



Deliverable D 4.1 Technology Integration Plan, C-REL

WP4 - Demonstration Execution Planning and Monitoring

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1. Executive Summary

This document constitutes deliverable D4.1 “Technology Integration Plan, C-REL” of the IP4MaaS project. The main goal of the document is to identify the activities necessary on the side of the IP4MaaS service providers to integrate them in the Shift2Rail IP4 ecosystem in preparation of the C-REL demonstrations (which will involve the Athens, Barcelona and Padua demo sites).

The deliverable provides:

- a summary of the technical requirements that need to be met to integrate in the Shift2Rail ecosystem the services available in the demo sites involved in the C-REL phase demonstrations, as obtained from discussions with Call For Members (CFM) project partners;
- the references to the services – and associated technical documentation – to be integrated in the C-REL demonstrations; where possible, the technical documentation is provided as web pages available to the public; otherwise, it is provided as documents stored on the cloud and made available to CFM project partners;
- a list of actions to be performed by each service provider to prepare their services to be integrated in the Shift2Rail ecosystem.

Notice that the actual integration of the services in the Shift2Rail ecosystem will be performed by CFM projects, and not by IP4MaaS Travel Service Providers, who nonetheless need to make their services available for integration (providing, for example, the necessary information).

The following table gives a quick overview of the services that are going to be integrated for each C-REL demonstration. Indeed, some TSPs rely on the same software service for certain functions (for example, the same Journey Planner covers the OASA, Brainbox and Taxiway TSPs).

Demo site service providers			
	Barcelona	Padua	Athens
Journey Planning	TMB	Trenitalia	Miraklio OASA Brainbox Taxiway
Network data	TMB BusUp	Trenitalia	Miraklio OASA Brainbox Taxiway
Booking	BusUp (incomplete)	Trenitalia	Taxiway
Ticketing and validation		Trenitalia	OASA Brainbox Taxiway

The integration activities outlined in this deliverable will be the basis for the activities of the Integration Committee in WP4, and also for the execution of the C-REL demonstrations, which will be monitored by WP5.

2. Abbreviations and acronyms

Abbreviation / Acronym	Description
API	Application Programming Interface
CFM	Calls for Members
C-REL	Core Release
FAQ	Frequently Asked Questions
GA	Grant Agreement
GTFS	General Transit Feed Specification
IP4	Innovation Programme 4
OC	Open Call
pTT	partial Trip Tracker
S2R JU	Shift2Rail Joint Undertaking
TC	Travel Companion
TRIAS	Travellor Realtime Information and Advisory Standard
TSP	Travel service provider
TTO	Trip Tracking Orchestrator
URL	Uniform Resource Locator
VDV	Verband Deutscher Verkehrsunternehmen
WP	Work Package
WSDL	Web Services Description Language

3. Background

The main goal of the IP4MaaS project is to support the demonstration activities of the technologies developed in the Shift2Rail (S2R) Innovation Programme 4 (IP4). These demonstrations will require the integration of services provided by IP4MaaS Transport Service Providers (TSP) into the S2R IP4 ecosystem. Deliverable D2.1 “Technology Survey, C-REL”, has already identified what services are currently available in each of the six demo sites of the IP4MaaS project. To support the actual definition in practice of the demonstrations, a plan is necessary to identify the steps that are necessary to include the services in the demonstrators. This document provides this plan.

The present document constitutes Deliverable D4.1 “Technology Integration Plan, C-REL” in the framework of the WP4, Task 4.1 of the IP4MaaS project (S2R-OC-IP4-01-2020, GA 101015492). It contributes as well to WP5 of the IP4MaaS project, which will rely on the information regarding the steps to integrate the services from TSPs to monitor the execution of the demonstrations (including their implementation).

