D2.21 – Standardisation and harmonisation of SIGN-AIR technical solution

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Abstract

This report provides a comprehensive overview of standardisation and harmonisation strategies, as well as an elaborate plan sought for the project to achieve its objectives, specifically the utilisation of standardised data for its Monitoring Dashboard, the communication with Travel Companions, as well as to ease the contracts to have standardised data fields and facilitate the exchange of standardised data between Transport Service Providers.

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SIGN-AIR

[IMPLEMENTED SYNERGIES, DATA SHARING CONTRACTS AND GOALS BETWEEN TRANSPORT MODES AND AIR TANSPORTATION]

SIGN-AIR

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1. Executive summary

The deliverable D2.21 – “Standardisation and harmonisation of SIGN-AIR technical solution" provides a comprehensive analysis of specific standardisation and harmonisation strategies for the SIGN-AIR project that will be implemented, focusing on the utilisation of standardised data to enhance multimodal transportation services, which are essential for achieving the project’s objectives. Specifically, D2.21 outlines the development of two specific tools that facilitate the standardisation and harmonisation capabilities of the SIGN-AIR solution:

a. the standardisation mechanism for the International Air Transport Association Standard Schedules Information Manual (IATA SSIM) within TransiTool[1], the third-party platform that will be connected with the SIGN-AIR solution, and
b. the Field Matching Tool that will be implemented directly in the SIGN-AIR platform.

Both those tools will serve the standardisation and harmonisation strategies, enhance the SIGN-AIR solution, and provide added value to the end users, the Transport Service Providers (TSPs) of multiple modes of transport regarding adoption of data standards. Thus, those tools will be enabling them to gain all the benefits that derive from such an adoption of standards and establishing the SIGN-AIR solution as a more holistic and inclusive solution for multiple modalities.

First mechanism the D2.21 will introduce is the SSIM standardisation mechanism in TransiTool. The deliverable D2.21 introduces the SSIM standardisation mechanism in TransiTool, a critical tool for standardising and seamlessly exchanging transport data. TransiTool addresses the challenge of non-standardised data with advanced algorithms and a user interface that maps data fields to standardised formats. This capability will assist users in implementing data sharing agreements and contracts between Transport Service Providers (TSPs) within the SIGN-AIR platform.

The extension of TransiTool to include the IATA SSIM standard is particularly noteworthy, as it benefits aviation stakeholders and enables SIGN-AIR to support a broader range of transport modes. Building on the Transmodel consortium's successful harmonisation of General Transit Feed Specification (GTFS) and Network Timetable Exchange (NeTEx) standards (Nicholas JS Knowles, 2019), D2.21 explores the harmonisation of GTFS, NeTEx, and potentially SIRI with IATA SSIM. This effort aims to create a seamless integration between these data standards and IATA SSIM, enhancing data exchange efficiency and consistency in the aviation sector.

Harmonisation is essential for achieving a unified approach to managing multimodal transport data, contributing to more efficient and reliable transportation services. By standardising aviation messages as per the IATA SSIM, TransiTool showcases the feasibility of harmonising standards such as IATA SSIM, GTFS, NeTEx, and potentially SIRI in the future. Despite the challenges posed by differences in transport modes and data attributes, this development demonstrates how these challenges can be tackled and the opportunities for harmonisation. The document details the creation of a user interface (UI) for data entry and database components for converting SCR and other formats to a Relational Database Management System (RDBMS).

[1] Official website of TransiTool: https://transitool.com/

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Secondly, D2.21 also provides an overview regarding the second essential tool, the Field Matching Tool, that is being developed with the goal to associate non-standardised data fields registered in the SIGN-AIR platform and are to be incorporated in the Data Sharing Agreements (DSA) in the Negotiation phase with standardised format. This Field Matching Tool will be implemented in the SIGN-AIR platform, will read the data fields and provide recommendations and mechanisms for end users to define each field in accordance with the applicable standards (depending on the data sets and data fields defined, as well as the types of modes involved), allowing conversion to standardised data. This implementation follows an investigation of the IATA SSIM and its correspondence with Transmodel and GTFS.

The European Air Traffic Management (ATM) community, including the European Air Traffic Management Master Plan (ATM MP) Stakeholder Consultation Group (EASCG), will benefit from improved data standardisation, leading to more efficient air traffic management. Other stakeholders, such as the European Union's Single European Sky Coordination Group (EUSCG) and the European Standardisation Coordination Group (ESCG), will gain valuable insights to advance SESAR's standardisation activities.

In conclusion, D2.21 specifically focuses on the IATA SSIM and its harmonisation with GTFS/NETEX, along with the development of tools for associating data fields. These elements should be reviewed in conjunction with the D2.2 (D2.2 – Standardisation (STAND) - Initial, 2023) report and the work of the Transmodel consortium on harmonisation between NETEX and GTFS. The tools and strategies outlined in D2.21 significantly contribute to the SIGN-AIR platform, promoting standardisation and harmonisation, supporting TSPs in standardising data, and laying a foundation for future developments. D2.2, on the other hand, captures the standardisation needs of the SIGN-AIR SESAR solution, providing a snapshot of the standardisation context at the beginning of the development phase and detailing the status of widely used data standards across transportation modes.

2. Glossary of terms

For full clarity and to comprehensively understand this document, readers are advised to read this Glossary of Terms in conjunction with the section focused on acronyms. This combined reference will ensure a thorough comprehension of the terminology and abbreviations used throughout the document.

Table 1: Glossary of terms

Term	Definition	Source
Access	Physical (spatial) possibility for a passenger to access or leave the public transport system	FprCEN/TS 16614-1 (2020) (NeTEx)
Access point	Digital interface where data listed in the Annex [to the revised MMTIS Delegated Regulation] together with the corresponding metadata are made accessible for reuse to data users, or where the sources and metadata of those data are made accessible for reuse to data users	MMTIS (revision)
Accessibility of the data	The possibility to request and obtain the data at any time in a digital machine-readable format	MMTIS (revision)
Actor	A person, an organization, or another (sub-) system playing a coherent set of roles when interacting with the Interoperable Fare Management (IFM) system within a particular use case.	ISO 24014-1 (2020)
Airport CDM (A-CDM)	A-CDM is about partners working together and making decisions based on more accurate and higher quality information, where every bit of information has the exact same meaning for every partner involved. More efficient use of resources, and improved event punctuality as well as predictability are the target results.	EUROCONTROL
Air Traffic Management (ATM)	The dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management — safely, economically and efficiently — through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.	ICAO Doc 4444
Air Traffic Management	European ATM Master Plan' means the main planning tool for ATM modernisation defining the development and deployment priorities needed to deliver the SESAR, as endorsed by Council Decision 2009/320/EC. It defines the	SESAR & TEN-T revision

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Term	Definition	Source
Master Plan (ATM MP)	development and deployment priorities needed to deliver the Single European Sky ATM Research (SESAR) vision. The Master Plan is regularly updated, through strong collaboration between all ATM stakeholders, in order to respond to the evolving aviation landscape.	
Application programming interface (API)	Set of functions, protocols, parameters, and objects of different formats, used to create software that interfaces with the features or data of an external system or service.	ISO/IEC/IEEE 26531 (2023)
Catalogue of catalogues	The Catalogue of Catalogues is a Data Catalogue and Vocabulary concept that is derived from DCAT must be adapted to the needs of the SIGN-AIR project and the operation of the project's innovative graph database-based Knowledge Base implementation. A user will provide his/her available data categories in the Catalogue that allows the usage of other functionalities of the SIGN-AIR platform such as the Matching Mechanism.	SIGN-AIR Grant Agreement No 101114845, part B
Connecting flight	Connecting flight means a flight that carries the passenger from a transfer point to which the passenger was transported by a feeder flight, if the flights are under a single contract of carriage. This excludes stopovers, i.e. the voluntary interruption of the performance of the contract of carriage by the passenger and agreed in advance by the air carrier as it appears on the ticket. Such a stopover point shall be regarded as a final destination.	https://data.consilium.europa.eu/doc/document/
Connection flight	The ability to transfer passengers, baggage, cargo or mail from one flight to another within a reasonable time period. On-line connections concern transfers between flights of the same airline designator and interline connections between flights of different airline designators	IATA
Data sharing	'Data sharing' means the provision by a data holder of data to a data user for the purpose of joint or individual use of the shared data, based on voluntary agreements, directly or through an intermediary.	Data Governance Act
Data sharing agreement, DSA	A data sharing agreement is an e-contract* that defines the data that a data provider TSP makes available to a data consumer TSP, and that sets out the specific terms and conditions for the lawful use of such data. The objective of a data sharing agreement (such as single ticketing, synchronisation of timetables, optimization of resources,	SIGN-AIR Grant Agreement No 101114845, part B

Term	Definition	Source
	increased ridesharing, etc.) may be detailed in a smart contract. A DSA is an e-contract that defines the datasets that the Data Provider TSP makes available to the Data Consumer TSP and that sets out the terms and conditions for the use of such Data. By signing a data sharing agreement, the datasets (what) and the objective of sharing them (why) will be clear.	
Deployment	'SESAR deployment phase' refers to successive phases of industrialisation and implementation, during which the following activities are conducted: standardisation, production and certification of ground and airborne equipment and processes necessary to implement SESAR Solutions (industrialisation); and procurement, installation and putting into service of equipment and systems based on SESAR Solutions, including associated operational procedures (implementation).	SESAR Joint Undertaking
Direct flight	A direct flight is any flight between two points by an airline with no change in flight numbers, which may include one or more stops at an intermediate point(s). A stop may either be to get new passengers (or allow some to disembark) or a technical stop over (e.g., i.e., for refueling). Non-stop flights are a special case of direct flights involving no intermediate stops.	
International airport	Any airport designated by an ICAO Contracting State in whose territory it is situated as an airport of entry and departure for international air traffic, where the formalities such as customs, immigration, public health, agricultural quarantine and similar procedures are carried out.	ICAO Glossary
Interoperability	Ability of (sub)systems to interact with other (sub)systems according to a set of predefined rules interface.	EN 12896-1 (2016) (Transmodel)
Interoperable	Ability of (sub)systems to interact with other (sub)systems according to a set of predefined rules (interface).	prEN 12896-10 Transmodel, Alternative modes
Interoperable data	High quality and interoperable data from different domains increase competitiveness and innovation and ensure sustainable economic growth. The same dataset may potentially be used and reused for a variety of purposes and	Data Act

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Term	Definition	Source
	to an unlimited degree, without any loss in its quality or quantity.	
Journey	Planned movement of a public transport vehicle on a day type from the start point to the end point of a journey on a specified route.	EN 12896-1 (2016) (Transmodel)
Journey part	Part of a vehicle journey created according to a specific functional purpose, for instance in situations when vehicle coupling or separating occurs.	FprEN 15531-1 (2022) (SIRI), definition taken from Transmodel
Leg	Term in Transmodel: pt ride leg. Part of a trip corresponding to the theoretical movement of a user (passenger, driver) on one and only one public transport vehicle, from one scheduled stop point to another, on one journey. Leg in aviation is the operation of an aircraft from take-off to its next landing.	FprEN 15531-1 (2022) (SIRI), EN 12896-1 (2016) (Transmodel), ICAO
Matching Mechanism	The Matching Mechanism will allow the identification of potential collaboration opportunities given the data categories that a user defines in the Catalogue of Catalogues. This will be based on the Data Flow Diagrams (DFDs) that define the ontologies of the platform's innovative graph database.	SIGN-AIR Grant Agreement No 101114845, part B
Metadata	A structured description of the contents of this e data facilitating the discovery and use of the data.	MMTIS (revision)
Mobility-as-a-Service (MaaS)	Mobility as a Service (MaaS) is the integration of various forms of transport and transport-related services into a single, comprehensive, and on demand mobility service. MaaS offers end-users the added value of being able to access mobility through a single application and a single payment channel (instead of multiple ticketing and payment operations). To meet a customer's request, a MaaS operator hosts a diverse menu of transport options, including (but not limited to) public transport, active modes such as walking and cycling, ride/ car/bike-sharing, taxi, and car rental or lease, or a combination thereof.	MaaS Alliance, MaaS Market Playbook (2021)
Monitoring Dashboard	The Monitoring Dashboard aims to monitor the contracts signed in SIGN-AIR which is empowered by the fact that contracts are fully digitized; each contract defines quantifiable triggers and actions that the Monitoring Dashboard will use. In addition, the dashboard will provide a	SIGN-AIR Grant Agreement No 101114845, part B

Term	Definition	Source
	UI with graphs and metrics to help users understand progression of triggers' metrics.	
NAPCORE	NAPCORE (National Access Point Coordination Organisation for Europe) is the name of the formed organisation to coordinate and harmonise more than 30 mobility data platforms across Europe. NAPCORE aims to be a coordination mechanism to improve interoperability of the NAPs as backbone of mobility data exchange.	SIGN-AIR Grant Agreement No 101114845, part B
National Access Point (NAP)	NAPs facilitate access, easy exchange and reuse of transport related data, in order to help support the provision of EU-wide interoperable travel and traffic services to end users.	European Commission, Mobility and Transport
Passenger	Any person except members of the crew carried or to be carried with the consent of the carrier, on board any transport vehicle such as aircraft, train, bus, ship. Holds the attributes specific to a one booking, from shopping to fulfilment.	IATA
Platform (SIGN-AIR)	The SIGN-AIR platform brings all the functionalities envisioned in the project under the roof of a web application. The innovation of the platform lies in the fact that it will digitise a process that is dominantly manual up to today. This will lead to determination of completely new issues increasing the needs for requirements elicitation and platform testing. The use of APIs and connection with TCs, to provide added value to the travellers through the services provided will also be paramount for a step forward in informed multimodality.	SIGN-AIR Grant Agreement No 101114845, part B
Public transport (PT)	Any means of transport advertised and available for use by the general public.	prEN 12896-10 (2022), Transmodel
Regional airport	Regional airport generally refers to an airport of medium or small city that is mainly served by short-haul regional services. An airport should be considered as regional if it: 1) Primarily serves short and medium range routes and 2) Primarily serves point-to-point destinations	ICAO, doc 9626, ACI EUROPE

Term	Definition	Source
Short-haul flights	Flights lasting up to 3 hours	IATA
Smart Contract	A SC composed of a legal part in natural language and a software part in executable computer code, to detail the Objective of one (or more) Data Sharing Agreement(s) by defining specific Triggers and Actions as well as the terms of Revenue Sharing and Responsibility Sharing. By signing a smart contract, the way operational obligations (actions) (how) and when to execute them (when) will be clear and continuity of data sharing will be secured with a proof statement.	SIGN-AIR Grant Agreement No 101114845, part B
Stakeholder	A stakeholder is a person, group or organization with a vested interest, or stake, in the decision-making and activities of a business, organization or project.	https://www.techtarget.com/searchcio/definition/stakeholder
Strategic planning	Planning involving the formulation, implementation, evaluation and continual improvement of factors that are relevant to an organization's interests over a defined period, and the means of achieving its objectives.	ISO 30400 (2022)
Synchronisation of timetables	The vehicle arrivals of a one TSP at the specific point (e.g. an airport) and vehicle departures of another TSP from the same point are organised in a way that provides many destinations offered with the reduced transfer time between these operations. This reduced transfer time can be defined by setting the maximum connecting time that is acceptable to consider two timetables synchronised. It allows passengers to have a seamless and faster journey.	SIGN-AIR Grant Agreement No 101114845, part B
Transport mode	Characterisation of the operation according to the means of transport (e.g. bus, tram, metro, train, ferry, ship).	FprEN 15531-1 (2022) (SIRI), taken from Transmodel and NeTEx
Transport operator	The term transport operator is used to describe both public and private actors that are providing transportation services for customers.	https://www.diva-portal.org/smash/get/diva2:1371960/FULLTEXT01.pdf
Transport Service Provider	The Service Operator provides a service to the Customer against the use of a product. MaaS Alliance lists quite some stakeholders in the "MaaS ecosystem": Public Transport Authorities, Public Transport Operators, Cities, National and	ISO 24014-1 (2022), MaaS Alliance

Term	Definition	Source
	Regional Regulators, Mobility Service Providers, Automotive Sector, Cycling Sector, Fleet Managers, Technology Providers, Engineering and Consulting Companies and MaaS Operators	
Travel companion (TC)	TCs are considered to be applications, web or smartphone, which provide travel-related functionalities to the user such as Journey Planning and ticket issuing.	SIGN-AIR Grant Agreement No 101114845, part B
Traveller	Alternative term (also see): Passenger	
Trip	A trip (or journey) is a one-way course of travel from one place to another with a single main purpose. The movement from an origin to the final destination. A trip can also consist of several stages or legs.	EUROSTAT

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3. List of Acronyms

Table 2: List of acronyms

Acronym	Definition
AIDM	Airline Industry Data Model
DSA	Data Sharing Agreement
EN	European standard
TS	Technical specification
TR	Technical Report
SSIM	Standard Schedules Information Manual
SCR	Slot Clearance Request/Reply
NeTEx	Network Timetable Exchange
GTFS	General Transit Feed Specification
SIRI	Standard Interface for Real-time Information
ATM	Air Traffic Management
EATM MP	European Air Traffic Management Master Plan
EUSCG	Single European Sky Coordination Group
WASG	Worldwide Airport Slot Guidelines
WASB	Worldwide Airport Slots Board
ASWG	Airport Slot Working Groups
SMG	Slot Messaging Group
SPG	Schedules Publication Group
MCTG	Minimum Connect Times Group
PSC	Passenger Standards Conference
SSM	Standard Schedules Message
ASM	Ad Hoc Schedule Message

SMI	Standard Message Identifier
SAL	Slot Initial Allocation List message
SAQ	Schedule Availability Query message
SCR	SLOT CLEARANCE REQUEST/REPLY
SHL	Slot Historic List message
SIR	Slot/Schedule Information Request/Reply message
SMA	Schedule Movement Advice/Reply
TSP	Transport Service Provider
WCR	Waitlist Change/Reply message
WIR	Waitlist Information Request/Reply

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4. Introduction

4.1 Purpose of the document

The project aims to develop and pilot a new platform for sharing data in multimodal travel. To be more particular, this platform will enable transport service providers (TSPs) to register, establish data sharing agreements, and manage their contractual relationships. Key features include simplified legal management with contract templates, electronic management of contract information, and enriched routing information for Travel Companions (TCs) to support single ticketing through a comprehensive understanding of contracts and managed data.

