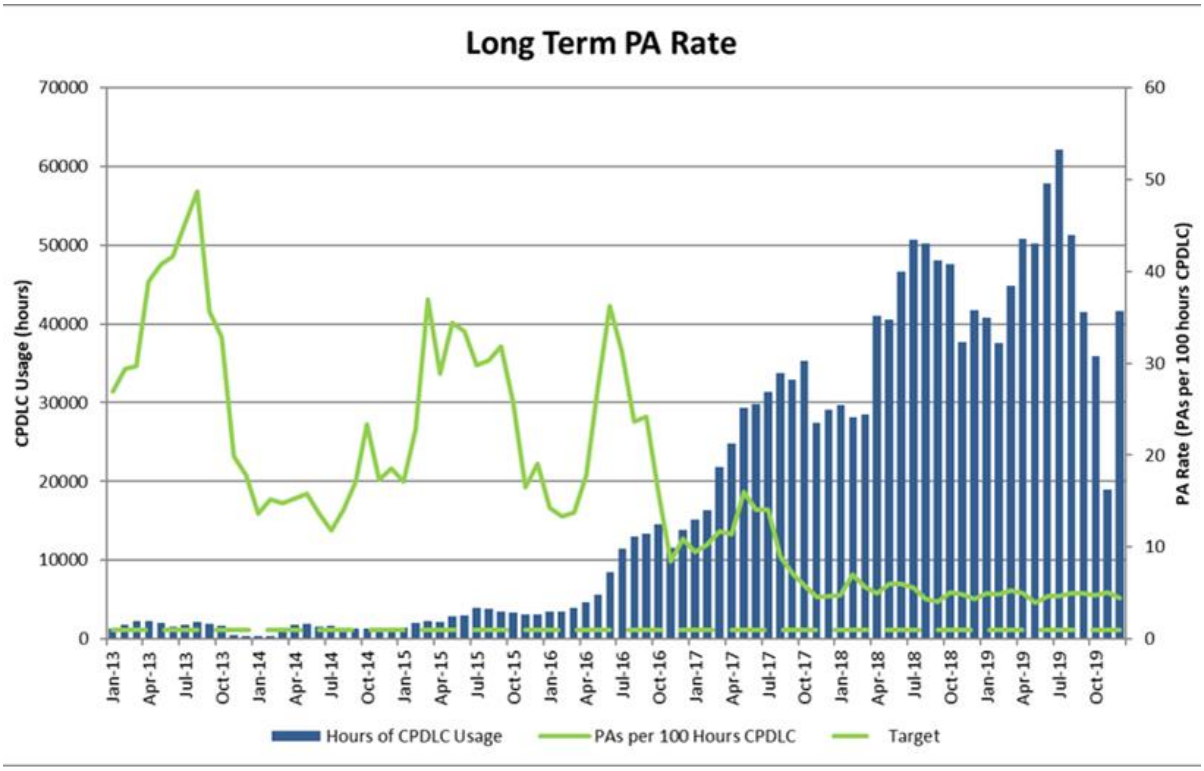


Figure 14 - PA Rate Long view

From the figure above, it is clear that:

- The CPDLC usage has strongly increased over time: in fact, in January 2013, the total hours of CPDLC was just above 0 hours, while in July 2019 the value is above the 50,000 hours. In addition, it is worth mentioning that the minimum values have been registered between October 2013 and January 2014, while the maximum usage has been reached around April and September 2019.
- A massive performance improvement in the Provider Abort rate is visible. Starting the analysis from the middle of 2016, it is visible that the CPDLC usage has grown around 5 times until today. While, at the same time, the PA rate decreased with a factor of 7. However, the target has not been reached yet. Further investments are required to reach the target of a maximum of 1 PA per 100 hours of CPDLC usage.

