WELCOME

WEBINAR

Methodologies and Data-based Technology Solutions for Improved European Mobility

November 22, 2022
14:00 CET

These projects have received funding from the European Union's Horizon 2020 research and innovation programme

organised by MOBIDATALAB
Labs for prototyping future mobility data sharing solutions in the cloud

supported by synair. SoBigData++ RECIPROCITY

Meet the Speakers

Methodologies and Data-based Technology Solutions for Improved European Mobility

Thierry Chevallier

MobiDataLab

Ismini Stroumpou

SYN+AIR

Luca Pappalardo

SoBigData++

Marcell Romsics

RECIPROCITY

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Agenda

Methodologies and Data-based Technology Solutions for Improved European Mobility

14:00	Welcome and Introduction	*Danijel Pavlica (F6S)*
14:05	MobiDataLab's Transport Cloud	*Thierry Chevallier (AKKODIS)*
14:20	SYN+AIR Technology Solution	*Ismini Stroumpou (Sparsity)*
14:35	SoBigData++ Technology Solution	*Luca Pappalardo (ISTI-CNR)*
14:50	RECIPROCITY Project Methodology	*Marcell Romsics (Zone Cluster)*
15:05	General Q&A Session and Farewell	*All Participants*

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MOBIDATALAB

Labs for prototyping future mobility data sharing solutions in the cloud

MobiDataLab

Labs for prototyping future mobility data sharing solutions

Webinar Methodologies and Data-Based solutions for improving Mobility
22/11/2022

mobidatalab.eu

MobiDataLab is funded by the EU under the H2020 Research and Innovation Programme (grant agreement No 101006879)

MOBIDATALAB

Funded within the H2020 context Mobility for Growth 2018-2020 Call of the European Union

A European wide set of partners with different skills and backgrounds working commonly on shared project objectives.

Project Information

MobiDataLab

Grant agreement ID: 101006879

DOI

10.3030/101006879

Start date 1 February 2021

End date 31 January 2024

Funded under

SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

AKKODIS · AETHON ENGINEERING · F6S · here · ICOOR · kisio · KU LEUVEN · POLIS · UNIVERSITAT ROVIRA i VIRGILI

Ref.: https://cordis.europa.eu/project/id/101006879

Objectives

Open Knowledge Base

- Assess the mechanisms enhancing data sharing in the transport sector
- Know how to improve the findability, accessibility, interoperability and re-usability of mobility data