For SIGN-AIR to be able to utilize standardised data and use them in its Monitoring Dashboard as well as the medium of communication with the TCs, a clear understanding and technical examination for each of the data standards – European standards (EN), technical specifications (TS) or technical reports (TR) - must be reached. Followingly, a successful understanding of the data standards and management of those will provide a source input to the National Access Points (NAPs) whose purpose is to provide a single interface through which transport-related data from various data providers are made accessible to the public. Datasets are accompanied by a standardised set of metadata in order to facilitate their exchange and reuse. Such an in-depth examination is being conducted, which led to the compilation and release of D2.2 STAND – Initial, which should be read in conjunction with this report. D2.2 captures the standardisation needs of the SIGN-AIR SESAR solution in general, concerning numerous types of transport, while D2.21 focuses on the most adopted set of data standards that apply in aviation and public transport and their harmonisation, strictly for the purposes of the specific standardisation tools the project aims to develop and connect/implement in the SIGN-AIR solution.

Apart from this mapping and comprehension of the standards in the transportation field, the SIGN-AIR technical solution requires enhancements, in order to tackle standardisation and harmonisation needs of the TSPs and thus enable them to implement their agreements, seamlessly exchange data, adopt appropriate standards, and streamline their operations and collaborations. This is where this document, D2.21, comes in, which focuses in two specific tools that can offer those significant enhancements of the SIGN-AIR's capabilities, specifically in the standardisation-harmonisation aspect and thus even pave the way towards future developments and enhancements. Those crucial tools are the following:

1. SSIM Standardisation Mechanism in TransiTool: This tool extends TransiTool's capabilities to include the International Air Transport Association Standard Schedules Information Manual (IATA SSIM) standard. TransiTool already addresses the challenge of non-standardised data with advanced algorithms and a user interface that maps data fields to standardised formats, such as GTFS and NeTEx. This extension benefits aviation stakeholders and enables SIGN-AIR to support one more paramount transport mode, that of aviation;
2. Field Matching Tool: This tool is designed to associate non-standardised data fields registered in the SIGN-AIR platform with standardised formats. It will be implemented directly in the SIGN-AIR platform, reading data fields, and providing recommendations and mechanisms for end users to define each field according to applicable standards. This facilitates the conversion to standardised data, following an investigation of the IATA SSIM and its correspondence with Transmodel and GTFS.

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This report, and the tools it outlines, focus -in essence- on facilitating the comprehension of the applicable standards by the TSPs and how those standards can be applied in practice with certain guidance and added-value services from the SIGN-AIR platform and the said tools.

The most adopted set of data standards in the aviation industry regarding the exchange of airline time schedules is the aforementioned publication, the IATA Standard Schedules Information Manual (SSIM)[2] (IATA, 2023). It is the official set of standards, guiding the industry with recommended practices, messaging formats and data processing procedures that are to be used by all IATA member airlines and their business partners for the exchange of airline schedules, communication of airport coordination information and minimum connect time data. For that purpose, the project will develop a standardisation mechanism for IATA SSIM that would then be connected to the SIGN-AIR platform for data retrieval and sending. The IATA SSIM tool for standardisation will involve the creation of the UI (map where the user can insert the information) and the database components (conversion from SCR and other formats to a Relational Database Management System). Especially for the case of the IATA SSIM data standard further investigation has been conducted regarding the cost of accessing the documentation of the standard and other aspects as well.

Moreover, the second tool to be created will be able to associate non-standardised to standardised data. This tool is called Field Matching Tool and will be implemented in the SIGN-AIR platform when the user (TSP) registers information to create his data attributes Catalogue and when the said TSP engages in a negotiation within the platform with another party (a second TSP), in order to compile a Data Sharing Agreement (DSA) and form thus a synergy for achieving a mutually beneficial goal that requires the exchange of data (e.g. to achieve efficient management of disruptions, synchronisation of timetables in order to accommodate the travellers better and thus increase their revenues while also optimise their resources allocation etc.). This specialised tool, the Field Matching Tool, will read the data fields defined in the DSA and provide suggestions and guidance regarding the applicable data standards which the end users can consult and follow, in order to standardise their data and thus achieve a much smoother, seamless and of high-quality data exchange between them for their agreement purposes.

In addition, another aspect that was very prominent and thus we researched during the development of the mechanism in TransiTool, is the aspect of data harmonisation. As it has already successfully been conducted by the Transmodel consortium[3] which has executed a study on harmonising the industry standard and the EU - approved standard (NeTEx and GTFS) regarding public transport, the SIGN-AIR project aims to generate a study in the similar direction regarding NeTEx/SIRI and IATA SSIM harmonisation which will be possible after a successful mapping of all relevant data standards. As mentioned previously, an extensive mapping of multiple standards for many modes of transportation has been conducted in D2.2 – Standardisation (STAND) – Initial, and more in-depth information regarding standards and harmonisation efforts will be provided in the rest of the STAND series, meaning D2.5 – Standardisation (STAND) – Intermediate (December 2024) and D2.12 – Standardisation (STAND) – Final (January 2026).

[2] Official website of IATA SSIM publication can be found here: https://www.iata.org/en/publications/store/standard-schedules-information/

[3] https://netex-cen.eu/faq/how-does-netex-compare-with-gtfs/

It is important to note that this deliverable focuses on data standardisation in accordance with IATA SSIM within TransiTool, as well as the harmonisation between SSIM and GTFS/NeTEx to a great extent, due to the development being in a very advanced stage. On the other hand, the Field Matching Tool for the detection of applicable standards and the facilitation of converting non-standardised data fields to standardised formats is elaborated up to a certain degree and leaves a part of the identification of standardisation need(s) required for the deployment of the SIGN-AIR platform for the said platform's next version. Currently, the platform is at the Minimum Viable Product stage and is expected to reach a higher Technical Readiness Level by April 2025. The primary reason for this phased approach is that the platform's design and architecture need to be more advanced to accurately identify and address these standardisation needs. Additionally, the relationship between the SIGN-AIR platform and the Air Traffic Management (ATM) system remains unclear, as SIGN-AIR targets multimodality rather than solely focusing on air transport.

Finally, it is equally important to note that D2.21 emphasises on aviation due to the unique challenges in harmonising IATA SSIM with public transport standards like GTFS and NeTEx. These challenges arise from differences in transport modes, regulations, data formats, procedures, relations between key actors in the field (airports, airlines and coordinators) and the complexity of aviation data transmission (e.g., Schedule Change Request - SCR messages are being transmitted between actors for scheduling flights and clearing the appropriate slots, unlike the way e.g. stops, routes and schedules are being planned and executed in public transport and rail). The novel focus on harmonising aviation with public transport standards in D2.21 tackles the unique challenges posed by differences in modes, regulations, and data management practices. This focus ensures the SIGN-AIR platform can effectively support diverse transport modes, laying the groundwork for broader harmonisation efforts across the transportation sector. The upcoming D2.5 deliverable, expected in late 2024 - early 2025, will expand on additional transportation standards, making the STAND series a series that covers the majority standards. It will delve deeper into the harmonisation of NeTEx and GTFS, already addressed by the Transmodel consortium, thus complementing this report, and providing coverage for even more transportation modes and harmonisation aspects relevant to both the project, the SIGN-AIR solution, and all SESAR Joint Undertaking's future initiatives.

4.2 Intended readership

This section outlines the specific audience for whom the insights and recommendations presented in this report are intended. The primary readership for this deliverable encompasses the European Air Traffic Management (ATM) community, prominently the European Air Traffic Management Master Plan (ATM MP) Stakeholder Consultation Group (EASCG). Additionally, this report holds relevance to other stakeholders, including the European Union's Single European Sky Coordination Group (EUSCG), and the European Standardisation Coordination Group (ESCG). The collaborative input and consideration of these key stakeholders are pivotal in advancing SESAR's contributions to standardisation activities, particularly in collaboration with organizations such as EUROCAE.

5 Literature Review

In this chapter, for the purposes of the standardisation mechanism in TransiTool and harmonisation endeavour between SSIM and GTFS/NeTEx, we document all the research conducted during the creation of this deliverable, along with all prerequisite knowledge. The research primarily focused on the reference manuals of IATA, an elementary knowledge to grasp before conducting any kind of exercise and development towards 'translating' aviation data into other kinds of formats such as GTFS, for standardisation – harmonisation purposes.

5.1 Prerequisite Knowledge

In this subchapter, we delve into the structure and operations of key players in the airline industry and provide an in-depth explanation of the prerequisite knowledge related to the processes outlined by IATA.

5.1.1 Airport Coordination

Airport coordination manages airport capacity by applying rules outlined in the Worldwide Airport Slot Guidelines (WASG). It involves allocating limited airport capacity to airlines and other aircraft operators to ensure efficient airport and air transport operations. The primary goal is to optimize the use and allocation of available airport capacity for the benefit of travellers, considering the interests of both airports and airlines. Objectives that can be achieved are shown below.

Table 3: Objectives of airport coordination (Association, Worldwide Airport Slot Guidelines (WASG), 2024)

	Enhancing consumer choice of air services, improving global connectivity, and increasing competition at congested airports for passengers and cargo.
	Providing consumers with convenient, consistent, and reliable schedules that meet demand.
	Ensuring that slots at congested airports are allocated in an open, fair, transparent, and non-discriminatory manner by an independent slot coordinator.
	Maximizing airport infrastructure capacity and promoting regular reviews of capacity and demand for effective seasonal slot allocation.
	Balancing access opportunities for both existing and new airlines.
	Allowing flexibility for the industry to respond to regulatory changes, market conditions, and consumer demand.
	Reducing congestion and delays.

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5.1.2 Levels of airport activity

Airports as described in the IATA WSMG document are classified in of the following three levels depending on their ability to handle upcoming passenger demand for a given season based on their existing infrastructure and services.

Table 3: IATA airport levels (Association, Coordinated Airports, n.d.)

Level 1
• Airports that have sufficient capacity to meet user demand and are considered non coordinated from a scheduling perspective.
Level 2
• Airports that are nearing capacity, requiring formal cooperation to prevent over capacity. These airports are known as schedules facilitated.
Level 3
• Airports that experience demand which exceeds capacity during peak periods, making it impossible to address the issue through voluntary airline cooperation. After consulting with all parties and finding no short term solutions, formal procedures are implemented to allocate capacity and coordinate schedules. These highly congested airports are termed fully coordinated.

The pair of world maps illustrates the distribution of NS24 and NS25 levels, delineated by yellow and red markers, respectively. In the first map below titled "NS24 Level," regions across Europe, Asia, and parts of Africa host these markers, with red markers indicating NS24 Level 3. The second map below, titled "NS25 Level," mirrors this pattern, with similar concentrations of data points across the same continents. This visual comparison highlights the global distribution and density of NS24 and NS25 levels, facilitating a clear understanding of their geographical prevalence. (Association, Coordinated Airports, n.d.)

The following graph was generated using the open access dataset “List of level 2 & 3 Airports[4]”

[4] https://www.iata.org/contentassets/4ede2aabfcc14a55919e468054d714fe/wasg-annex-12.7.xlsx

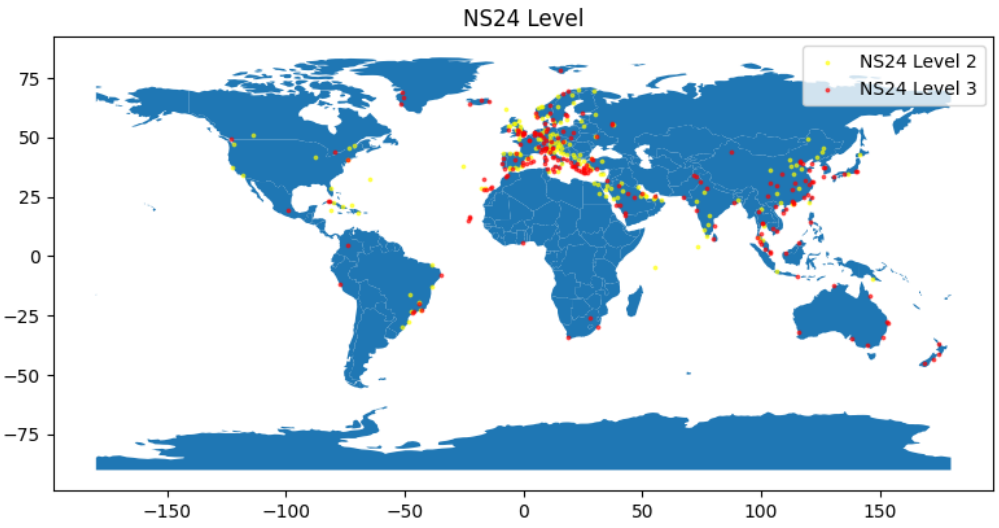

Figure 1: IATA airport levels for 2024

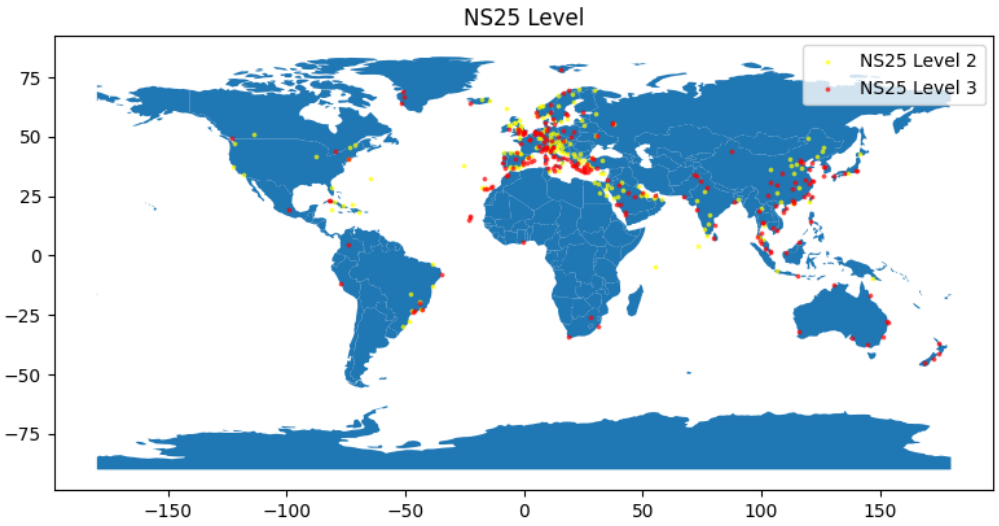

Figure 2: IATA airport levels for 2025

The infographic by IATA Consulting outlines benchmarks crucial for efficient passenger terminal operations, focusing on departure and arrival processes. It details optimal time and space requirements for key stages such as check-in, security, passport control, boarding gates, customs control, baggage claim,. It suggests that departure processes ideally take 1-2 minutes for check-in, 5-10 minutes for security, and 1-5 minutes for passport control, with similar benchmarks for arrival processes. Notably, the infographic underscores the importance of providing adequate seating space and minimizing wait times, highlighting the "Level of Service (LoS)" concept to improve operational standards. The information serves as a tool for airport management to enhance terminal performance,

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ultimately aiming to offer passengers efficient and satisfactory experiences by reducing waiting times and ensuring sufficient space throughout their journey.