The integration plan defined in this deliverable only concerns the demo sites that are involved in the C-REL phase of the demonstrations (Athens, Barcelona, Padua). In addition, it only focuses on services that are planned to be used in the C-REL demonstrations. The updated information concerning the plan for the demonstrations and involved services is described in the companion deliverable, also in the scope of WP4, Deliverable D4.2 “Demonstration Execution Plan, C-REL”. The integration plan for the services involved in F-REL demonstrations will be described in Deliverable D4.3 “Demonstration Execution Plan and Technology Integration Plan, F-REL”, due at month 20.

Deliverables D4.1 and D4.2 are closely related, and they should be read and considered together. In particular, D4.1 is only concerned with technical integration issues of available services. The overall plan of the demonstrations, including risks and mitigation actions related to demonstration execution are to be found in D4.2.

Notice that, in the rest of this document, the term “service” (without further qualification) will refer to a software mechanism (e.g., a web service) that can be used (e.g., through the invocation of suitable software primitives) by software clients (in the broad sense of the term) to achieve some result. We will use the expression “transport service” to refer to the physical transportation service.

4. Objective/Aim

This document has been prepared to provide a plan for the technical integration of the services that are involved in the C-REL version of the demonstrations to be carried out within the IP4MaaS project. The document first summarizes the services to be integrated in each demo site and describes the technical requirements that must be met to integrate them. Then, for each demo site involved in C-REL demonstrations (Athens, Barcelona, Padua), the specific technical steps that must be carried out to integrate the corresponding services in the S2R ecosystem are laid out.

Notice that the actual integration of the services in the S2R ecosystem is outside of the scope of the IP4MaaS project, which supports the development and execution of the demonstrations, but it is not, *per se*, a technical project. Indeed, the integration of the services is the responsibility of partners of Call For Member (CFM) projects (and especially partners of the COHESIVE and ExtenSive S2R IP4 projects). It is expected that CFM project partners will use the information contained in this deliverable to carry out the technical integration of the services. For this reason, this deliverable (which is public) – and any supporting information that is outside of the scope of this document (e.g., contact information of technical people, which is not of public interest) – will be shared with CFM partners.

5. Integration of IP4MaaS services in the S2R ecosystem

Table 1 shows the services provided by IP4MaaS TSPs that, at the time of this writing, have been identified that can be integrated in C-REL demonstrations (hence, only for the demo sites of Athens, Barcelona, and Padua).

Demo site service providers			
	Barcelona	Padua	Athens
Journey Planning	TMB	Trenitalia	Miraklio OASA Brainbox Taxiway
Network data	TMB BusUp	Trenitalia	Miraklio OASA Brainbox Taxiway
Booking	BusUp (incomplete)	Trenitalia	Taxiway
Ticketing and validation		Trenitalia	OASA Brainbox Taxiway

Table 1 – Overview of the services to be integrated in IP4MaaS demo sites for C-REL demonstrations.

The next chapters detail the information available for the services of each demo site, and identify possible issues (if any) that might hinder integration. To this end, the next section summarizes the technical requirements that are to be met to integrate each type of service.

Technical requirements for integration

We separate the technical requirements for each service by the main function that it serves: shopping (journey planning and offer building), booking, ticket issuing, and trip tracking. Indeed, though no C-REL demo site does not appear to have services available concerning trip tracking, the technical requirements are included in this deliverable for completeness' sake.

Journey planning and offer building. To integrate journey planning and offer building services in a demo site, the following data and assets must be available:

- A web service providing a journey planning function that, given an origin and a destination, can provide an itinerary solution (possibly multi-modal). In addition, the information about the fare to be paid associated with the provided solution.

- If the transport service involves fixed routes (e.g., bus service, metro service, etc.), a file in GTFS format¹ should be available, describing the transport network covered by the service. The GTFS file can be retrieved through a web service, but it can also be sent to interested parties when updates to the transport service are available.
- If, instead, the transportation mode does not rely on a fixed network (e.g., taxi, car sharing, bike sharing), then a web service returning the description of the area (polygon) covered by the service in GeoJSON² format should be available. The web service should also return information about the available transport mode (e.g., car, bike).