Transport cloud prototype

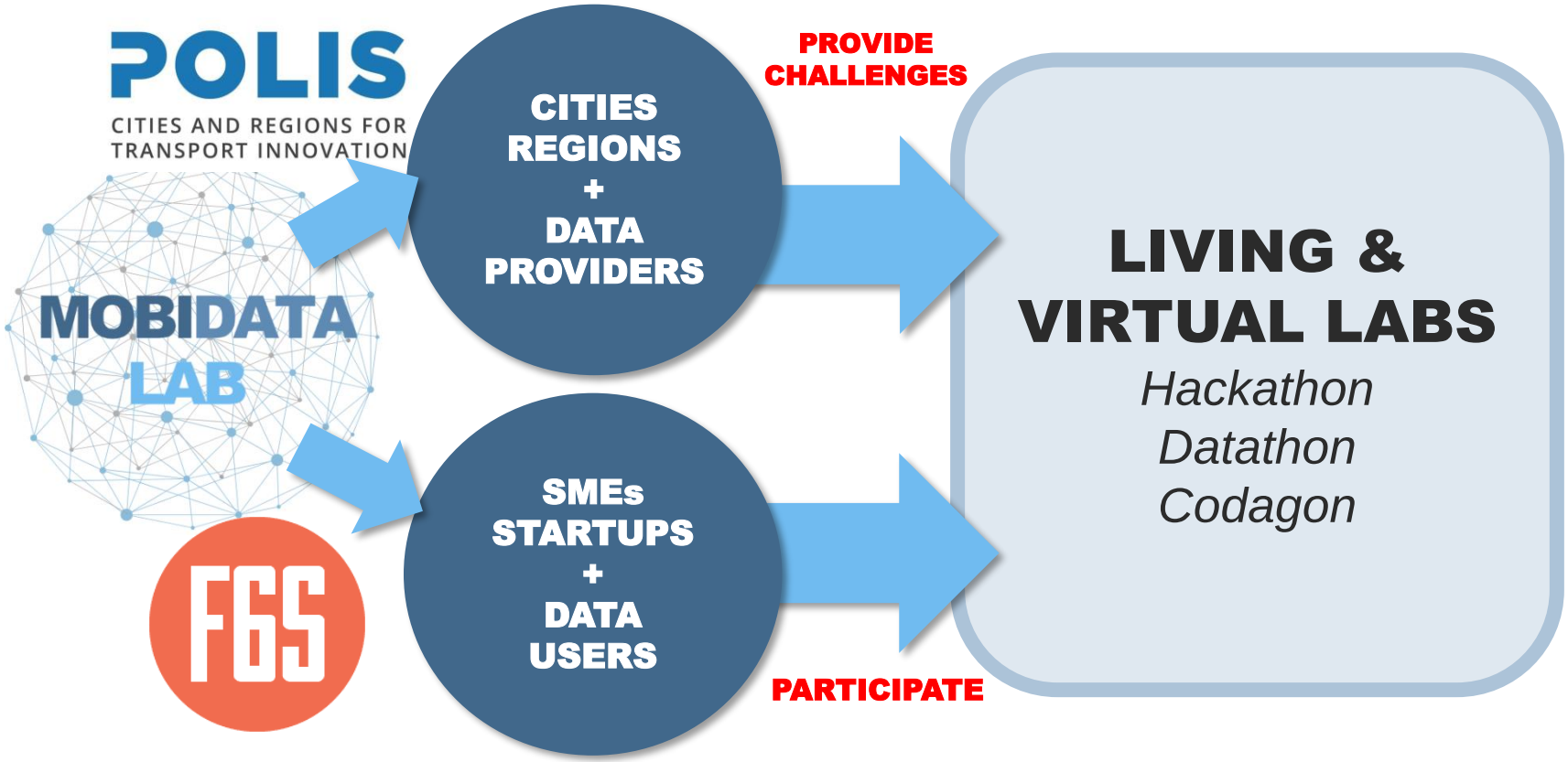
- Prototype a scalable cloud solution for sharing mobility data
- Showcase the most effective means to access and exchange mobility data

Living & Virtual Labs

- Gather representatives of mobility data providers and consumers
- Conduct innovation sessions to co-create, explore, experiment, using (open) data as a tool

Living & Virtual Labs

OUR METHOD TO IMPROVE MOBILITY THROUGH DATA SHARING



Reference Group
of mobility stakeholders

mobilità ROMA
EINDHOVEN
AGENZIA MOBILITÀ AMBIENTE TERRITORIO
PROMÁLAGA
HOCHBAHN
nvbw
Nahverkehrsgesellschaft Baden-Württemberg mbH
e-trikala
NEW YORK STATE OF OPPORTUNITY. Department of Transportation
MIVB STIB .brussels
Stad Leuven

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Living & Virtual Labs

DATATHON, HACKATHON, CODAGON

*MDL Living Labs are envisioned to be **open innovation environments** aiming to design and develop new concepts and solutions, based on available **datasets** and **data providers' challenges**, that generate value or efficiencies to end-users/ citizens/ corporates and communities.*

For the 3 MDL Living Labs the following characteristics were defined:

- Target participants
- Type of expected outcome
- Requirements
- Example MDL Use-Cases

	Datathon	**Hackathon**	**Codagon**
	2 days, hybrid event, May 2023	2 days, hybrid event, Sept 2023	3 weeks, virtual event, Nov-Dec 2023
Target Group	researchers, data analyst/scientists	software developers, data engineers	Both
Target Solution	**Exploration and Experimentation** Insights, Data Access, Data Enrichment and Combination	**New Tools and Services** Development and testing of new software	
Require-ments	Data analytics results presented in graphs, reports and proposals	Digital tools in smartphone or web applications	
Relevant Use cases	Emission reporting, Analytics and learning	Journey Planning apps, Improved Estimated Time of Arrival	

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Mobility challenge definition

ONE-ON-ONE INTERVIEWS WITH THE REFERENCE GROUP MEMBERS

Reference Group: relevant mobility stakeholders (local/regional authorities, transport authorities, transport associations/clusters, transport operators and others).