Figure 3: IATA Infographic regarding airport level of service

(Association, Airport Level of Service Concept, n.d.)

In the following table, a description is given for each different operational level of an airport as defined in the IATA SSIM documentation.

Table 4: Airport levels

Airport Level	Description
1	Airlines operating or planning to operate at a Level 1 airport should give adequate notice of their planned operations to their appointed handling agent and either the airport managing body or the data collection agent if one is appointed. Operations at Level 1 airports are not addressed at the SC
2	All airlines operating or planning to operate at a Level 2 airport must submit details of their planned operations to the facilitator before operating at that airport. For this purpose, details of the format to be used are shown in SSIM Chapter 6. Airlines should be prepared to accept an alternative time if offered by the facilitator to avoid exceeding the coordination parameters, otherwise the airport may need to consider

	changing to Level 3. The deadline dates for data submission can be found in the Calendar of Coordination Activities[5].
3	All airlines operating or planning to operate at a Level 3 airport must be allocated a slot by the coordinator before operating at that airport. For this purpose, details of the formats to be used are shown in SSIM Chapter 6. Airlines should have adequate resources, expertise, and systems to effectively participate in the coordination process.

5.1.3 Main Actors

There is a total of three actors described in the IATA SSIM data documentation, the Coordinator, the Facilitator and the Airlines.

- Coordinator: The entity or individual in charge of assigning slots at a Level 3 airport.
- Facilitator: The entity or individual responsible for gathering data on scheduled activities at a Level 2 airport and suggesting voluntary schedule changes if needed.
- Handling Agent: An individual or organization acting on behalf of an airline at an airport, overseeing passenger or cargo services, or aircraft dispatch.

5.1.4 Role of industry groups in airport coordination

The Worldwide Airport Slot Guidelines (WASG) are a set of standards and best practices created by airports, airlines, and slot coordinators/facilitators. These guidelines provide detailed procedures for allocating and managing airport capacity. Airports, airlines, coordinators, and facilitators primarily use these guidelines. The WASG is jointly maintained by ACI, IATA, and WWACG, overseen by the Worldwide Airport Slots Board (WASB), which includes equal representation from airports, airlines, and slot coordinators/facilitators. The WASB is tasked with suggesting policy developments, improving procedures, and analysing future trends and technology. The WASB establishes Airport Slot Working Groups (ASWG) to address specific industry issues. These groups recommend changes to the WASG for WASB approval and help implement the standards. All changes to the WASG must be approved by the WASB, preventing any unilateral modifications by airports, airlines, slot coordinators/facilitators, or industry groups. The WASG is globally recognised as the industry standard for slot allocation at Level 3 airports and managing operations at Level 2 airports. States or governments developing their own procedures are encouraged to adopt these guidelines. Industry groups advocate using these guidelines as the basis for such regulations. The WASG ensures a consistent, transparent, and fair method for allocating and managing airport capacity. Given the global nature of air transport, harmonised slot allocation standards at both origin and destination airports are essential for maximizing efficient use of resources.

[5] www.wwacg.org

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5.1.5 Rules and Guidelines (based on the IATA WSMG)

The aviation industry relies heavily on the precise and efficient exchange of scheduling information, a process governed by the Standard Schedules Information Manual (SSIM). Established under the IATA Passenger Standards Conference Recommended Practice 1761b effective from July 1, 1972, the SSIM serves as a critical resource for standardising data processing and messaging procedures among IATA Member airlines and their business partners. This manual facilitates the streamlined exchange of Schedules, Slot, and Minimum Connecting Times information, ensuring consistency and efficiency across the global aviation network.

5.2 Standard Schedules Information Manual (SSIM)

The Standard Schedules Information Manual (SSIM) is constituted under IATA Passenger Standards Conference Recommended Practice 1761b that was declared effective on 01 July 1972. The Manual is designed to help originators and recipients of scheduling information in terms of data processing and messaging procedures. Its use is encouraged for all IATA Member airlines and their business partners as the standard for the exchange of Schedules, Slot and Minimum Connecting Times information throughout the industry.

5.2.1 Introduction

Airline schedule data is dispersed across various entities within the industry, including airline reservations systems, travel agencies, airline partnerships, traffic handling agencies, airport coordinators, air traffic control authorities, and governmental departments. Initially linked with airline reservations and ticketing systems, this data extends to other necessary information for schedule planning, production, and operational purposes. To optimize system efficiencies, it is suggested that a minimum of 360 days of advance schedule data, along with Minimum Connect Time data, be uniformly distributed among all schedules aggregators and reservations and ticketing systems involving a carrier. Given the escalating data volumes exchanged, there is a pressing need for quicker and more effective data exchange methods within the industry. Airlines stress the importance of developing compatible scheduling systems to facilitate cost-effective exchange of schedule information. Hence, all involved parties must employ processing/IT systems and established procedures to manage the substantial data flow efficiently. In response to this necessity, IATA Member Airlines initiated the formulation of Recommended Practices to guide the industry towards harmonious handling of schedule/slot data procedures. These practices, along with industry code sets, are documented in the Standard Schedules Information Manual (SSIM). The responsibility for maintaining the SSIM lies with the Schedules Publication Group (SPG), collaborating with the Slot Messaging Group (SMG) and the Minimum Connect Times Group (MCTG), all established under the Plan Standards Board (PSB) reporting to the IATA Passenger Standards Conference (PSC). Further information on IATA Passenger Standards development and adoption can be found in the PSC brochure available at iata.org/psc. Detailed Terms of Reference for these groups are accessible at www.iata.org/psc-plan. For those interested in participating or accessing activities under these groups, visit https://standards.iata.org.Harmonisation with other data standards. Benefits to be acquired once implementing:

Table 5: IATA SSIM Data standard benefits

	Implementing faster and more efficient input procedures will result in significant savings in manpower and time for both airlines and agencies.
	Decreasing lead times for timetable agency publication will enable the inclusion of more current information.
	The downtime of computer reservations systems for updating processes will be substantially reduced.
	Processing new season's timetables will be expedited and improved in accuracy, allowing for more efficient updates.
	Airlines or agencies equipped with computer facilities capable of handling information in the standard format can process and transmit this information on behalf of airlines lacking such facilities.
	The broader the adoption of recommended practices, the more feasible it becomes to establish schedule data banks for various analytical purposes.
	Streamlining the exchange and consolidation of computerized timetable data will greatly enhance operational control, airport and airspace coordination, both daily and for future planning. This will also facilitate fast-time ATC Simulation.

5.2.2 General

The publication which was purchased through the IATA SSIM website and was thoroughly studied is the Standard Schedules Information Manual (SSIM) Edition 33 Update 2 which is accessible via the Digital Publications Library, IATA, 2023.

5.2.2.1 Data Requirements

When exchanging schedules information, it is essential to standardise the set of data elements used. The main reason for this is that when the information is used in automated systems, the size of investment in hardware and communications facilities demands that the appropriate data be processed in these systems. However, manual systems will also benefit from such development.

A data element is in this connection defined as a sequence of alphanumeric, alphabetic, or numeric characters that, depending on the specific context, has a unique meaning.

Each individual data element must be described and used in the same way. For the successful automation of schedules information to occur, each data element must imply one and only one meaning to each system and individual who uses the data element.

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Likewise, it is necessary to set size limits for the data elements and define rules for the construction and interpretation of the contents so that the transmission and processing of the data elements can be conducted in an orderly fashion.

This Chapter contains a presentation of the rules applied when defining data elements and message formats in this manual and when referring to data elements in the procedures presented in this manual, as well as defining terms used by those handling schedules information.

5.2.2.2 Data Representation

To facilitate global communication, the use of primary characters is restricted to the following:

- Alphabet: Uppercase Roman letters from A to Z, encompassing twenty-six alphabetic characters.
- Numerals: Digits from 0 to 9, covering ten numeric characters.
- Special Characters: Includes the full stop (.), slash (/), and minus sign (−). Each is considered one special character.
- Non-Transmittable Characters in Telegraph Messages: Plus sign (+) and asterisk (*).

5.2.2.3 Data Element Status

The IATA SSIM data standard defines for each data element whether this element is mandatory, conditional, optional, or not permitted. Specifically,

- Mandatory: A mandatory data element is essential for data communication and must always be included.
- Conditional: A conditional data element becomes mandatory under specified conditions outlined in the Technical Specifications. It should be excluded if these conditions are not met, often depending on the presence, alteration, or removal of other essential data. Recipients may perceive conditional data as optional.
- Optional: An optional data element can be left out if not needed. Its absence does not impact other elements and is independent of their presence or absence in the Standard Schedules Message Procedure. An optional data element is one that is not required for the basic functionality of data communication but can be included if the sender finds it useful or relevant. These elements provide additional details that may enhance the quality or completeness of the data being shared but are not crucial for the core exchange of information.
- Not permitted: Data elements categorized as "not permitted" cannot be included in the schedule messages. Their presence would violate the standard's format and could lead to errors or inconsistencies in data processing. The SSIM defines the format and content of messages used for schedule updates. It clearly outlines which elements are acceptable and which are forbidden, helping to maintain consistency and reliability in the data being shared.

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To enable all airlines to electronically share updates to their basic schedules, which are the planned and regularly operated flights, standard message formats have been established. These formats also allow airlines to submit these updates to schedule aggregators.

5.2.2.4 Description

The message formats are designed for maximum clarity for users, and the details received can be processed either automatically or manually. Permanent changes to basic schedules are communicated using the Standard Schedules Message (SSM), which may contain one or more Action sub-messages, each identified by a specific Action Identifier indicating a particular change to the schedule. The rules for creating and using these messages, along with detailed specifications and examples, are provided in the following sections of this chapter. In contrast, changes to schedules on individual days can be communicated through the Ad Hoc Schedule Message (ASM), with its rules, specifications, and examples detailed in Chapter 5 of the IATA SSIM Documentation.

The SSM is part of a comprehensive system for exchanging schedule information. To ensure industry-wide adoption of these standards, a variety of optional features are included to guarantee full compatibility with the standards outlined in Chapter 7 for schedule data exchange. These features include the use of local dates and times, leg and segment-oriented traffic, and sales information presented in fixed or free format data elements.

5.2.2.5 Structure

Each SSM message comprises five key components:

- The message address/originator, following communication instructions.
- The message header, which includes the Schedule Standard Message Identifier (SSM), the Time Mode, and an optional Message Reference.
- One or more Action Sub-Messages, each containing the Action Identifier, flight identification, relevant data elements, and ending with a Sub-Message separator.
- An optional Supplementary Information Sub-Message that applies to the entire message.
- The message end, in line with communication instructions.

5.2.2.6 Available sub messages

Varius action sub messages have been defined which are an integral part of the SSM. The most common are defined below in the table.

Table 6: IATA SSIM Action Identifiers and uses

Action Identifier	Name	Functional Use
NEW	Insertion of New Flight Information	This sub-message adds new Flight Designator information, including new Periods of Operation and/or Day(s) of Operation, to an existing Flight Designator.

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CNL	Cancellation	This sub-message withdraws the complete routing of a Flight Designator within specified Periods and Day(s) of Operation.
RPL	Replacement of Existing Flight Information	This sub-message replaces existing information of a Flight Designator within specified Periods and Day(s) of Operation with new information.
SKD	Schedule Update	This sub-message cancels all existing information for a specified Flight Designator from a specified Effective Date to a Discontinue Date, if provided, and indicates upcoming schedule revisions.
ACK	Acknowledgement	This sub-message informs the sender that the message content has been accepted and successfully processed by the receiving system.
ADM	Change of Existing Information	This sub-message modifies specific data elements for a Flight Designator/Period of Operation/Day(s) of Operation without affecting other periods or days.
CON	Change of Aircraft Configuration	This sub-message changes Aircraft configuration Version information and/or conditional data elements for specified Flight Designator/Period of Operation/Day(s) of Operation.
EQT	Change of Equipment Information	This sub-message updates Equipment information and/or conditional data elements for specified Flight Designator/Period of Operation/Day(s) of Operation.
FLT	Change of Flight Designator	This sub-message modifies the Flight Designator and associated data elements for specified Periods and Day(s) of Operation.
NAC	Not Actioned	This sub-message notifies the sender that the message content was not successfully processed and includes details of the error.
REV	Revision of Period of Operation	This sub-message revises Periods of Operation and/or Day(s) of Operation within a Flight Designator, allowing additions or deletions as specified.
RSD	Request for Schedule Data	This sub-message requests or repeats schedule data for a specified Flight Designator within a specified validity period and mandates the structure of the reply.
TIM	Change of Time Information	This sub-message updates Timing information and/or conditional data elements for specified Flight Designator/Period of Operation/Day(s) of Operation.

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5.2.3 Ad Hoc Schedules Message Procedure

This is an extension of Chapter 4, to cover “ad hoc” or “occasional” changes to established and previously disseminated schedules, but which affect a flight on single dates. Such an “ad hoc” change of plan may be notified at any stage in advance of the operation and may refer to an “extra” flight.

In the case of a previously advised flight, it may reflect the cancellation of the whole or part of a flight, or a change of routing, timing, equipment, or configuration.

The telegraph message formats described in this chapter are intended to cover a wider variety of planning and operations control functions that are necessary in the case of the more basic schedule changes covered in the previous chapter.

It should be noted that procedures for the reporting of unplanned eventualities such as diversions and disruptions are covered in the IATA Airport Handling Manual.

5.2.4 Airport Coordination Procedure

When airport coordination is required for a given airport, the national airport slots are managed by a national body.

Airport coordination is an essential process for managing the high demand for takeoff and landing slots at busy airports, ensuring smooth and efficient flight operations. This coordination is particularly crucial at airports where the demand for slots exceeds the available capacity, necessitating meticulous planning and management. Here is an in-depth explanation of how airport coordination functions, focusing on airport slots and the circumstances under which coordination becomes necessary.

5.2.5 Presentation and Transfer of a Schedule Data Set

In the Standard Schedules Information manual and specifically in Chapter 7 named Presentation and Transfer of a Schedule Data Set published by IATA the described way for formatting an airline carrier’s complete schedule to enable the exchange of flight schedule information between various actors and information systems seamlessly. Since transmission of data depends on hardware and software used by the parties, it is suggested that a bilateral agreement is reached. The format described in this chapter can be used by various actors such as air traffic control authorities, government bodies, airports, travel agencies and other consultants.

The principles for transferring schedule data sets emphasize bilateral transfer, ensuring confidentiality by prohibiting the reforwarding of data without permission. They adhere to SSIM Standards, dictating a standard format for complete schedule transfer, with recipients responsible for selecting relevant portions and tracking changes. A recommendation suggests distributing at least 360 days of advance schedules equally among all relevant systems to optimize efficiency. Additionally, files may contain varied schedule sets for a single carrier, and upon receipt, the information supersedes any previously received data for the same period.

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The structure used to encapsulate a complete schedule is made of five sub records. Each record is strictly 200 bytes long and is subdivided into Data Elements. Specifically, each data element has a fixed length and occupies a fixed position in the record. Data elements can be mandatory, conditional, or even optional. A note to be made is that the times referenced inside a dataset can be either in local time or UTC.

Five record types are used and are mandatory in each dataset.