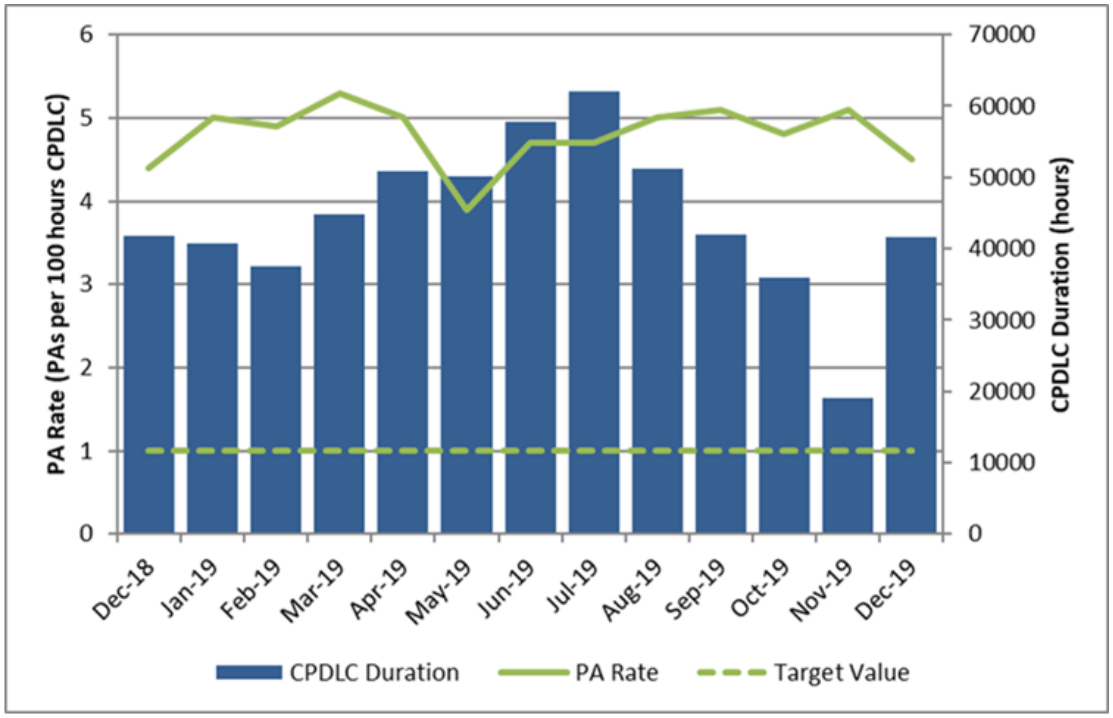


Figure 15 - PA rate in a shorth term view (December 2018 until December 2019)

Technical Round Trip Delays

The Technical round trip delay means the time required from when a message is uplinked, until its corresponding technical acknowledgment from the aircraft is received by the ground system. Consequently, in order to improve the performances, it is necessary to keep it at the minimum level required. The following graph (Figure 16) shows the latency at 95% and at 99%. The graph illustrates the timeframe from December 2018 until December 2019.

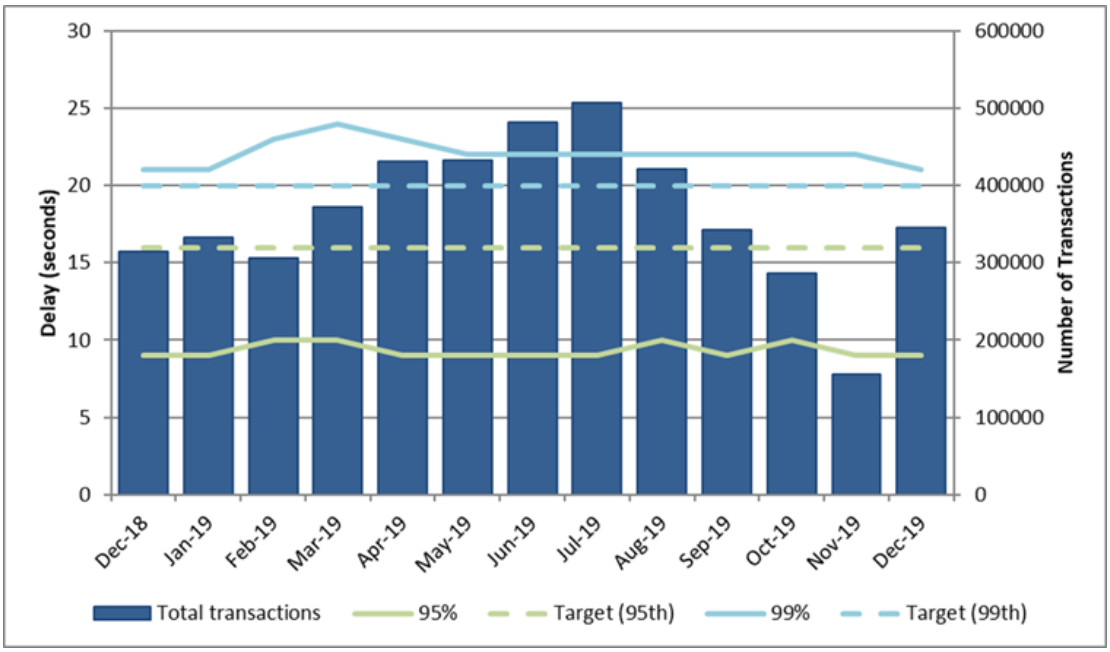


Figure 16 – Technical Round Trip delays

Path II Framework – Outcomes

Introduction

In the sections below are briefly recalled the activities stemming from the actions undertaken in the past. With the Path II framework, the so-called Path II project was suitably designed and submitted for the 2016 CEF Transport Calls, in order to support the SDM in the activities needed for the DLS target solution implementation within the deadlines set by EU regulations and PCP, through the following:

1. **Service Area Definition**: the SDM has proposed to implement a scenario with a single Service Area as the optimal one, through the intermediate implementation of two Service Areas. **This activity is considered fully concluded by the end of 2017, since the Service Areas have been successfully defined** (Figure 17)
2. **European technical architecture definition**: preliminary definition of the new European target model based on the identified Service Areas. This activity is considered concluded since two different Architecture proposals have been proposed (Figure 18 and Figure 19) and several technical open points have been identified;
3. **Elaboration of a Business case for the target solution**: elaboration of a preliminary Business case to compare the two proposed Architectures. This activity is considered concluded and several non - technical open points have been identified.

Service Areas Definition Overview

The work started in 2016 (2016 CEF Transport Calls – Path II project) with the service area definition, based on a two-steps approach, is briefly outlined below:

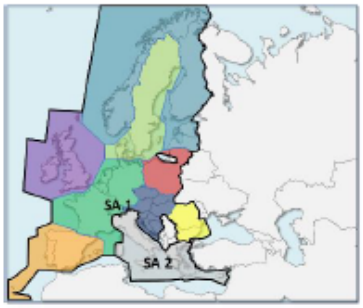
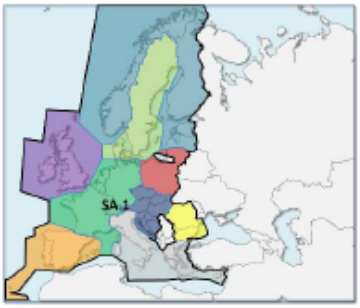
SDM proposal for Service Areas definition – two steps approach		
	First step (2 SAs)	**Final step (Single SA)**
		
Scenario	**Two Service Areas implementation of Model D.**	**Single Service Area implementation of Model D**
SAs #	**2**	**1**
Service Areas structure	**Service Area 1 composed by:** • South West FAB: Portugal, Spain. • UK-Ireland FAB: Ireland, UK. • FABEC: Belgium, France, Germany, Luxembourg, Netherland, Switzerland. • NEFAB: Estonia, Finland, Latvia, Norway. • DK-SE FAB: Denmark, Sweden. • Baltic FAB: Lithuania, Poland. • FAB CE: Austria, Bosnia-Herzegovina, Croatia, Czech Republic, Hungary, Slovakia, Slovenia. • Danube FAB: Bulgaria, Rumania. **Service Area 2 composed by:** • Blue Med FAB: Cyprus, Greece, Italy, Malta	**Service Area 1 composed by:** • South West FAB: Portugal, Spain. • UK-Ireland FAB: Ireland, UK. • FABEC: Belgium, France, Germany, Luxembourg, Netherland, Switzerland. • NEFAB: Estonia, Finland, Latvia, Norway. • DK-SE FAB: Denmark, Sweden. • Baltic FAB: Lithuania, Poland. • FAB CE: Austria, Bosnia-Herzegovina, Croatia, Czech Republic, Hungary, Slovakia, Slovenia. • Danube FAB: Bulgaria, Rumania. • Blue Med FAB: Cyprus, Greece, Italy, Malta

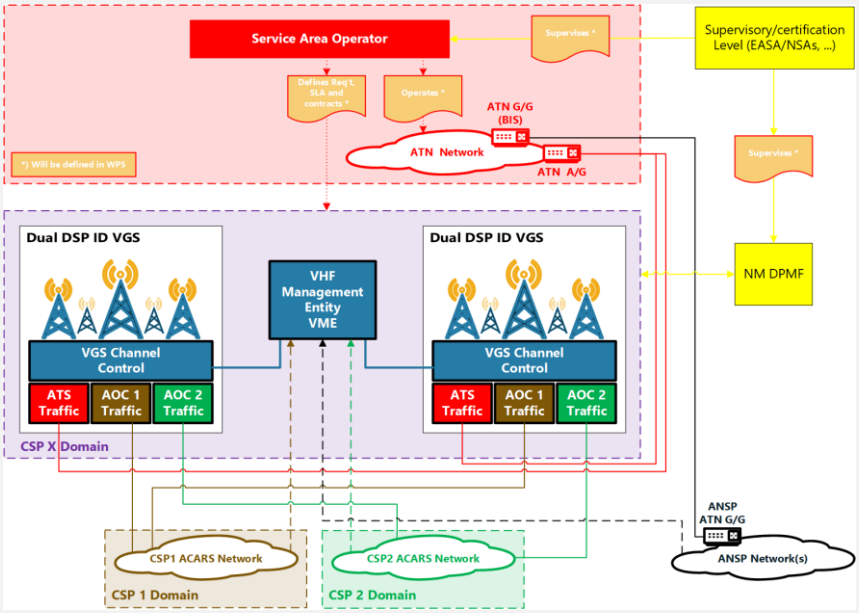
Figure 17 – SDM proposal for Service Areas definition: two-step approach