Booking. To integrate a booking function, a web service should be available that is able to perform the booking of a given itinerary. There are no specific requirements on the format of the booking request.

Issuing. To integrate an issuing function, a web service should be available that returns a verifiable token regarding the purchased entitlement. There are no specific requirements on the format of the issuing request. The token could be represented through a QR code, but also in other ways.

Trip Tracking. To integrate a trip tracking service in the S2R ecosystem, the TSP should provide a so-called partial Trip Tracker (pTT) component, which interacts with the S2R ecosystem, and in particular with the Trip Tracking Orchestrator (TTO). More precisely, the pTT should support publish/subscribe mechanisms that allow the TTO: (i) subscribe (and unsubscribe) to notifications concerning disruptions (e.g., delays, cancellations) related to a specific trip; (ii) receive notifications when disruptions occur. More precisely, the TSP should provide, as part of the pTT:

- A web service that provides APIs to subscribe and to unsubscribe to notifications concerning a trip. The web service should handle subscription requests that include the URL of the web service (in the TTO domain) to which notifications about disruptions should be sent.
- A function that, when a disruption concerning a monitored trip is detected, if subscription requests regarding that trip have been received, sends the disruption notification to the web services specified in the subscription requests.

Both the subscription (cancellation) requests received by the pTT from the TTO and the disruption notifications sent by the pTT to the TTO should be in TRIAS³ (Traveller Realtime Information and Advisory Standard, VDV 431-2) format.

Overview of the information provided for each demo site

The essential information provided in the next chapters about each available service is the

¹ <https://gtfs.org>

² <https://geojson.org>

³ <https://github.com/VDVde/TRIAS>

following:

- URL of endpoint of APIs of the service.
- URL of documentation concerning APIs. Where the documentation is provided in the form of documents and files that are not publicly available, they are packaged and made available to interested parties (and in particular to CFM project members) through a link to a cloud repository.
- Brief instructions and considerations concerning any authentication required to access the APIs.
- A list of actions to be performed by the service provider to facilitate the integration of the service in the S2R ecosystem.

The present deliverable is accompanied by a table (in the form of an excel file) that summarises the essential information about the services offered by each TSP involved in C-REL, plus provides information that is not publicly available, and that is only for the benefit of CFM project members:

- For the documentation that is provided in the form of documents and files that are not publicly available, URL of the cloud repository where the files have been stored.
- Contact point(s) – name and email address – to whom inquiries concerning technical issues shall be directed.

The information included in this deliverable is strictly complemented by the information included in the companion D4.2 deliverable, which includes the overall plan for the C-REL demonstrations. In particular, this deliverable does not include a timeline for the integration, nor a list of risks and mitigation actions, because these are part of the overall plan of D4.2, and they can be found there.

6. Barcelona Demo Site

Barcelona Demo Site TSPs		
	TMB	BusUp
API endpoint	https://api.tmb.cat/v1/	https://api.sandbox.busup.com/beta/
Documentation URL	https://developer.tmb.cat/api-docs/v1 Fares service documented separately, through a file in a private document repository (see annex)	https://documenter.getpostman.com/view/4899302/TzY4gFBM
Journey Planning	Information about fares provided through a separate service	Not available
GTFS	Provides API endpoint to download the GTFS file	Not available
Booking	Not available	Can only view or cancel
Ticketing and validation	Not available	Not available

Table 2 – Endpoints of services provided by the TMB and BusUp TSPs of the Barcelona demo site.

Table 2 summarizes the information about the services available in the Barcelona demo site.

Concerning TMB, the API and its documentation are both available and ready to use. Steps to obtain credentials to access the API are described in the authentication section of the documentation. The process to register to the portal and get access to the APIs is described at the link <https://developer.tmb.cat/docs/getting-started>. After “entering” the portal, one can register a new application, and obtain the application credentials to access the API. Each Application needs its specific API Credentials (id, key), which are provided in the last step of the application registration process.