- Header record (Record Type 1): Its purpose is to ensure users that the dataset is being accurately interpreted and, where relevant, specifies the number of subsequent seasons.
- Carrier Record (Record Type 2): The record provides information about the timeframe(s) during which the schedules on subsequent records are valid. It follows a standard length of two hundred bytes and is divided into specific fields.
- Flight Leg record (Record Type 3): The document outlines the details pertaining to a distinct Flight Leg Record as delineated in bytes 02–14. While there is no mandated sequence for Data Element Identifiers when there are multiple ones linked to the same Flight Leg Record, a suggested approach is as follows:
- If there are various Segment Data Records corresponding to different Off Points, arrange them based on the sequence of the Off Points in the itinerary.
- In cases where multiple Segment Data Records relate to the same Off Point, they should be grouped together and ordered according to the numeric sequence of the Data Element Identifiers, beginning with the lowest number. Nevertheless, systems should have the capability to process data elements irrespective of their order.
- Segment Data record (Record Type 4)
- Trailer Record (Record Type 5)

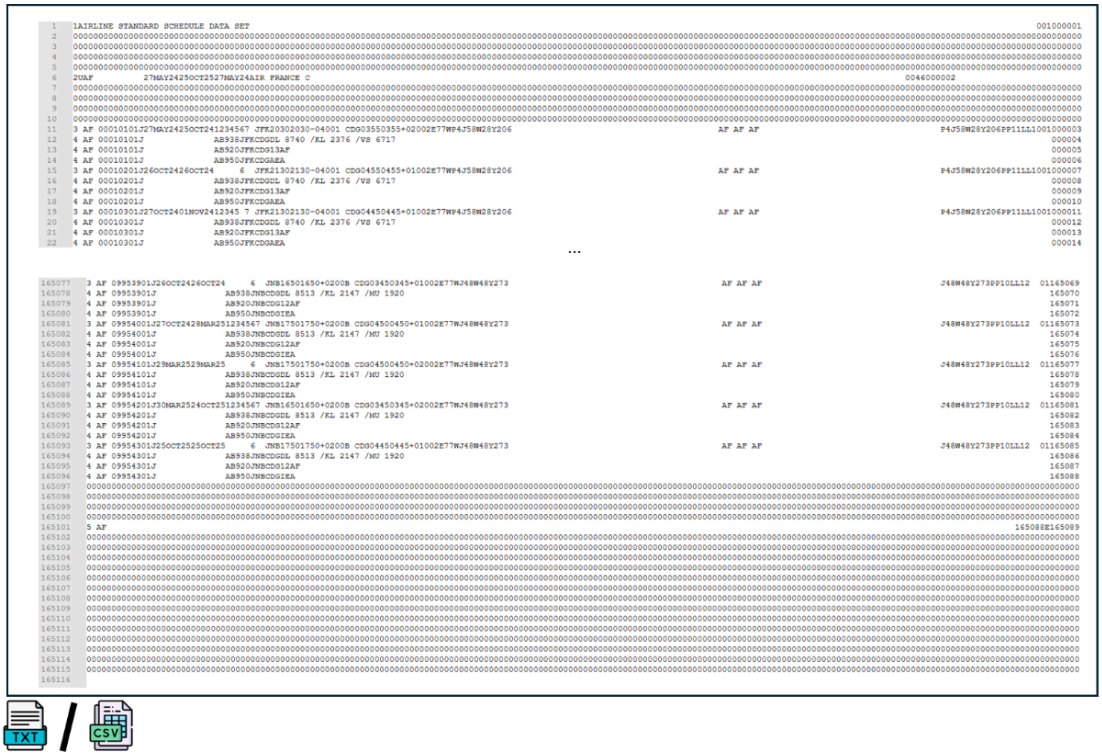

Figure 4: IATA SSIM Schedule Dataset structure

5.2.6 Slot coordination reply and request (SCR)

Slot coordination refers to the process where airlines request and receive approval for the use of airport slots—specific time intervals for take-off and landing. A slot coordination request is an airline's submission for a desired slot, specifying the times and dates they wish to operate at a particular airport. In response, the slot coordination reply is the feedback from the coordinating authority, either granting the requested slot, offering an alternative, or denying the request based on availability and regulatory constraints. This process ensures efficient use of airport capacity and helps to manage air traffic effectively.

5.2.7 Standard Message Identifier SMI

The Standard Message Identifier (SMI) is an IATA approved three-letter code used to uniquely identify a given type of message. It is always included as the first line of the standard message after the Message Address Envelope.

The SMIs used in these procedures are SAL, SAQ, SCR, SHL, SIR, SMA, WCR and WIR

Table 7: IATA SSIM Standard message Identifiers and explanation of usage

	SAL (Slot Initial Allocation List message)

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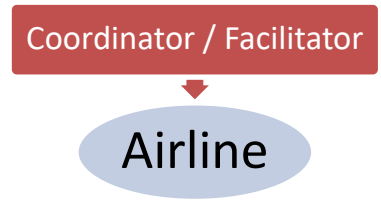
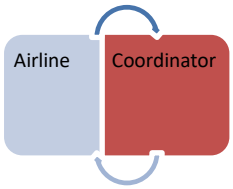
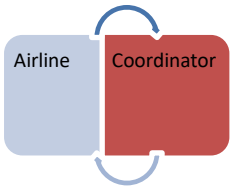
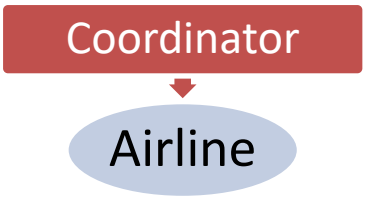
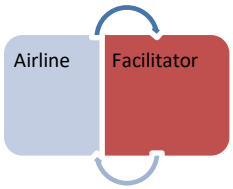
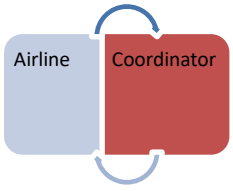
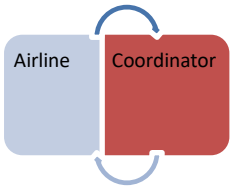
	Standard message used by coordinators and facilitators to inform airlines of the results of Initial Coordination at a Level 2 or Level 3 airport
	**SAQ (Slot/Schedule Availability Query message)** Standard message used by an airline to inquire about a potential change and/or by a coordinator or facilitator to inform airlines on the feasibility of their considered change.
	**SCR (SLOT CLEARANCE REQUEST/REPLY)** Standard message used by airlines and coordinators, for planning purposes for the clearance of flights at Level 3 airports.
	**SHL (Slot Historic List message)** Standard message used by coordinators to inform airlines of the status of their historic slots.
	**SIR (Slot/Schedule Information Request/Reply message)** Standard message used by an airline to request a planned operations data for a specific airport and/or used by coordinators and facilitators to inform airlines of the status of their planned operations. An SIR can be requested by an airline or sent to the airline unsolicited by a coordinator or facilitator.
	**SMA (Schedule Movement Advice/Reply)** Standard message used by airlines and facilitators for exchange of data on planned operations at a Level 2 airport.
	**WCR (Waitlist Change/Reply message)** Standard message initiated by an airline to request a change to any waitlisted flights without changing the allocated data. It also allows the airline to add or delete flights on the waitlist whether slotted or un-slotted.

	**WIR (Waitlist Information Request/Reply)** Standard message initiated by an airline to request its own waitlist data or that of another airline. A WIR can also be sent unsolicited by a coordinator or facilitator to inform an airline of the status of its waitlist.

5.2.8 Action Codes

Action Codes are essential for delineating particular tasks performed by designated users (e.g., airline, coordinator, or facilitator) in Level 3 and Level 2 messages. These codes are tailored to both the assigned user and the message's function. Tables provided below outline the permissible Action Codes for each message alongside the corresponding user. Messages and their associated Action Codes are organised alphabetically. These codes serve to specify the exact function of the message, with subsequent sections elaborating on the typical utilization of each Action Code by both the message sender and recipient.

Available action codes (based on page 194)

5.2.8.1 Historic Slot Determination Procedure

The coordinator provides the historic slot information electronically through an SHL message, which must be submitted by the deadlines outlined in the WASG. The Period of Operation for historic slots in the SHL should reflect the dates adjusted for the upcoming season. For records covering the entire Period of Operation, the start and end dates should align with those of the new season.

If flights do not cover the entire Period of Operation, the start and end dates of the historic slots should be the nearest dates corresponding to the same days of operation in the previous season. This includes adjusting a full season series of slots by one week if the new season is longer or shorter by a week compared to the previous one.

When flight records are fragmented due to changes like ad hoc cancellations or aircraft type changes during the previous season, the coordinator must reconstruct these records to create a single historic record for each qualifying flight. The SHL message will use Action Code H for slots with historic precedence and Action Code U for slots without it. Slots marked with Action Code U will include the reason for their ineligibility for historic rights, either using the Coordinator Reason Codes from SSIM Appendix J or free text in an SI Line.

For transit and turnaround flights, historic slots may be established for the arrival flight but not the departure flight (or vice versa), with separate arrival and departure lines marked with the relevant Action Code. For new entrants, the H data lines might include Coordinator Reason Codes indicating limitations on the continued use of these historics, requiring airlines to contact the coordinator for further details.

5.2.9 Airport Coordination Procedures

Airlines must submit slot requests at least three business days before the intended operation date. All dates, days, and times should be in Coordinated Universal Time (UTC). Only one scheduled arrival and/or departure time per flight designator and date at a specific airport is allowed.

Airport coordinators are required to respond to slot requests within three business days. Their clearance offers are valid for the same period. If clarification is needed, coordinators will notify the airlines. If the requested slot time is unavailable, the nearest alternative will be offered.

For turnaround flights (arrivals and departures in a single record), any changes to either arrival or departure times must include all unchanged elements to maintain the turnaround link. If flights are initially filed using an over-midnight indicator, subsequent changes must also use this format.

Where apron occupancy or terminal capacity is coordinated, the aircraft type code must be specified, and the transit/turnaround format should be used.

Slot Clearance Request (SCR) messages must be in plain text and included directly in the email body, without attachments, signatures, logos, or special characters. The message must start with the standard format header. These messages are used by airlines and other aviation stakeholders to communicate updates, changes, or cancellations in flight schedules. The SSIM outlines standardized formats and codes for these messages to ensure consistency and clarity in the communication of schedule-related information. Some key features of those message include standardised format, specific codes, and detailed information regarding the flight, e.g. flight numbers, dates, times, and affected routes.

Coordinators aim to reply to requests within three business days. If the requested slot is not available, an alternative will be provided, along with a reason code explaining the main constraint. These reason codes are explained in the SSIM manual.

This whole standardised process ensures clear and efficient communication between airlines and airport coordinators, facilitating smooth slot allocation. The following figure provides an overview of the coordination process, as well as an example of an SCR message, which is in plain text, as described, with detailed slot request information.

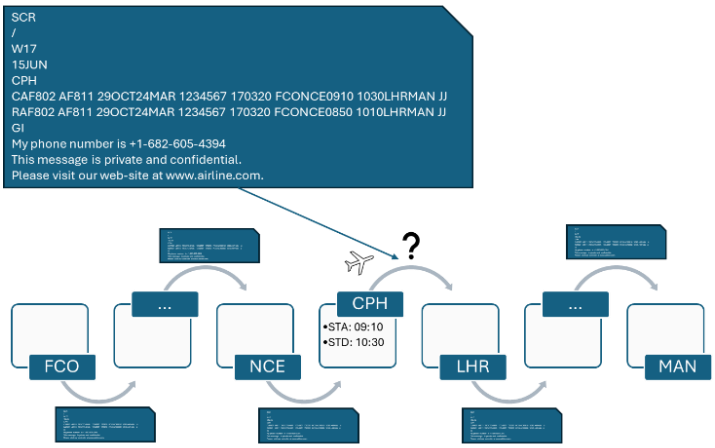


Figure 5: Airport coordination explanatory diagram

5.3 User stories, user story mapping and use cases

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This section will explain all the theoretical background required to understand the tools that will be used in the following sections in order to capture user stories, map them and finally identify use cases for the tools this D2.21 outlines and that are to be either connected to or implemented in the SIGN-AIR platform. Those tools are specifically the standardisation mechanism in TransiTool, in accordance with SCR messages of the IATA SSIM, and the Field Matching Tool that will be implemented directly to the SIGN-AIR platform. For the development purposes the Agile principles will be implemented. Following Agile principles and applying Agile Development ensures flexibility, faster delivery, and continuous improvement through iterative feedback, leading to higher quality and user-focused solutions.

At the beginning of Agile Development, the requirements of the application are defined, as seen in the following figure. This way was chosen because of the flexibility of this practice since it enables continuous adaptation to change in requirements. One of the ways of extracting these requirements is through the creation of User Stories, which then lead to the development of Use Cases, from which the requirements and functions of the system become apparent. Each story, is analysed and broken down, if necessary, into Tasks in order to better organise them individually (Antoniou, Diafas, Sakelariou, & Siatra, 2021)

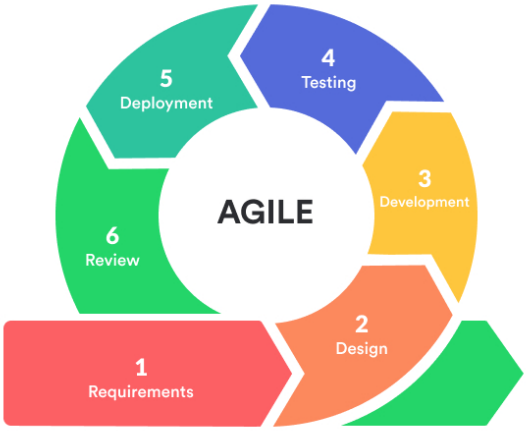

Figure 6: Agile methodology illustration

(Agile and Scrum Methodology, 2022)

5.3.1 Definition of User Stories and their mapping (User Story Mapping)

In software development and product management, a user story is an informal description of features of a software system in natural language (Wikipedia, 2022). A user story provides a short descriptive sentence that describes the who, what, and why of a requirement or set of requirements of an application. User stories set the context around interactions, which allows for focusing their efforts on perspectives, features, functionality, and outcomes (Francino & Stephen, 2019).

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A user story describes the functionality that will be valuable to either the user or the purchaser of a system or software. User stories consist of three aspects:

1. a written description of the story used to design

2. discussions about the story that serve to refine the details of the story

3. tests that convey and document details and that can be used to determine when a story has been completed (Cohn, 2004).

The usual format of a user story (User Stories) has the following structure:

As a(n) <user type>, <goal>, in order to <profit>

The objectives define the key processes, i.e., the main set of activities of the application, without which there would be no product. The Backbone lists all the basic activities, which require different actions - tasks from the users (User Tasks) in order to be implemented. Having the Backbone ready and having defined the basic activities (User Activities) of the product, each Activity can be split into one or more User Tasks. For each task, alternative user scenarios are described. The description of all User Scenarios for each Task and their mapping in a diagram is called User Story Mapping, which captures the main categories of User Activities, the User Tasks of each category and the User Stories developed for each Task. Each User Story Mapping (User Story Mapping) is for one type of user (Antoniou, Diafas, Sakelariou, & Siatra, 2021).

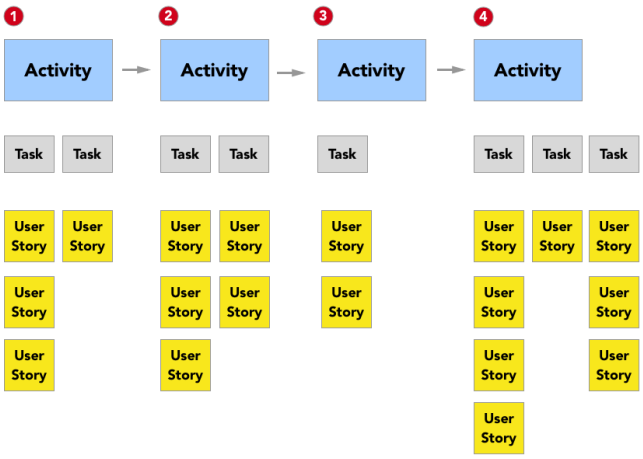

Figure 7: User story mapping

(O'Malley, 2019)

5.3.2 The Extraction of Use cases from Users' stories

After the recording of User Tasks and User Stories, the next step is the creation of all possible use cases of the platform by the user (business) or the traveller, and all alternative scenarios and exceptions. In this way, the needs that the platform users have and what they expect to see are captured.

The generated use cases contain the description of a set of interactions between the platform and the users. A Use Case is a methodology used in system analysis to identify, clarify, and organize system

requirements (Rouse, 2007). It consists of a set of possible interactions between the software and users (and possibly other systems) in an environment and is related to a specific objective. The use case should contain all system activities that are relevant to the users. It can be considered a sequence of actions or steps that typically define the interactions between a user (known as an actor) and a system to achieve a goal (Antoniou, et al., 2021).

The purpose of a use case is to illustrate how the product, in this case a platform, will solve a specific scenario for a particular market segment. It explains why a technology or service is ideally used and how it will benefit that particular type of customer. In the case of a user story, the goal is to define an action that users should perform and why. Defining functionality in this way helps the development team to understand what exactly they are building and the reasons why it matters to end users (Haaff, 2020). In the following section, the user stories are initially captured from the perspective of each user, followed by mapping the user stories and finally creating the use cases.