Architecture Proposals Overview

From the technical point of view, the work started in 2016 (2016 CEF Transport Calls – Path II project) with the two Architecture Proposals definition is illustrated below:

The Architecture Proposal 1:

ARCHITECTURE PROPOSAL 1



Architecture proposal 1: global view

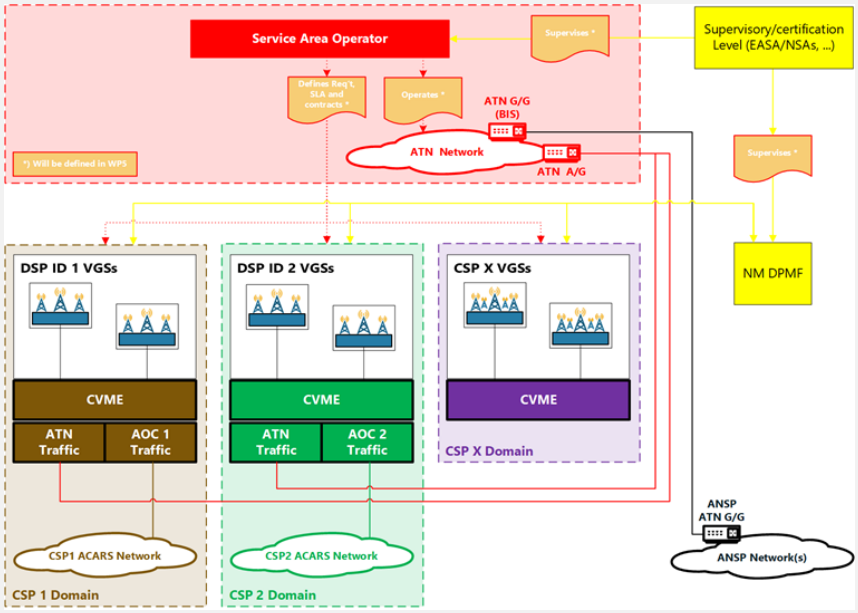
From a technical point of view, this proposal embodies the main Model D characteristics, according to ELSA study, as follows:

- **Optimisation of the RF spectrum usage**, since up to five VDLM2 frequencies are made available, giving proper operational flexibility, implementing an efficient system scalabilty;
- **Presence of a single RF network through a rationalisation of the RF networks** already implemented and consequently the possibility to **clear assign the channel technical management responsibility;**
- **Presence of ground stations supporting DUAL DSP ID (Dual Language)** belonging to ARINC and SITA (routing each AOC messages separately on their respective networks), avoiding the avionic systems upgrade to new GSIFs (Ground Station Information Frames);
- **Presence of the VDL Management Entity (VME)** as a key element for managing the required number of VDL frequencies, including the load balancing and geographical functions.

Figure 18 – Path II Project - Architecture Proposal 1 overview

The Architecture Proposal 2:

ARCHITECTURE PROPOSAL 2



Architecture proposal 2: global view

The most important criticality of this proposal is the simultaneous presence of multiple RF networks. This aspect, on one hand, ensures to keep the ARINC and SITA GSIFs (Ground station information Frames) (even if it is not a requirement), on the other one, collides with one of the Model D cornerstone, as stated in the ELSA study (i.e. one RF network for each Service Area for a better use of spectrum considering the limited number of VDL M2 channels).

The adoption of this solution does not fully exploit the benefits stemming from the utilisation of a single infrastructure throughout Europe; nevertheless, the *architecture proposal 2* should be considered as an enhancement of the ground segment of the Model B deployed by Path I project, and as a consequence a key step forward the definitive Model D implementation.

Figure 19 - Path II Project - Architecture Proposal 2 overview