Role:

- **Provide challenges** corresponding to concrete mobility problems that data analysis, visualisation and enrichment may help solve.
- **Participate in the Living Labs**: challenges will be proposed to a community of innovators and data users in hackathons/datathons during the year 2023.
- **Validate project results** and provide customised feedback

Initial mobility challenges

Optimisation of transport flow and ETA

Emission reporting

Analytics and learning

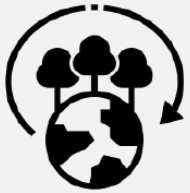
Journey planning services

Mobility as a Service

Use cases for operations

Use cases for research

Inclusive transport



Sustainable transport

Linked Open Data

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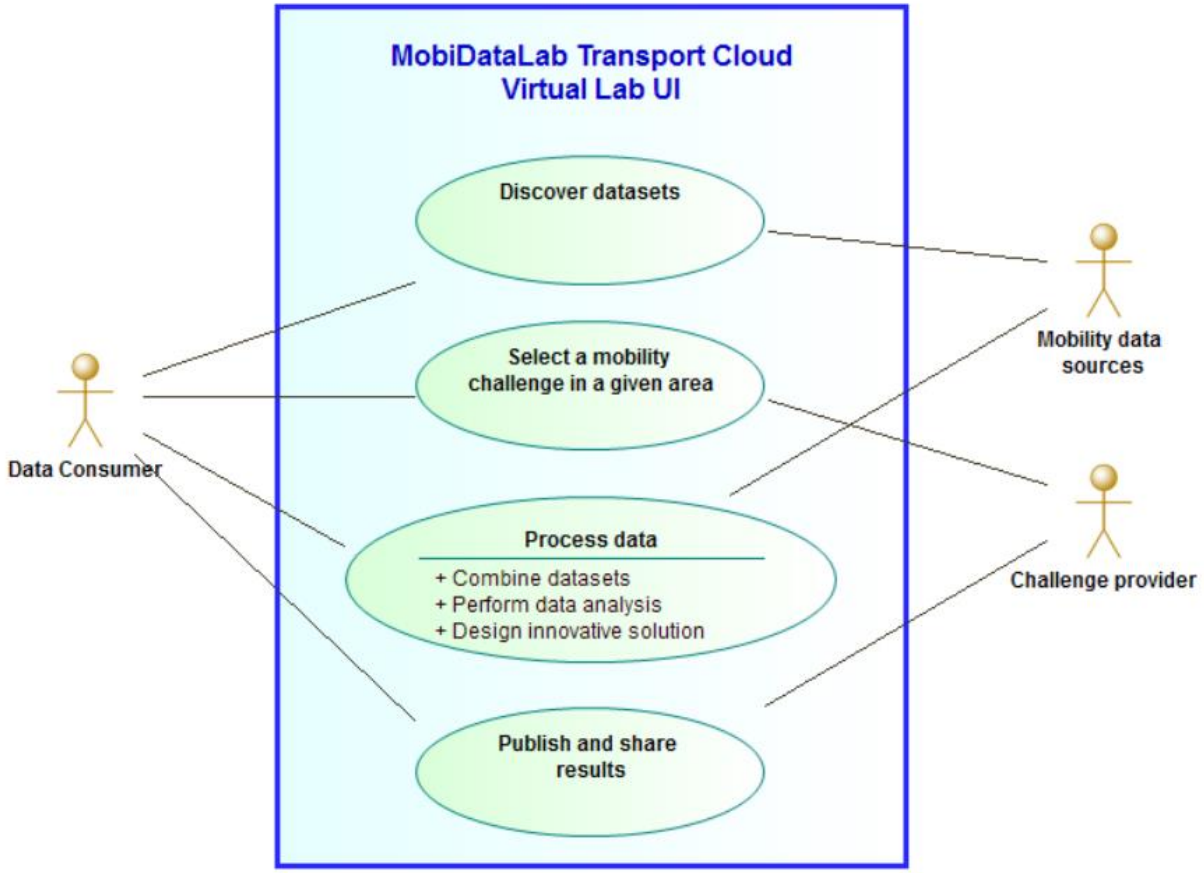
Living & Virtual Labs

GENERIC USE CASE DIAGRAM FOR THE VIRTUAL LAB



System: the Virtual Lab User Interface (UI) allowing accessing the challenges proposed by the MobiDataLab stakeholders

Actors

- Primary: the MobiDataLab Data Consumer or participant to Virtual Lab sessions
- Secondary:
  - the mobility data sources made available through the data catalogue
  - the challenge provider: member of the MobiDataLab Reference Group of stakeholders, providing challenges corresponding to concrete problems they face

Use cases

- Discover datasets
- Select a mobility challenge in a given area: the data consumer can explore the challenges proposed by the referring municipalities and select one to take up
- Process data
  - Combine datasets using data access channels and data processors
  - Perform data analysis
  - Design innovative solution to the selected challenge.