5.4 Related forms of harmonisation between NeTEx, GTFS and IATA SSIM

In this document so far, we provided a comprehensive overview of the IATA SSIM publication (IATA, 2023), upon which the standardisation tool within TransiToool will be developed. This document, read in conjunction with the STAND documents, such as D2.2 (Engineering, 2023), and the Transmodel efforts towards harmonisation between GTFS and NeTEx (Nicholas JS Knowles, 2019), completes the picture regarding those most prominent standards and sets the basis for this crucial section: harmonisation effort between NeTEx, GTFS and the SSIM.

The following table comprehensively details data requirements for various transport modes, including timetable-based (aviation, railway, metro, buses, ferries, planes), demand-based (shuttle buses, taxis, car sharing, bike sharing), and personal transport (cars, motorbikes, bicycles, walking). It categorizes data by operational needs, covering geographic data, operating calendars, stations, facilities, routes, timetables, operators, vehicles, tickets, environmental factors (CO2 per passenger km), and historical data on delays. Data standards like DATEX II, INSPIRE, NeTEX, SIRI, TAP-TSI, and IATA SSIM are outlined. The table also includes operational details such as station status, parking availability, and estimated departure/arrival times, ensuring comprehensive planning, operation, and user information across transport systems. The following table provides a comprehensive overview of data requirements for various modes of transportation and is designed to help with planning, operations, and user information across different transport systems, since it categorizes data needs by transport mode and operational requirements, incorporating various data standards to ensure consistency and interoperability.

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Table 8: Overview of data requirements (Agency, 2024)

	Timetable-based transport	Demand-based transport	Personal means of transport
	Aviation, railway, light rail, metro, buses, long-distance buses, ferry and plane (NeTEx, TAP-TSI, SIRI, IATA SSIM)	Shuttle bus, taxi, car sharing, car sharing, car rental, bike sharing, spare wheels and bicycle bearings (DATEX II, NeTEx, SIRI, INSPIRE)	Passenger car, motorbike, bicycle and walking (DATEX II, INSPIRE, NeTEX, SIRI)
Planned	Geographic data (addresses, places) Operating calendar (day types) Stations/stops (name, ID, coordinates) Station facilities (overview map, ticket sales, accessibility, parking etc.) Route network (lines, route points) Timetables (stops, times) Operators (contact information) Vehicles (wifi, bicycle allowance, availability etc.) Tickets (rates, sales channel, payment methods, terms) Environmental factor (CO_2per passenger km)	Collection locations (coordinates/area) Vehicles (car class, wifi, toilet, etc.) Reservation (channel, procedure) Payment (channel, payment method) Costs (relevant parameters) Environmental factor (CO_2per passenger km)	The road network The cycle path (quality, type, possible restrictions) Pavement network (availability) Parking (price, channel, payment method) Costs (relevant parameters) Environmental factor (CO_2per passenger km)
Historical and observed	Historical data on delays (statistics) Observed data on major delays (duration, cause) Observed data on cancellations (reason)	Historical data on delays	
Real time	Disturbances Status (delay, cancellation) Station status (elevator, escalators) Estimated departure and arrival times	Disturbances Status (delay, cancellation) Availability for partial mobility	Disturbances Status (delay) Availability of parking spaces

5.4.1 Mapping of the IATA SSIM with GTFS

In this chapter the mapping of the IATA SSIM SCR message data standard to GTFS is described. The harmonization of IATA Standard Schedules Information Manual (SSIM) Schedule Change Request (SCR) messages with General Transit Feed Specification (GTFS) involves a detailed process of converting aviation schedule data into a format suitable for public transportation systems. This section provides a comprehensive overview of how SCR messages can be mapped and integrated into GTFS, ensuring consistent and standardized data exchange between different modes of transport. When attempting to map the two standards, it is evident that the two standards serve two different purposes and thus a great challenge right there is to overcome. GTFS is the industry wide standard used to communicate to end users (passengers) schedule information regarding different modes of public transport that follow the following three conditions:

- There must be a fixed schedule, or a reliable schedule for frequency-based systems.
- There must be no reservations for seats. Tickets must be purchasable on board, or at the station / boarding point.
- It must be open to the public, and commuters may use it for their general travelling purpose.

IATA SSIM in the other hand, is used as a transfer protocol via email in order to allow airlines, facilitators(airports) and coordinators manage upcoming flight connections regarding airport slot allocation. An IATA SSIM SCR message can be mapped to the GTFS data standard utilizing data from the tables: agency, routes, trips, calendar, calendar_dates, stop_times and stops.

An example is as follows (please also consult Figure 5): The provided IATA SSIM SCR describes flights operating between Copenhagen Airport (CPH) and other destinations. The message was sent on June 15th with recipient Copenhagen Airport (CPH), which in this case is a level 3 airport and therefore is obliged to be coordinated thus indicating the communication protocol to be IATA SSIM SCR messages., this message details alterations to flight numbers and timings for the Winter 2017 season, spanning

from October 29th to March 24th. Specifically, the corresponding flights are CAF802 and AF811, with revised departure and arrival schedules indicated for specific days of the week. This SCR message is sent on seamless operational planning and passenger service management. Therefore, the SCR message in this fictional scenario is as follows, in accordance with the guidelines and format the IATA SSIM dictates:

```
SCR
/
W17
15JUN
CPH
NAF802 AF811 29OCT24MAR 1234567 170320 FCONCE0910 1030LHRMAN JJ
GI
```

Figure 8: SCR Message Example

This SCR message details the schedule change for flights, including specific departure and arrival times.

To harmonize SCR messages with GTFS, each component of the SCR message needs to be mapped to the corresponding GTFS fields. Below is a step-by-step breakdown of this process using the provided example.

Agency Information (GTFS: agency.txt): The airline's information must be recorded in the GTFS agency table, for the aforementioned example such a table would look like the following:

Table 9: GTFS Agency Table Example

agency_id	agency_name	agency_url	agency_timezone	agency_lang	agency_phone
AF	Airline Force	www.airline_force.com	utc	en	03012334567

Routes Information (GTFS: routes.txt): The routes serviced by the airlines must be defined, for the aforementioned example such a table and the data fields would look like the following:

Table 10: GTFS Routes Table Example

route_id	agency_id	route_short_name	route_long_name	route_desc	route_type
FCO_MAN	AF	FCO-MAN	Rome - Manchester		1100

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Trip Information (GTFS: trips.txt): Each flight leg is defined as a trip; the following table shows how such a conversion would look like for the given example:

Table 11: GTFS Trips Table Example

route_id	service_id	trip_id	trip_headsign	trip_short_name	direction_id	shape_id
FCO_MAN	1	FCO_NCE_CPH_LHR_MAN_1				

Service Calendar (GTFS: calendar.txt): The days of operation for the flight must be specified, based on the information of the SCR in our example such a conversion into GTFS would look like the following:

Table 12: GTFS Calendar Table Example

service_id	monday	tuesday	wednesday	thursday	friday	saturday	sunday	start_date	end_date
ser_1	1	1	1	1	1	1	1	20231029	20240424

Stop Information (GTFS: stops.txt): Each airport involved in the particular flight schedule must be listed as a stop, as per the GTFS and its data fields dictates, for our example such a conversion would look like the following table (with coordinates):

Table 13: GTFS Stops Table Example

stop_id	stop_code	stop_name	stop_desc	stop_lat	stop_lon	stop_timezone	stop_url
fco	fco	Rome Fiumicino		41.8002778	12.2388889		
nce	nce	Nice Côte d'Azur		43.6584116	7.2158721		
cph	cph	Copenhagen		55.617916	12.656005		
lhr	lhr	Heathrow		51.470020	-0.454295		
man	man	Manchester		53.365	-2.272		

Stop Times (GTFS: stop_times.txt): Then the specific departure and arrival times for each leg of the trip must be defined, as follows:

Table 14: GTFS Stop Times Table Example

trip_id	stop_sequence	stop_id	stop_headsign	arrival_time	departure_time
FCO_NCE_CPH_LHR_MAN_1	1	fco	af800	06:00	06:00
FCO_NCE_CPH_LHR_MAN_1	2	nce	af802	07:45	08:05
FCO_NCE_CPH_LHR_MAN_1	3	cph	af810	09:10	10:30
FCO_NCE_CPH_LHR_MAN_1	4	lhr	af815	11:40	12:10
FCO_NCE_CPH_LHR_MAN_1	5	man	af820	14:00	14:00

Harmonizing IATA SSIM SCR messages with GTFS is a critical step in achieving seamless multimodal transport data integration, and rather complex, due to SCR messages being more 'condensed,' regarding encoded information, and due to the more 'simplistic' structure of data in a GTFS format. By managing though to overcome this challenge and convert SCR messages into GTFS format, transport service providers can leverage standardized data for enhanced operational efficiency and improved passenger services. The effort to standardize and harmonize these data formats will ultimately contribute to the broader goal of creating a more integrated and reliable transportation network.

5.4.2 SSIM Parser

The IATA SSIM (Standard Schedules Information Manual) file parser[6] is a tool designed to read and interpret the standard IATA file format, which is widely used for airline schedules. This parser enables efficient extraction and manipulation of flight schedule data, facilitating smoother operations for airlines and related industries. However, the software is currently in its alpha stage of development, which means it is still undergoing active improvements and bug fixes[7].

5.4.3 Ssim2gtfs

6 GitHub site: https://github.com/Schiphol-Hub/ssim

7 GitHub site: https://github.com/Schiphol-Hub/ssim

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Transmodel experts have noted significant challenges in converting data from the General Transit Feed Specification (GTFS) to Transmodel due to the inherent complexity of the latter compared to the more simplified GTFS framework. Similarly, a comparable challenge was anticipated when converting data from the IATA SSIM to other data standards. The IATA SSIM, with its detailed and specific data requirements for airline scheduling, presents complexities that are likely to complicate the conversion process. This complexity is expected to pose difficulties similar to those experienced with GTFS-to-Transmodel conversions, as the SSIM framework encompasses a comprehensive and intricate set of data elements and rules that are not directly translatable to simpler data models.

Despite the aforementioned challenges, the ssim2gtfs tool efficiently converts IATA SSIM flight schedule data into a GTFS (General Transit Feed Specification) zip file. This conversion includes detailed information on trips, stops, stop times, and calendars, enabling comprehensive integration of airline schedules into public transit systems and applications. By transforming SSIM data into the widely used GTFS format, ssim2gtfs facilitates enhanced accessibility and interoperability, allowing for streamlined travel planning and improved user experiences across multimodal transportation networks[8].

5.4.4 Mapping of the IATA SSIM with NeTEx

The harmonization of IATA Standard Schedules Information Manual (SSIM) Schedule Change Request (SCR) messages with Network Timetable Exchange (NeTEx) can be conducted similarly to the harmonization with GTFS. NeTEx is a European CEN standard for exchanging public transport schedules and related data. Given its flexibility and detailed structure, NeTEx can effectively accommodate the complex data inherent in aviation schedules. This section provides an overview of how SCR messages can be mapped and integrated into NeTEx, ensuring standardized data exchange across different transport modes.

Using the same fictional example as before, the SCR message describes flight operations between Copenhagen Airport (CPH) and other destinations, detailing changes for the Winter 2017 season.

To harmonize SCR messages with NeTEx, each component of the SCR message needs to be mapped to the corresponding NeTEx elements. Below is a step-by-step breakdown of this process.

Agency Information (NeTEx: Operator): In NeTEx, the airline's information is recorded in the Operator element, as the following example:

```
<Operator id="AF">
  <Name>Airline Force</Name>
  <ContactDetails>
    <Url>www.airline_force.com</Url>
    <Phone>030123345678</Phone>
  </ContactDetails>
</Operator>
```

Figure 9: NeTEx Operator Example

8 GitHub site: https://github.com/planarnetwork/ssim2gtfs

Route Information (NeTEx: Route): The routes serviced by the airline must be defined, the following figure shows how would that look in NeTEx format:

```
<Route id="FCO_MAN" name="FCO-MAN">
  <Description>Rome - Manchester</Description>
  <TransportMode>air</TransportMode>
</Route>
```

Figure 10: NeTEx Route Example

Journey Information (NeTEX: Timetable): Each flight leg is defined as a journey within a timetable, the following example shows how the initial SCR message would look, in regard to timetable, in NeTEx format:

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```
<Timetable id="W17">
  <ValidityPeriod>
    <StartDate>2017-10-29</StartDate>
    <EndDate>2018-03-24</EndDate>
  </ValidityPeriod>
  <Journeys>
    <Journey id="FCO_NCE_CPH_LHR_MAN_1">
      <RouteRef ref="FCO_MAN"/>
      <OperatingDays>
        <DayOfWeek>monday</DayOfWeek>
        <DayOfWeek>tuesday</DayOfWeek>
        <DayOfWeek>wednesday</DayOfWeek>
        <DayOfWeek>thursday</DayOfWeek>
        <DayOfWeek>friday</DayOfWeek>
        <DayOfWeek>saturday</DayOfWeek>
        <DayOfWeek>sunday</DayOfWeek>
      </OperatingDays>
      <PassingTimes>
        <PassingTime>
          <StopPointRef ref="FCO"/>
          <ArrivalTime>06:00</ArrivalTime>
          <DepartureTime>06:00</DepartureTime>
        </PassingTime>
        <PassingTime>
          <StopPointRef ref="NCE"/>
          <ArrivalTime>07:45</ArrivalTime>
          <DepartureTime>08:05</DepartureTime>
        </PassingTime>
        <PassingTime>
          <StopPointRef ref="CPH"/>
          <ArrivalTime>09:10</ArrivalTime>
          <DepartureTime>10:30</DepartureTime>
        </PassingTime>
        <PassingTime>
          <StopPointRef ref="LHR"/>
          <ArrivalTime>11:40</ArrivalTime>
          <DepartureTime>12:10</DepartureTime>
        </PassingTime>
        <PassingTime>
          <StopPointRef ref="MAN"/>
          <ArrivalTime>14:00</ArrivalTime>
          <DepartureTime>14:00</DepartureTime>
        </PassingTime>
      </PassingTimes>
    </Journey>
  </Journeys>
</Timetable>
```

Figure 11: NeTEx Timetable Example

Stop Information (NeTEx: StopPlace): Then, each airport (or as we referred in GTFS 'stop') involved in the flight schedule (all legs of the journey included) must be listed as a stop place, as the following example shows:

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```
<StopPlace id="FCO">
  <Name>Rome Fiumicino</Name>
  <Location>
    <Longitude>12.2388889</Longitude>
    <Latitude>41.8002778</Latitude>
  </Location>
</StopPlace>
<StopPlace id="NCE">
  <Name>Nice Côte d'Azur</Name>
  <Location>
    <Longitude>7.2158721</Longitude>
    <Latitude>43.6584116</Latitude>
  </Location>
</StopPlace>
<StopPlace id="CPH">
  <Name>Copenhagen</Name>
  <Location>
    <Longitude>12.656005</Longitude>
    <Latitude>55.617916</Latitude>
  </Location>
</StopPlace>
<StopPlace id="LHR">
  <Name>Heathrow</Name>
  <Location>
    <Longitude>-0.454295</Longitude>
    <Latitude>51.470020</Latitude>
  </Location>
</StopPlace>
<StopPlace id="MAN">
  <Name>Manchester</Name>
  <Location>
    <Longitude>-2.272</Longitude>
    <Latitude>53.365</Latitude>
  </Location>
</StopPlace>
```

Figure 12: NeTEx StopPlace Example

Service Calendar (NeTEx: OperatingPeriod): the days during which the flight will be in operation (e.g. Monday to Sunday) for the said period of time (e.g. winter season) can be converted into NeTEx format as follows:

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```
<OperatingPeriod id="ser_1">
  <FromDate>2017-10-29</FromDate>
  <ToDate>2018-03-24</ToDate>
  <OperatingDays>
    <DayOfWeek>monday</DayOfWeek>
    <DayOfWeek>tuesday</DayOfWeek>
    <DayOfWeek>wednesday</DayOfWeek>
    <DayOfWeek>thursday</DayOfWeek>
    <DayOfWeek>friday</DayOfWeek>
    <DayOfWeek>saturday</DayOfWeek>
    <DayOfWeek>sunday</DayOfWeek>
  </OperatingDays>
</OperatingPeriod>
```

Figure 13: NeTEx OperatingPeriod Example

Same as in GTFS, this conversion into NeTEx from SCR format shows that the harmonisation between those standards can be possible, by associating specific parts of the 'code' (specific capital letters, numbers, and other elements of the SCR message) with specific data fields within the NeTEx format. The effort to standardize and harmonize these data formats will ultimately contribute to the broader goal of creating a more integrated and reliable transportation network.

5.4.5 Mapping of IATA SSIM SCR in GTFS and NeTEx

We previously saw the mapping of SCR and how the harmonisation can be done, by associating certain elements of the SCR message with elements in GTFS and NeTEx and converting the information of the SCR message in specific values in the most appropriate data fields per each data standard. The primary goal is to facilitate the harmonisation of aviation and public transportation schedules, improving data interoperability and consistency across different modes of transport. This effort addresses the unique challenges posed by the distinct nature and purposes of these standards, aiming to enhance operational efficiency and passenger service management.

The table below provides a detailed mapping of IATA SSIM SCR elements to their corresponding GTFS and NeTEx elements. It includes explanations for unmapped elements and the challenges encountered in the harmonisation process.

Table 15: Detailed mapping of IATA SSIM SCR message to GTFS and NeTEx

Section	Data Element	GTFS Mapping	NeTEx Mapping
Header Information	Standard Message Identifier	*unmapped*	*unmapped*
	Creator Reference	*feed_publisher_name*	
	Season	feed_start_date, feed_end_date	
	Day of Message	*unmapped*	RequestTimestamp
	Month of Message	*unmapped*	RequestTimestamp
	Airport	*Stop_id (i)*	

	Message Reference	*unmapped*	*unmapped*
Information Data Line	Action Code	unmapped	
	Arrival Airline Designator	stop_headsign (at stop = i)	
	Arrival Flight Number		
	Arrival Operational Suffix		
	Departure Airline Designator	stop_headsign (at stop = i + 1)	
	Departure Flight Number		
	Departure Operational Suffix		
	From Day and Month	start_date	
	To Day and Month	end_date	
	Day(s) of Operation	monday,tuesday, wednesday,thursday, saturday, sunday	
	Number of Seats	*unmapped*	passenger_capacity
	Aircraft Type	*unmapped*	vehicle_type
	Origin Airport	stop_id (stop_sequence=1)	
	Previous Airport	stop_id (stop_sequence=i-1)	
	Scheduled Time of Arrival	arrival_time	
	Scheduled Time of Departure	departure_time	
	Overnight Indicator		
	Next Airport	stop_id (stop_sequence=i+1)	
	Destination Airport	stop_id (stop_sequence=max())	
	Arrival Service Type	*unmapped*	*unmapped*
	Departure Service Type	*unmapped*	*unmapped*
	Frequency Rate	Exception_date, exception_type	
Additional Information (message Related, optional)	Aircraft Registration	*unmapped*	RegistrationNumber
	Change Reason (p.33)	*unmapped*	*unmapped*
	Cleared Times	*unmapped*	*unmapped*

	Coordinator Reason	*unmapped*	*unmapped*
	Minimum Ground Time	*unmapped*	*unmapped*
	Passenger Terminal Identifier	*unmapped*	*unmapped*
	Reference Number	*unmapped*	*unmapped*
	Requested Aircraft Code	*unmapped*	*unmapped*
	Requested Aircraft Seats	*unmapped*	*unmapped*
	Requested Arrival Route	*unmapped*	*unmapped*
	Requested Departure Route	*unmapped*	*unmapped*
	Requested Passenger Terminal Identifier	*unmapped*	*unmapped*
	Requested Timings	*unmapped*	*unmapped*
	Status Information	*unmapped*	*unmapped*
	Timing Flexibility Identifier	*unmapped*	*unmapped*
Footer Information	Supplementary Information (SI)	*unmapped*	*unmapped*
	General Information (GI)	*unmapped*	*unmapped*

When converting IATA SSIM SCR messages with GTFS or NeTEx standards, several unmapped elements highlight the inherent differences between aviation and public transport systems. Key elements such as the Standard Message Identifier, Message Reference, and Action Code are specific to aviation's operational protocols and coordination, lacking direct equivalents in GTFS or NeTEx, which are primarily concerned with public transport scheduling. Similarly, details like Aircraft Type, Aircraft Registration, and Minimum Ground Time are unique to aviation operations and do not find counterparts in public transport standards. Additionally, sections such as Supplementary Information (SI) and General Information (GI) often contain operational details beyond the scope of GTFS or NeTEx.

The challenges in harmonising these standards are significant. Regulatory frameworks and data requirements in aviation differ substantially from those in public transport, complicating direct mapping. The complexity of aviation data, including encrypted messages and codified information, adds another layer of difficulty, as such details are not typically needed in public transport systems. Furthermore, the intricate relationships between aviation data elements, such as specific flight schedules and operational suffixes, contrast sharply with the more straightforward data relationships in public transport. Addressing these challenges is crucial for creating an integrated and efficient data exchange environment, ultimately enhancing the functionality and reliability of the overall transportation system.

The mapping and thus the harmonising endeavour between IATA SSIM SCR messages and GTFS/NeTEx standards is strategic and aims to foster seamless integration across different modes of transporation. This harmonization endeavour is essential for several reasons. Firstly, it ensures that Transport Service Providers comply with applicable regulations, facilitating a smoother regulatory process. By aligning aviation schedules with established public transport standards, we can enhance data consistency, which is crucial for the accurate and reliable operation of multimodal transport systems. This integration supports the creation and enforcement of data sharing agreements and contracts, thereby reducing legal and operational complexities. In addition, harmonization enables the comprehensive management of multimodal transport data, enhancing the efficiency of transport services and improving the passenger experience. It reduces the risk of data discrepancies and operational conflicts, ensuring that all stakeholders operate as seamlessly and harmoniously as possible, as well as monitor the implementation of their contracts and data sharing agreements within the dashboard SIGN-AIR platform offers. Ultimately, this effort promotes interoperability, data quality, and operational efficiency, paving the way for a more integrated and resilient transportation ecosystem.

5.5 IATA SSIM Standardisation Mechanism

Addressing the challenges of harmonising aviation and public transport data standards requires a strategic approach to standardisation. To effectively manage the complexities of unmapped elements and differing data requirements, we develop a mechanism for standardising data exchange in alignment with the IATA SCR protocol, focusing on the most essential elements that are mandatory and can be mapped in both SCR and GTFS.

The IATA SSIM Standardisation Mechanism was developed within the product TransiTool and has since expanded its functionalities beyond the standardisation of public transport data. This extension includes enhancements that facilitate more comprehensive data management and integration. In the following subchapters the user stories, user story mapping, as well as the final wireframes are presented.

TransiTool is critical for standardising and seamlessly exchanging transport data, tackling the challenge of non-standardised data with advanced algorithms and a user interface that maps data fields to standardized formats. Since SIGN-AIR solution will facilitate the establishment of certain data sharing agreements and contracts between TSPs, TransiTool will be there at the users' disposal for standardising the necessary data they need to exchange, in order to implement the agreements and contracts and thus achieve mutually beneficial and agreeable goals. The extension of TransiTool to include the IATA SSIM standard is particularly noteworthy. This inclusion benefits aviation stakeholders and enables SIGN-AIR to support a wider range of transport modes.

Building on the Transmodel consortium's successful harmonisation of General Transit Feed Specification (GTFS) and Network Timetable Exchange (NeTEx) standards (Nicholas JS Knowles, 2019), D2.21 leverages this foundation to explore the harmonisation of GTFS, NeTEx, and potentially SIRI with IATA SSIM. This effort aims to create a seamless integration between these data standards and IATA SSIM, enhancing data exchange efficiency and consistency in the aviation sector. Harmonisation is essential for achieving a unified approach to managing multimodal transport data, ultimately contributing to more efficient and reliable transportation services. TransiTool will connect to the SIGN-AIR platform for data retrieval and sending.

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By creating a mechanism in TransiTool standardising aviation messages as per the IATA SSIM highlight the feasibility of harmonising standards such as IATA SSIM, GTFS, NeTEx, and potentially SIRI in the future to a certain extent. The challenges are many, considering the differences between the modes of transport each standard accommodates, and also considering the complexity of each standard and the differences in data attributes definition and data management behind them. This document shows how this development took place and thus how those challenges can be tackled and what opportunities lie there for harmonisation. This document will delve into the creation of a user interface (UI) for data entry and database components for converting SCR and other formats to a Relational Database Management System (RDBMS), aspects in which this report delves.

Notably, these advancements are pertinent to the Data4PT[9] Validation Tool, which plays a crucial role in ensuring the adherence of public transport data to the Transmodel and NeTEx standards. The integration of the Data4PT tool's validation capabilities with the extended functionalities of the TransiTool underscores a significant enhancement in data quality and interoperability. This integration not only supports the validation of public transport data but also aligns with the broader objectives of standardisation and data consistency across various transport frameworks.

5.5.1 User Stories

This chapter will analyse the user stories from the perspective of each user interacting within SIGN-AIR where the sole user of the use cases is the Airline. The structure of each use case is the following:

As a(n) <user type>, <goal>, in order to <profit>

A total of three user stories were defined as depicted below in the following table.

Table 16: IATA Standardisation Mechanism user stories

	Goal	Benefit
ID	As an airline,	in order to
A	I need to comply with the standard communication format required by IATA	successfully communicate with coordinators, facilitators, and airports so that I can negotiate changes in schedule.
B	I want to automate the process of encoding/decoding IATA SSIM messages	reduce human effort (time) and error and to be able to share my schedules to data aggregators and other data exchange platforms.
C	I want to have access to analytics tools	optimize current procedures.

Our decision to create user stories from the perspective of airlines is driven by several key considerations. Airlines operate in a highly specialized and complex environment with strict regulatory requirements, intricate scheduling, and unique operational constraints. This focus allows us to address these complexities in detail, ensuring user stories accurately reflect the nuanced needs of the sector. Additionally, the IATA SSIM Standardisation Mechanism is specifically tailored to airlines, enabling us

[9] Official website of Data4PT project can be found here: https://data4pt-project.eu/

to leverage its full potential and demonstrate effective standardisation. Lastly, the airline industry's precedence in data standardisation and integration practices can facilitate smoother adoption across other public transport modes in future phases.