Only TMB has currently available a service that provides a journey planning function. The journey planner also has information about walking distance and last mile, since it is based on OpenTripPlanner. Query results are given in custom JSON format. GTFS data concerning the transport network can be retrieved through the API.⁴ Information about fares is available through

⁴ <https://developer.tmb.cat/api-docs/v1/static>

a web service that is documented separately (see annex). The service does not link the fares information with the planning of the trip.

Moreover, TMB is a TSP dedicated to local public transportation modes, which means it cannot provide any service for the booking of a solution. Also, the APIs do not provide ticket issuing functions.

BusUp, on the other hand, has no publicly available Journey Planner service because it has contract-based routes. Adding routes is an option available only on demand as the process is subject to manual review. Currently there is also no API endpoint to retrieve a GTFS file for BusUp, while the booking service allows clients to view user reservations, but no accessible endpoint can create them. However, a range of internal services has already been created by BusUp for interaction with third parties, and at least some of them can be adapted to fit the needs of the S2R ecosystem. In particular, discussions are still ongoing, at the time of this writing, to make available the following services for C-REL demonstrations:

- A journey planner service, with information about fares.
- GTFS files describing the transport network handled by BusUp.
- A service for booking trips.
- A service for retrieving QR codes for validation purposes.

Lastly, concerning tracking services, neither TSP provides a complete solution on the matter. BusUp has only partial real time vehicle information by means of position and geolocation of the vehicle on the route. TMB, on the other hand, has not provided access yet to their tracking information systems out of privacy concerns and other bureaucratic factors. Information about the fleet of vehicles is collected, but the tracking information (positions and disruptions/status) is provided only through a social media feed, which is not usable for S2R purposes.

Integration steps

To summarize, the steps to be performed by the TSPs of the Barcelona demo site to allow the integration of their services in the S2R ecosystem for the C-REL demonstration are the following.

TMB:

1. All services are available, provide information and clarifications if necessary.

BusUp:

1. Make available journey planner endpoint.
2. Make available booking service endpoint.
3. Make available endpoint for retrieving QR codes.
4. Provide transport network information in GTFS format.
5. Provide access credentials to CFM project members.

7. Padua Demo Site

Padua Demo Site TSP	
Trenitalia	
API URL endpoint	https://api.lefrece.it/pico/olta
Documentation URL	Available as a set of files provided through a private document repository (see annex)
Journey Planning	Multimodal, point to point, but does not include last mile
GTFS	Available on request
Booking	Available also for groups
Ticketing and validation	Provides pdf document to download. Validation done using custom hardware/software

Table 3 – Endpoints of services provided by the Trenitalia TSP of the Padua demo site.

Table 3 summarizes the essential information, and in particular the URLs of the services that are available for integration in the Padua demo site. Each detailed function used in the Padua demo site is described in a separate WSDL description containing the operation and the necessary messaging information. Although the documentation of each available function has been provided, access to some additional resources needs to be requested separately.

In particular, the documentation has been provided as a set of documents that are not publicly available; they are made available to interested parties (and in particular to CFM project members) through a private cloud repository whose link is contained in a file annexed to this deliverable. More precisely, the documentation provided includes the following files:

1. Basic Concepts & Services: a step-by-step guide of essential services for a correct implementation of all services. These basic services must be called for storing their data in the cache.
2. Sales process: step-by-step guide of the one way implementation of a sales process, described from a channel perspective, considering the different flows and choices supported by PICO web services.
3. PICO System – Channel Programming Guide: document which describes how to implement a channel that invokes PICO Web Services. It describes the model used to expose the web services and analyses the behaviour that has to be realised on the channel side to perform processes and operations supported by the PICO platform.
4. Finally, a series of documents is made available, related to PICO's APIs, necessary to understand how to correctly use them: FAQs related to the services supported by the APIs, tips on how to call services and how to optimise API calls, how to access to them.

Access to the services is based on filtering of the IP address of the caller, and on credentials to be provided by the service provider. Hence, to allow developers of CFM projects to access the services, the IP address of the caller needs to be authorized by the service provider, who also needs to provide them access credentials.