Therefore, by focusing on airlines for our user stories, we ensure that the analysis is precise, actionable, and immediately relevant to a critical segment of the transport industry. This targeted approach allows us to build a robust foundation that can support broader integration efforts in the future, benefiting the entire public transport ecosystem.

5.5.2 User Story mapping

In this subchapter the user stories are mapped as shown in the following figure. This in turn results in the definition of the user stories of the following chapter.

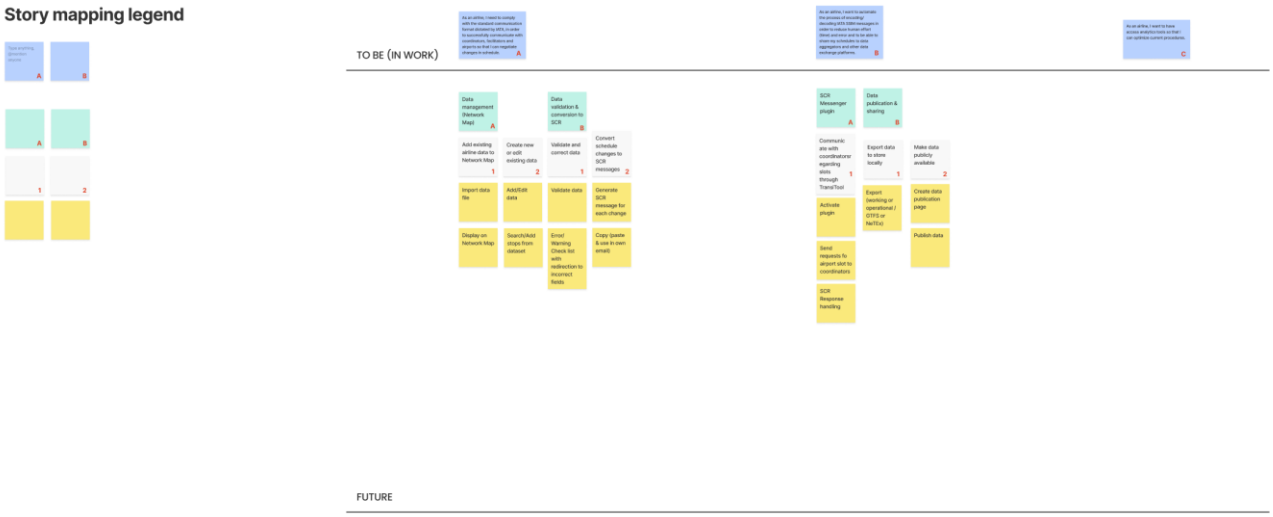

Figure 14: IATA Standardisation Mechanism user story mapping

5.5.3 Use cases

This chapter analyses and explains all the use cases, which are identified in the individual components of the product. For each use case there is a detailed description of the use case, its triggering conditions, assumptions and preconditions, the user involved, the flow of actions to be performed and possible alternative flows and exceptions.

Table 17: IATA Standardisation Mechanism use cases

AA	Use case
A1	Import IATA SSIM Data
A2	Add stop

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A3	Data validation
A4	Generate SCR messages
B1	Activate SCR Messenger
B2	Communication with coordinators though SCR Messenger Plugin

5.5.4 Wireframes

Below the wireframes created to support the created use cases are listed below for each of the Use cases. Moreover, in the Appendix chapter, tables of each use case are available, containing all required information of each use case in the form of UML use cases.

5.5.4.1 Import IATA SSIM Data

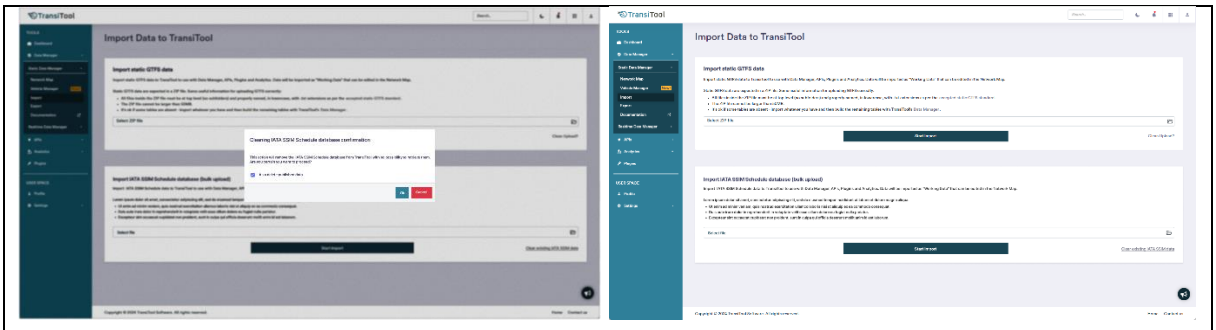

Figure 15: Wireframes of use case A1

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5.5.4.2 Add Stop

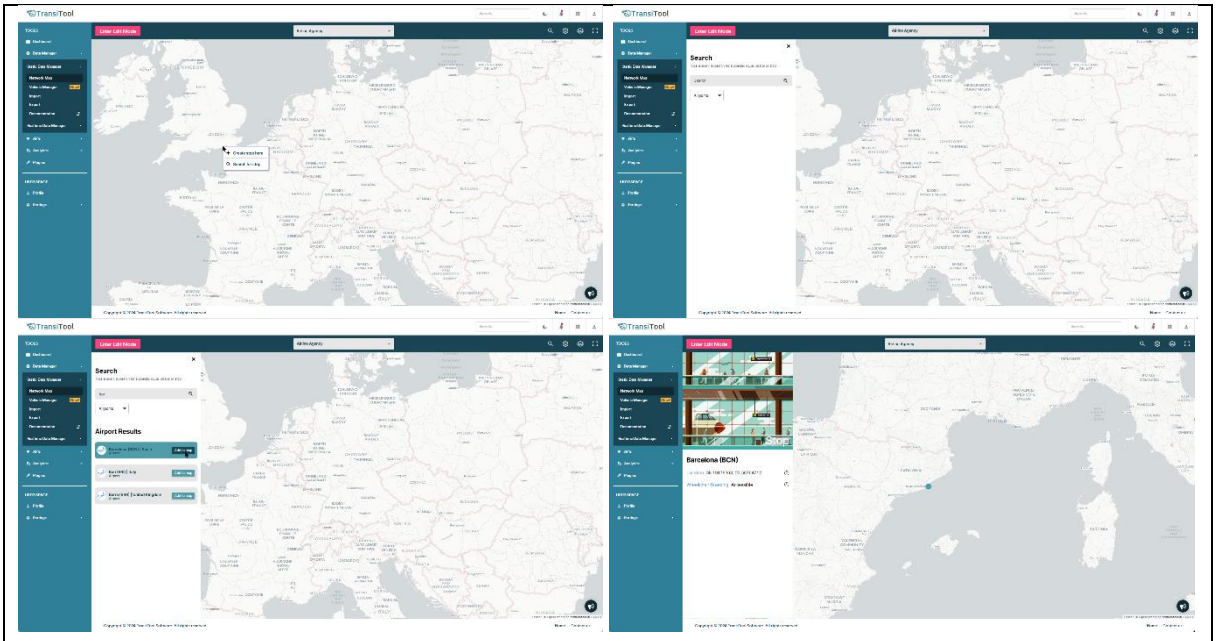

Figure 16: Wireframes of use case A2

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5.5.4.3 Data Validation

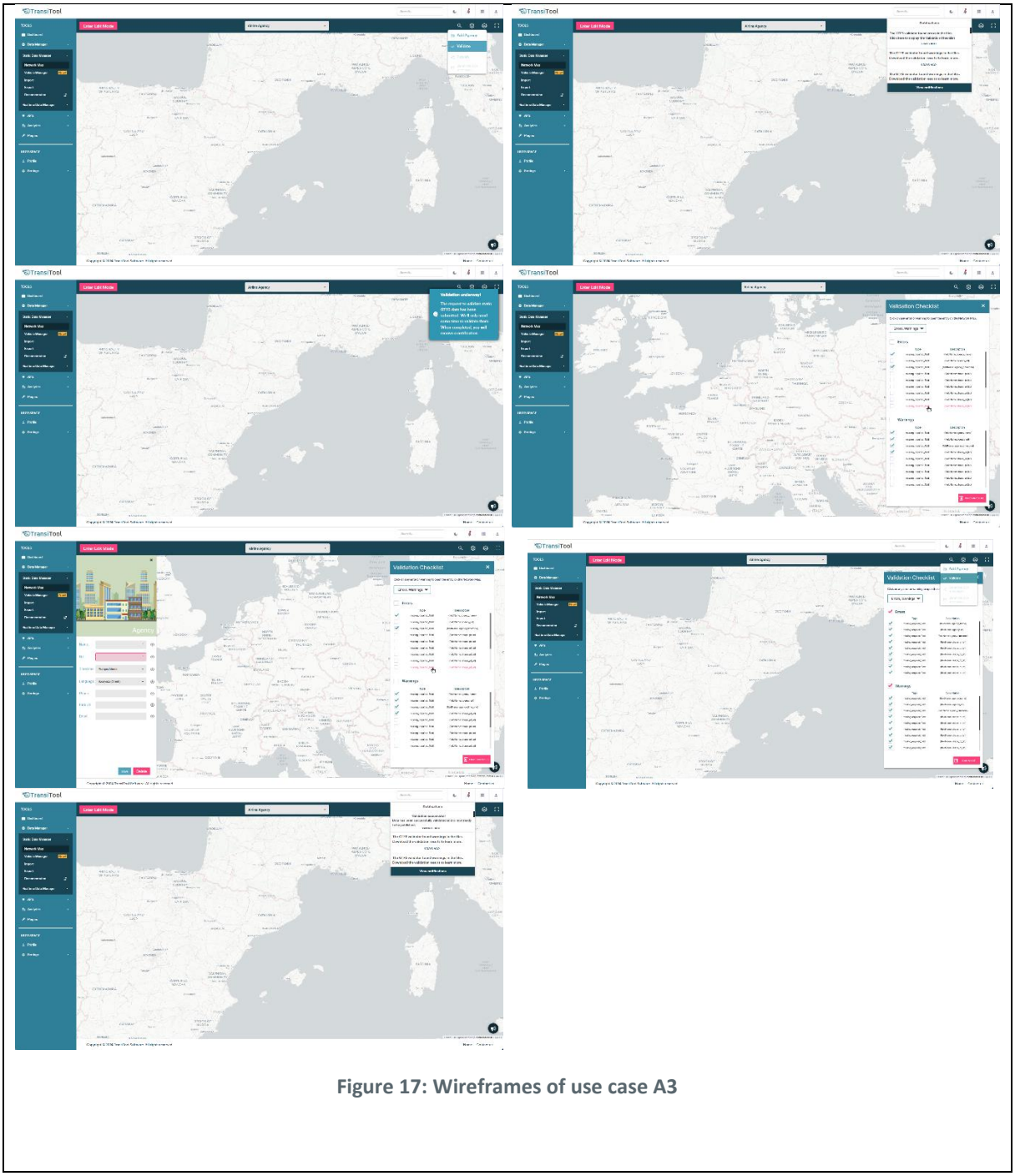

Figure 17: Wireframes of use case A3

5.5.4.4 Generate SCR Messages

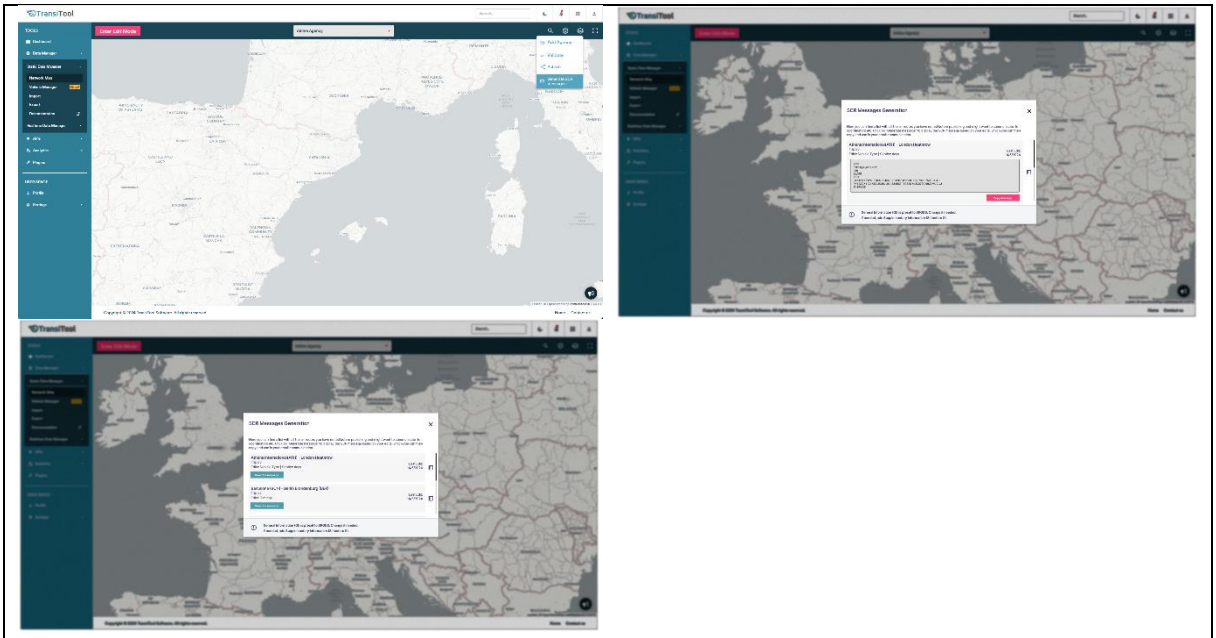

Figure 18: Wireframes of use case A4

5.5.4.5 Activate SCR Messenger

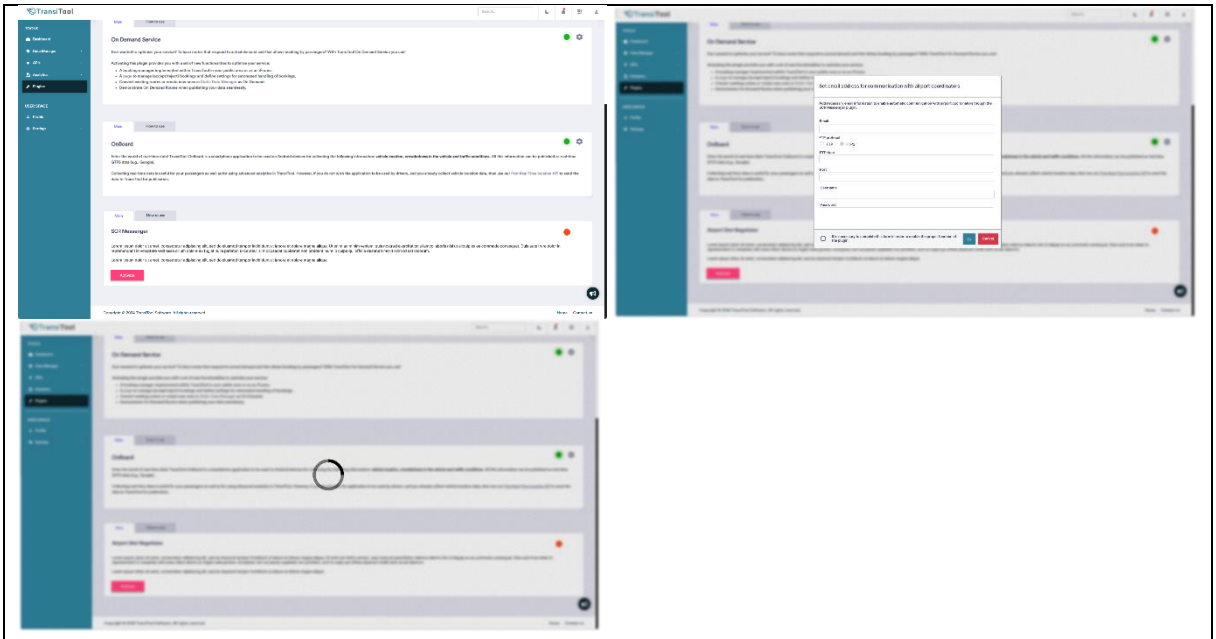

Figure 19: Wireframes of use case B1

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5.5.4.6 Communication with coordinators though SCR Messenger Plugin

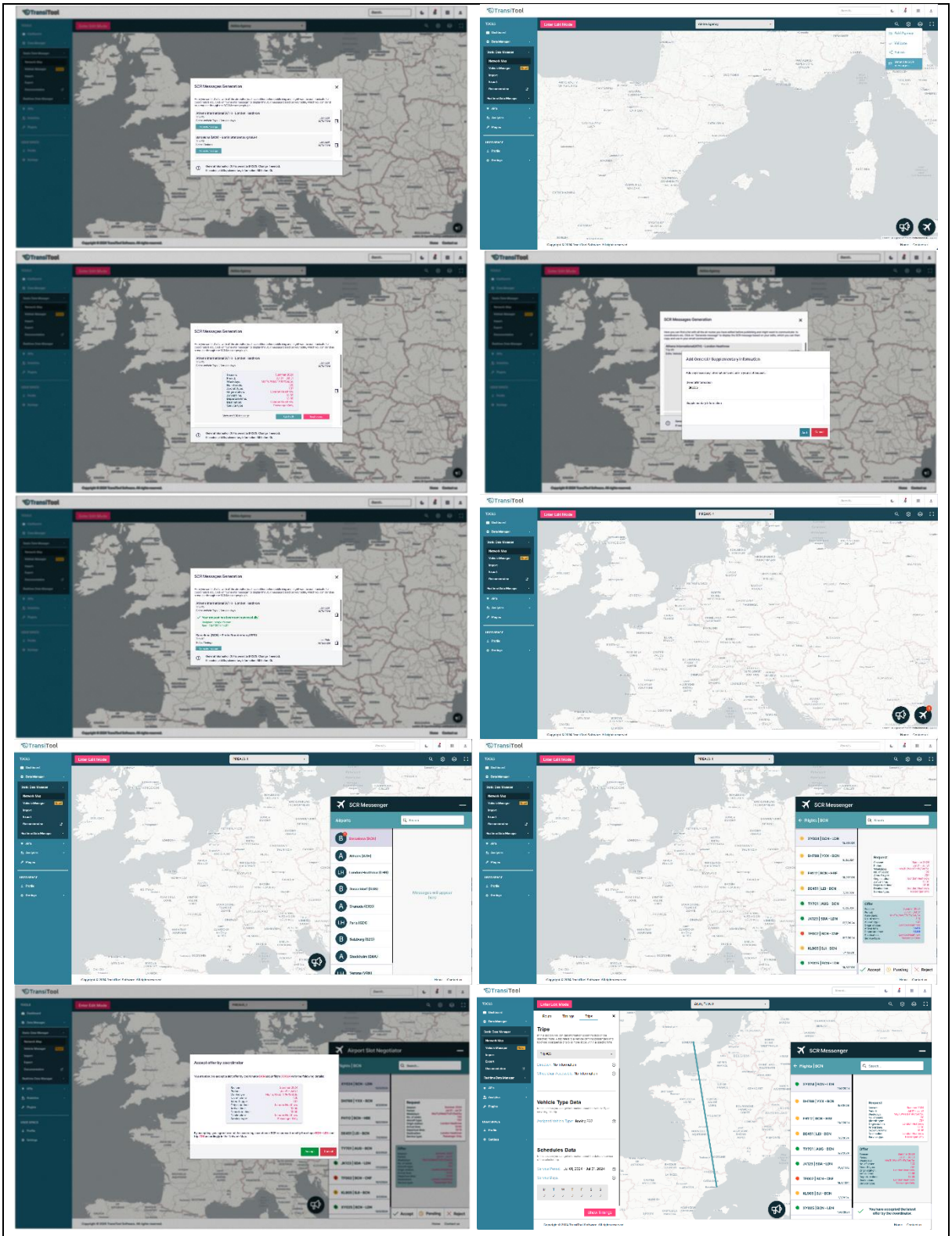

Figure 20: Wireframes of use case B2

5.6 Field Matching Tool

Building on our detailed examination of the standardisation of Slot Clearance Request (SCR) messages according to the IATA SSIM publication, we now shift our focus towards an innovative tool, the second one that the dedicated activities of the SIGN-AIR project aim to produce, which is the Field Matching Tool. The Field Matching Tool, implemented directly within the SIGN-AIR platform, complements our efforts towards achieving comprehensive standardisation and harmonisation.

This tool is crucial for facilitating and enabling Transport Service Providers to standardise data fields, forming a robust foundation not only for agreements but also for future integrations, developments, optimisations, and innovations. By ensuring uniformity and interoperability across different transport systems, the Field Matching Tool supports mutually beneficial goals and fosters synergies between public transport and airline data management. This tool represents a significant step forward in our mission to create a standardised and harmonised framework that underpins all future advancements in the transport sector.

The tool will read the data fields that the TSPs define within their Data Sharing Agreements and provide a mechanism for the users to define each field in accordance with suggested applicable standards, to allow conversion of said data to standardised ones. The above implementation aspect follows an investigation of the IATA SSIM and the correspondence with Transmodel and GTFS.

Specifically, as defined by internal communication with the project's partners, the input of the tool is going to be the Discovery Matrices as generated by the University of Belgrade and were compiled, reviewed and finalised through multiple iterations, in close collaboration with the TSPs partaking in the project and its activities. The Matrices shared are listed below. Those matrices were created per each use case and goal the TSPs will achieve with the use of the SIGN-AIR platform and the functionalities it offers, and contain datasets, data fields and attributes per each one of them.

- SIGN-AIR_Discovery matrices_1.1_Seasonal ticket
- SIGN-AIR_Discovery matrices_1.2_Combined ticket_final
- SIGN-AIR_Discovery matrices_1.3_Single ticket
- SIGN-AIR_Discovery matrices_2.1_Synchronisation
- SIGN-AIR_Discovery matrices_2.2_Synchronisation
- SIGN-AIR_Discovery matrices_2.3_Synchronisation
- SIGN-AIR_Discovery matrices_3.1_Disruption_ap without A_CDM
- SIGN-AIR_Discovery matrices_3.2_Disruption_ap with A_CDM
- SIGN-AIR_Discovery matrices_Combined ticket_final
- SIGN-AIR_Discovery matrices_Seasonal ticket_final
- SIGN-AIR_Discovery matrices_Single ticket
- SIGN-AIR_Discovery matrices_Synchronisation 2.1
- SIGN-AIR_Discovery matrices_Synchronisation 2.2
- SIGN-AIR_Discovery matrices_Synchronisation 2.3 and
- SIGN-AIR_Discovery matrices_All data sets and data attributes

All the matrices are in the form of excel files (.xlsx) with multiple sheets inside. All the discovery matrices reference the fields found in the **SIGN-AIR_Discovery matrices_All data sets and data attributes** file, and specifically the sheet **Data attributes s.t. This sheet contains the columns** Attribute

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code of data generated, Name of attribute and Data properties which combined uniquely identify a data element, as referenced in each different use case. Additionally, once a unique combination of those fields is accessed, the columns Standard (Y, N), If, yes and Format (txt, numerical) contain the required information regarding the Data Standard or Data Standards which support this data element while also describing the data type (txt, numerical, alphanumerical etc.). A final conversion was executed to JSON file containing all the data elements. This JSON file is accompanying this document and will be utilised for the development of the tool within the platform. It contains each applicable standard(s) for each data field, depending also on the mode of transporation those matrices define.

Based on the JSON file and all the listed standards, per each TSP type and per each data field that is expected to be defined in data sharing agreements (and thus correspond to data that the TSPs will exchange in order to fulfil their agreements at a later stage), the tool will be created with SIGN-AIR, for mapping data fields sent by the operators-users of the platform. This will take the form of a UI (User Interface), where the user (TSP) associates the fields of the provided data with the fields of a standardised dataset. It will be an open source tool, as the Grant Agreement of the project dictates (GA number 101114845, Part B).

The Field Matching Tool is expected to bring added value to the SIGN-AIR solution and its end users. By standardising data fields, the tool ensures high quality of data, as well as consistency in both the data sharing agreements as well as their fulfilment in practice, which is quite critical for ensuring reliable and efficient transport services.

Such a tool also ensures transparency. When the specific standards and the form of data fields are well defined when creating those agreements, then both engaged parties that draft the said agreement can have full knowledge of what is applicable in their case, what standards to follow and respect, and thus reach an agreement on the exact format of each data field they will exchange prior to proceeding with agreeing and signing the agreement. This will lead in a very clear and elaborate agreement and the exact requirements that need to be fulfilled on that level. This also promotes the adoption of data standards. Therefore, certain legal and operational aspects of data sharing agreements get much simpler, which leads to the reduction of complexities and potential disputes between the two negotiating parties (TSPs).

Since this tool promotes and facilitates the adoption of data standards, the interoperability between different transport modes can be enhanced, thus leading to seamless travel experience for the travellers and more efficient operations for the TSPs.

By laying a standardised foundation, the tool also supports future developments and innovations within the transport sector, enabling the integration of new technologies and services in the future. It is also a tool that can also be extended to more standards, thus having the potential of accommodating the needs of the future, as well.

The Field Matching Tool aligns and serves the broader standardisation and harmonisation strategy of the project, since it promotes a unified framework that underpins all future advancements in the transport sector. It assists in ensuring that the TSPs comply with applicable standards and regulations, and thus facilitates a smoother regulatory process, while it also reduces risks of non-compliance. By supporting the standardisation of data across different modes of transportation, the tool contributes to the seamless integration of multimodal transport systems and provides guidance even to those TSPs that may have no knowledge and/or any experts in the workforce that can undertake the investigation on what standards apply. It is of great assistance to those TSPs that wish to comply but simply do not know how to start, what standards should they consult, nor know how those data fields may be in a standardised format. Lastly but equally important, this Field Matching Tool encourages in essence the

collaboration between public transport providers, airline operators, railways etc. promoting thus even more the smooth formation of synergies and the materialisation of mutual benefits.

In conclusion, the Field Matching Tool represents a significant step forward in achieving comprehensive standardisation and harmonisation within the SIGN-AIR project. It not only enhances the capabilities of the SIGN-AIR platform but also provides substantial benefits to its end users, paving the way for a more integrated and efficient transport ecosystem.

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6 Appendix

6.1 Data sources

For the various tasks of this deliverable, several datasets have been collected to validate several aspects of the IATA SSIM Data standard and to recreate several use cases.

6.1.1 AIR FRANCE

Air France through their National Access Point offers access to several historic schedule data of AIR FRANCE flights the Schedule dataset format as described in the IATA SSIM Chapter 7[10].

6.1.2 OAG Sample data

OAG is a global travel data provider and aggregator founded in 1929. After completing a form request for data, sample data can be provided in the Schedule dataset format as described in the IATA SSIM Chapter 7[11].

6.1.3 TransiTool

TransiTool is a Transport Management platform that provides a user-friendly environment, facilitating seamless data standardisation capabilities to meet the regulatory requirements of both the industry and the European Union.

6.2 Use cases

10 https://transport.data.gouv.fr/datasets/programme-des-vols-air-france

11 https://www.oag.com/try-oag

Use Case ID	A1
Use Case Title	Import IATA SSIM Data
Related Users Actions-Goals	TransiTool user wants to automate the process of uploading their existing flight schedules on the Network Map.
Created By	Markos Psychos
Date Created	23/5/2024
Actors	TransiTool User (Tech employee)
Description	Actor uploads files containing data regarding their current schedules on TransiTool, which then gets translated to the TransiTool data model and is displayed on the Network Map.
Trigger	Actor needs to automate the process of uploading and converting their flight schedule data.
Preconditions	Actor is logged in.
Outcome	Actor's current flight schedules are displayed on the Network Map.
Normal Flow	1. Actor navigates to the Import page, then to the "Import IATA SSIM database" section and clicks on "Select file". 2. System displays a file manager modal. 3. Actor selects the desired file, the modal closes and Actor clicks "Start Import". 4. System displays a message informing the Actor that their existing Working Data will be deleted. 5. Actor clicks "I am certain". 6. System displays a notification informing the user that the import has started.Meanwhile, System uploads the file and converts it to TransiTool data model. When the process is done, System displays a success notification.