GTFS files concerning the transport network data are not currently available, but they will be made available for the demonstration.

As for the Barcelona demo site, though trip tracking services are available in the demo site, they cannot be integrated, because they do not meet the necessary requirements.

Integration steps

To summarize, the steps to be performed by the TSPs of the Padua demo site to allow the integration of their services in the S2R ecosystem for the C-REL demonstration are the following.

Trenitalia:

1. Make GTFS information about the transport network available.
2. Provide access credentials to PICO APIs to CFM project members and enable IP addresses provided by them.

8. Athens Demo Site

Athens Demo Site TSPs		
	OASA	Miraklio
API endpoint	https://ip4maas-jp-api.imet.gr	<a href="https://api.transitool.com/apis/get/get-directions/<id TBD>/v1.0/">https://api.transitool.com/apis/get/get-directions/<id TBD>/v1.0/
Documentation	Available as a set of files provided through a private document repository (see annex)	Available as a set of files provided through a private document repository (see annex)
Journey Planning	The Journey Planner will cover all OASA modes. The Journey Planner could provide also multimodal result integrating other modes such as bikes and taxis too. This option is under investigation. The integration with a fare service is under development	The Journey Planner covers MIRAKLIO buses
GTFS	Available	Available
Booking	Not available	Not available
Ticketing and validation	The user can issue a voucher that can be exchanged with an appropriate ticket product loaded on an Athena contactless smart card; the user will do this exchange at OASA offices. Voucher's issuing and relevant API are under development	Not available

Table 4 – Endpoints of services provided by the OASA and Miraklio TSPs of the Athens demo site.

Athens Demo Site TSPs		
	Taxiway	Brainbox
API endpoint	https://ip4maas-jp-api.imet.gr/	Ticket issuing: https://admin.sharing.bike/api/ip4maas/coupon/create
Documentation	Available as a set of files provided through a private document repository (see annex)	
Journey Planning	The Journey Planner will cover car routing. The integration with taxi fare calculation service is under	The Journey Planner will cover bike routing. The integration with fare service is under development

	development	
GTFS	Service area polygon will be available in GeoJSON	Service area polygon will be available in GeoJSON
Booking	The service covers appointment with taxi vehicle at specific time/date and pick up point	Not available
Ticketing and validation	The user can issue a QR code entitlement which represents the selected taxi booking. The entitlement's issuing and API are under development	The user will get a coupon; the user can then download the Brainbox app. Then he/she can use the app to fill in the coupon and get credits at the Brainbox app's e-wallet. All other bike sharing functions will be performed by the Brainbox app. Service available.

Table 5 – Endpoints of services provided by the Brainbox and Taxiway TSPs of the Athens demo site.

Table 4 and Table 5 summarise the essential information, and in particular the API endpoints and the documentation of the services that are available for integration in the Athens demo site.

Most services are available but there are a few still under development. Development is expected to be completed by the end of February 2022. Services are being developed by interacting with CFM project partners, to understand what is necessary for their integration.

The services are provided by three main entities, namely CERTH/HIT (for OASA, Taxiway TSPs and Journey Planner for OASA, Taxiway and Brainbox), AETHON (Journey Planner service for MIRAKLIO) and BRAINBOX (for all bike sharing services except Journey Planner) using different authentication methods.

In particular, the authentication method for services provided by CERTH/HIT and Brainbox is HTTP Basic Authentication.

The MIRAKLIO Journey Planner, which is based on AETHON's technology, does not require any authentication.

There are two Journey Planners, both available, one based on OTP, provided by CERTH/HIT, and covering OASA, Taxiway (car routing) and Brainbox (bike), and one based on TransiTool provided by AETHON, and covering MIRAKLIO. Regarding the former Journey Planner, the only pending issue is integration of fare calculation for OASA, taxi and bike sharing. Finally, the same Journey Planner has the possibility to have a multi-modal trip result or a mono-modal trip result (i.e., a complete multimodal trip for a request between origin A to destination B vs trips with only one mode, either public transport or bike or taxi).