Alternative Flows	Alternative Flow #1 3. Actor navigates to the "Import IATA SSIM database" section and clicks on "Clear existing IATA SSIM data". 4. System displays a modal informing the Actor that their data will be removed permanently. 5. Actor checks the box next to "Also delete published data" and clicks "Ok". 6. System deletes the existing IATA SSIM working & operational data. 7. Flow resumes from step 3 of Normal flow.
Exceptions	6. System displays a notification informing the user that the import has started. After checking the file the System determines that it has the wrong format and displays an error message.
Frequency of Use	Low
Notes & Issues	

Use Case ID	A2
Use Case Title	Add stop
Related Users Actions-Goals	TransiTool user wants to add a stop point on the Network map in order to add it to a shape.
Created By	Markos Psychos
Date Created	24/5/2024
Actors	TransiTool User (Tech employee)
Description	Actor creates a stop point on the Network map by either entering details manually, or retracting details from the database.
Trigger	Actor has data they need to add to the Network map that include stops that are not already displayed.
Preconditions	Actor is logged in.
Outcome	A new stop point is created and displayed on the Network map.
Normal Flow	1. Actor right clicks anywhere on the Network map. 2. System displays a modal with the options "Create stop here" and "Search for stop". 3. Actor chooses "Search for stop". 4. System displays the search sidebar on left side, with the filter checkbox set to "Airports". 5. Actor types in the name of the stop (station) they are looking for. 6. System provides suggestions based on the Actor's input as a list under the search bar. 7. Actor finds their desired stop and clicks on "Add to map" next to the stop's name. 8. System creates a point on the location of the predetermined stop and displays the stop details on the left side of the Network Map.
Alternative Flows	Alternative Flow #1 3. Actor chooses "Create stop here". 4. System creates a point on the map and displays the stop detail form on the left side of the Network Map. 5. Actor completes the form with all the necessary information. 6. System auto-saves the stop with the provided details.
Exceptions	6. System cannot find any results because the name of the stop does not exist in the database & displays a "No results found" message.
Frequency of Use	Medium
Notes & Issues	

Figure 21: Use cases in UML format

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Use Case ID	A3
Use Case Title	Data validation
Related Users Actions-Goals	TransiTool user wants to ensure their data has the proper format & has no errors before publishing and contacting coordinators.
Created By	Markos Psychos
Date Created	24/5/2024
Actors	TransiTool User (Tech employee)
Description	Actor clicks on the "Validate" button and the System, after gathering errors and warnings in the data, presents them in the form of a Validation Checklist, which the Actor uses to assist them with the correction of those errors.
Trigger	Actor needs to publish their data or communicate with airport coordinators.
Preconditions	Actor has added some data to the Network Map.
Outcome	Actor's data is validated and has the correct format.
Normal Flow	1. Actor clicks on the gear icon on the Network Map and selects "Validate". 2. System informs the Actor that the request for validation has been submitted. When the process is done, System sends a notification to the user informing them that there are errors and/or warnings regarding their data. 3. Actor clicks on the notification. 4. System displays a floating validation checklist containing all the errors and warnings the user has to correct. 5. Actor clicks on any error/warning. 6. System displays the entry (stop/agency etc) that contains the error/ warning, highlighting the incorrect field. 7. Actor corrects the data, clicks on the checkbox next to the error/warning they just corrected and then clicks on the "Clear selected" button. 8. System removes the selected error/warning from the list. 9. Steps 4-8 are repeated until all errors are corrected. 10. Actor clicks again on Validate. 11. System informs the Actor that the request for validation has been submitted. When the process is done, System sends a notification to the user informing them that their data now contains no errors and is ready to be published.
Alternative Flows	
Exceptions	-
Frequency of Use	High
Notes & Issues	

Use Case ID	A4
Use Case Title	Generate SCR messages
Related Users Actions-Goals	TransiTool user wants to automatically encode the changes they have made to their flight schedules into SCR messages they can later use to communicate with coordinators.
Created By	Markos Psychos
Date Created	24/5/2024
Actors	TransiTool User (Tech employee)
Description	Actor chooses to generate SCR messages for any change they have made to flight schedules.
Trigger	Actor has made changes to their flight schedules and needs to communicate them to coordinators.
Preconditions	Actor has successfully validated their data.
Outcome	Actor has generated SCR messages for each change they have made to their flight schedules, which they can use in their email communication.
Normal Flow	1. Actor clicks on the gear icon on the Network Map page and selects "Generate SCR Messages". 2. System displays a modal, listing the flight routes that have edited data with a "Generate SCR Message" button for each one. 3. Actor chooses one of the listings and clicks the "Generate SCR Message" button. 4. System expands the modal to display the appropriate SCR message underneath the listing along with a "Copy" button. 5. Actor clicks on copy and can now transfer to their preferred email app. 6. System displays a successful copy to clipboard message. 7. Actor clicks on the "Delete" icon to remove the item from the list.
Alternative Flows	Alternative Flow #1 7. Actor closes the modal without deleting the item from the list. 8. System removes the item from the list after a determined amount of time.
Exceptions	
Frequency of Use	Medium
Notes & Issues	

Figure 22: Use cases in UML format (cont.)

Use Case ID	B1
Use Case Title	Activate SCR Messenger
Related Users Actions-Goals	TransiTool user wants to activate the SCR Messenger plugin in order to benefit from its functions.
Created By	Markos Psychos
Date Created	24/5/2024
Actors	TransiToool User (Tech Manager)
Description	Actor navigates to the Plugins page and activate the SCR Messenger plugin.
Trigger	Actor identifies the need to automate the handling of communication with airport coordinators.
Preconditions	Actor has the appropriate subscription type.
Outcome	Actor has successfully activated the SCR Messenger Plugin.
Normal Flow	1. Actor navigates to the Plugin page. 2. Actor locates the SCR Messenger plugin section and clicks on "Activate". 3. System displays a modal with a form asking the user to complete their email details. 4. Actor completes the form and clicks "Ok". 5. System displays a message informing the user that the activation is complete.
Alternative Flows	Alternative Flow #1 5. System displays an error message informing the user that the connection with FTP has failed and that they need to check their provided details. 6. Actor corrects their data and clicks "Ok". 7. System displays a message informing the user that the activation is complete.
Exceptions	4. Actor does not provide their email details. 5. Actor clicks on "Cancel". 6. System closes the modal and the plugin remains deactivated.
Frequency of Use	Low
Notes & Issues	

Use Case ID	B2
Use Case Title	Communication with coordinators though SCR Messenger Plugin
Related Users Actions-Goals	TransiTool user wants to automate the exchange of request and response messages with airport coordinators and easily transfer the final agreements on the Network Map.
Created By	Markos Psychos
Date Created	24/5/2024
Actors	TransiToool User (Tech employee)
Description	Actor communicates with airport coordinators though the SCR Messenger plugin, receiving responses & offers and transferring the finalized deal data to the appropriate Network Map entries.
Trigger	Actor has finalized and validated changes in their flight schedules and needs to communicate them to coordinators.
Preconditions	Actor has activated the SCR Messenger plugin. Actor has validated their data.
Outcome	Actor has successfully sent requests & handled responses by coordinators.
Normal Flow	1. Actor clicks on the gear button on the Network Map and selects "Generate SCR messages". 2. System displays a modal, listing the flight routes that have edited data with a "Generate SCR Message" button for each one. 3. Actor chooses one of the listings and clicks the "Generate SCR Message" button. 4. System expands the modal to display the details of the edited flight route, with the options to "Show as SCR Message", "Add GI/SI" and "Send request" 5. Actor chooses "Add GI/SI". 6. System displays another modal with 2 text fields (General Information, Supplementary Information). 7. Actor types as necessary and clicks "Add", then after returning to the previous modal clicks on "Send request" . 8. System informs the user that their request has been sent successfully. 9. Actor removes the entry from the "Generate SCR Messages" list by clicking the "Delete" icon, repeats the process for as many flight routes they desire and then closes the modal. 10. In a later time, System receives the response from the coordinator and displays a notification on the SCR Messenger plugin icon. 11. Actor clicks on the icon to open the messenger, then selects the coordinator and subsequently the flight they have received and offer for. 12. System displays the requests and responses in a chat format, along with options for the user to accept, maintain or reject the offer. 13. Actor clicks on "Accept". 14. System displays a modal asking the user to confirm the acceptance of the offer. 15. Actor clicks "Accept". 16. System sends an acceptance SCR message to the coordinator. Meanwhile, System edits the data of the linked Shape entry and displays the affected shape on Network map with the new data.
Alternative Flows	Alternative Flow #1 13. Actor clicks on "Reject" or "Pending". 14. System displays a modal asking the user if they are sure they want to reject / maintain the slot in order to make a new request. 15. Actor clicks "Accept". 16. System sends the according message & displays the linked shape entry on the Network Map for the user to edit and create a new request.
Exceptions	-
Frequency of Use	High
Notes & Issues	

Figure 23: Use cases in UML format (cont.)

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7 References

Agency, T. D. (2024, April 24). *National access point for open mobility data (Translated).* Retrieved from https://itsdanmark.dk/media/jtmm12pj/itsdanmark-aarsmoede-2024-national-adgangspunkt-for-aabne-mobilitetsdata.pdf

Antoniou, E., Diafas, G., Sakelariou, A., & Siatra, X. (2021). *Π2.1: Ανάλυση των βασικών απαιτήσεων, των λειτουργικοτήτων και των θεματικών αντικειμένων πλατφόρμας.* Athens: ΑΕΘΩΝ Σύμβουλοι Μηχανικοί Μονοπρόσωπη ΙΚΕ.

Association, I. A. (2024). *Worldwide Airport Slot Guidelines (WASG).* Montreal: International Air Transport Association.

Association, I. A. (n.d.). *Airport Level of Service Concept*. (International Air Transport Association) Retrieved June 1, 2024, from https://www.iata.org/en/services/consulting/airport-pax-security/level-of-service/

Association, I. A. (n.d.). *Coordinated Airports*. (IATA) Retrieved June 1, 2024, from https://www.iata.org/en/programs/ops-infra/slots/coordinated-airports/

Cohn, M. (2004). What Is a User Story? In *User Stories Applied: For Agile Software Development* (pp. 27-27). Boston: Addison-Wesley Professional.

Engineering, A. (2023). *D2.2 – Standardisation (STAND) - Initial.*

Francino, Y., & Stephen, B. (2019, October 25). *What goes into a user story vs. use case for Agile development?* (Techtarget) Retrieved July 22, 2022, from https://www.techtarget.com/searchsoftwarequality/answer/What-is-the-difference-between-a-user-story-and-use-case-in-software-testing

IATA. (2023, March 01). Standard Schedules Information Manual (SSIM) Edition 33.

Jason, J. (2022). *Agile and Scrum Methodology*. Retrieved August 5, 2022, from https://jaenhosjsaon.medium.com/agile-and-scrum-methodology-32a14ba3746f

Nicholas JS Knowles, T. C. (2019). *Report on Standards Harmonisation Including a GTFS to Transmodel / NeTEx mapping.*

O'Malley, P. (2019, September 25). *Openclassrooms*. Retrieved July 13, 2021, from https://openclassrooms.com/en/courses/4544631-learn-the-fundamentals-of-agile-estimation/5157761-discover-user-story-maps

Wikipedia. (2022, August 6). Retrieved July 2, 2022, from https://en.wikipedia.org/wiki/User_story

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