A booking service will be available for taxis only. The booking functionality is already available and will include information such as appointment time and pick up point.

The issuing service will be available for OASA, taxis and bike sharing in different ways due to the heterogeneity of the ticketing process for each TSP and integration issues that arose during meetings with CFM project partners. More precisely:

- Regarding OASA: Athena Card tickets cannot be incorporated in time for the demo site testing phase. QR code digital ticket issuing is excluded as well due to lack of suitable validation hardware and software by OASA. Workarounds have been designed in collaboration with CFM project partners to integrate issuing through alternative mechanisms (QR code voucher to be exchanged with tickets loaded in the Athena Card).
- Bike sharing has special entitlement, payment and renting processes that cannot be integrated with the Travel Companion at the time being. The selected solution is that the user can purchase a coupon, which will be issued at the Travel Companion. The user, upon purchase, will get a PDF document explaining how the user can download the Brainbox application. When the app is downloaded the user can fill in the coupon id to top up the app's e-wallet. The user will use this application to perform functions to register, book an available bike and then start/stop bike renting.
- Taxis: the user will be able to simply book (without payment) or purchase a fixed-price trip entitlement, which includes also booking rights. In both cases a QR code will be issued. The QR code entitlement will be validated by the taxi driver

Integration steps

To summarize, the steps to be performed by the TSPs of the Athens demo site to allow the integration of their services for the C-REL demonstration are the following.

OASA:

1. Upload on the platform GTFS information about the OASA transport network and validate the data.
2. Integrate fare products into the Journey Planner.
3. Develop voucher issuing.

MIRAKLIO:

1. Upload on the platform GTFS information about the MIRAKLIO transport network and validate the data.

Brainbox:

1. Integrate the fare calculation service into the Journey Planner.
2. Develop and provide service polygon (in GeoJSON format) for bike sharing.

Taxiway:

1. Integrate the fare calculation service into the Journey Planner.
2. Develop and provide service polygon (in GeoJSON format) for taxis.
3. Develop the booking and entitlement issuing services.

9. Conclusions

This deliverable identified, for each of the services to be integrated in the S2R ecosystem to carry out the IP4MaaS C-REL demonstrations, the necessary steps to facilitate their integration. Some of the services to be integrated are actually still being developed or adapted from existing systems, but all implementations on the service provider side are planned to be completed by February 2022, in time for the preparation of the demonstrations (as described in the companion deliverable D4.2).

It is expected that the integration activities will require some interaction between the CFM project partners carrying out the actual integration and the service providers. For this reason, the documentation provided to CFM project partners also includes a contact point for each service provider, to whom specific inquiries can be sent, for example to receive clarifications, if necessary.

If useful, (possibly virtual) meetings will be organized between CFM project partners and IP4MaaS service providers to facilitate the exchange of information. It will be the task of the IP4MaaS Integration Committee (described in Deliverable D4.2) to keep track of the integration activities and identify any problems.

As already mentioned, the planning of the demonstrations, with associated risks and mitigation actions, is described in the companion Deliverable D4.2. The information provided by this deliverable will also be the basis for the demonstration support activities to be carried out in WP5.

10. Annexes

An excel file (“IP4MaaS_available_services_per_tsp_C-REL.xlsx”) with essential information about the services to be integrated – including information that is not publicly available – is part of the deliverable for the benefit of CFM project members, but it is not publicly distributed.

The excel file contains the following information, for each TSP:

- URL of endpoint of APIs of the service.
- URL of documentation concerning APIs. Where the documentation is provided in the form of documents and files that are not publicly available, the URL of the cloud repository where the files have been stored.
- Contact point(s) – name and email address – to whom inquiries concerning technical issues shall be directed (the contact point might be responsible to forward the inquiry to the right people in the organisation who can provide specific answers).
- Brief comments on available services.