Transport cloud requirements

- Virtual Lab interface
- Metadata catalogues
- Service catalogue
- Data access through APIs (API gateway)
- Data access through desktop / SaaS softwares
- Processors, functions, libraries (SDK)
- Anonymisation methods

Metadata catalogue solutions

Generic catalogues

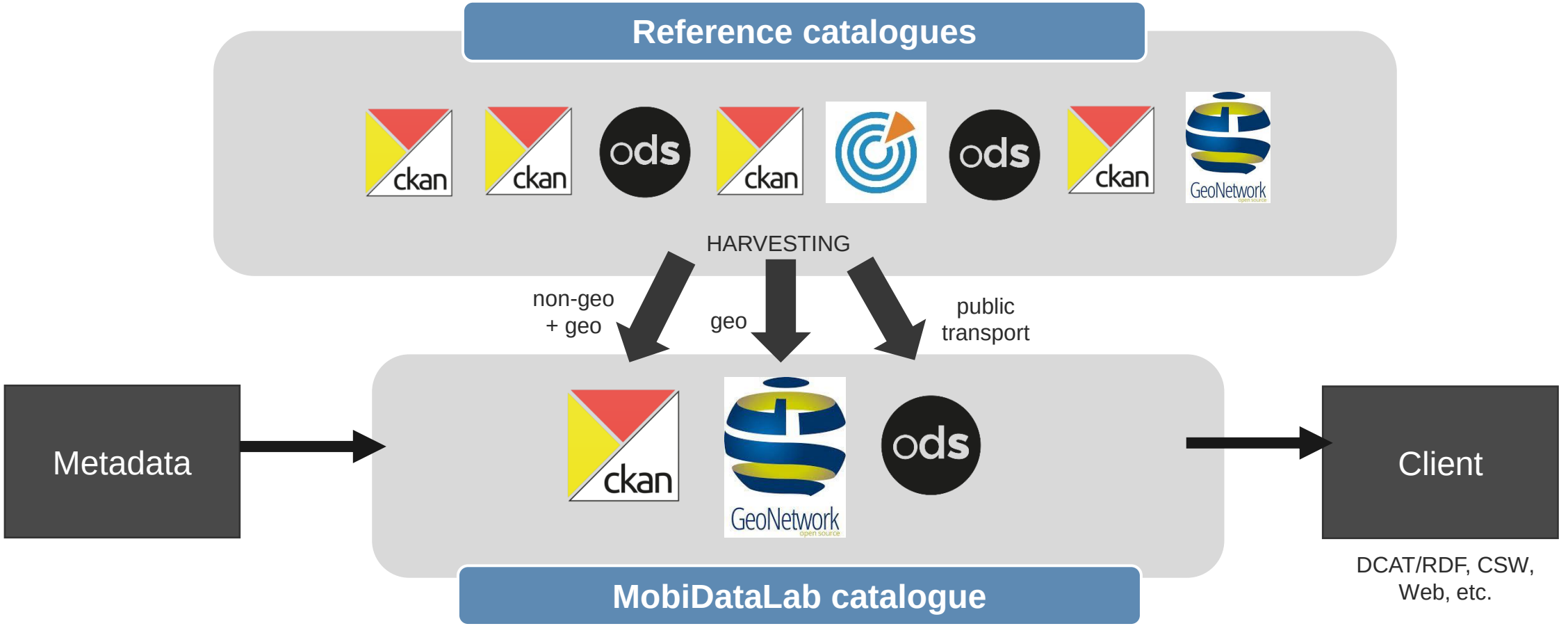
Rome, Milan, Malaga, Trikala, Timisoara, Bade Würtemberg, Flanders, etc. + certain NAPs

New York State
data.ny.gov

Eindhoven, Brussels, Toulouse, etc. + Kisio/Hove

Geo-referenced catalogues

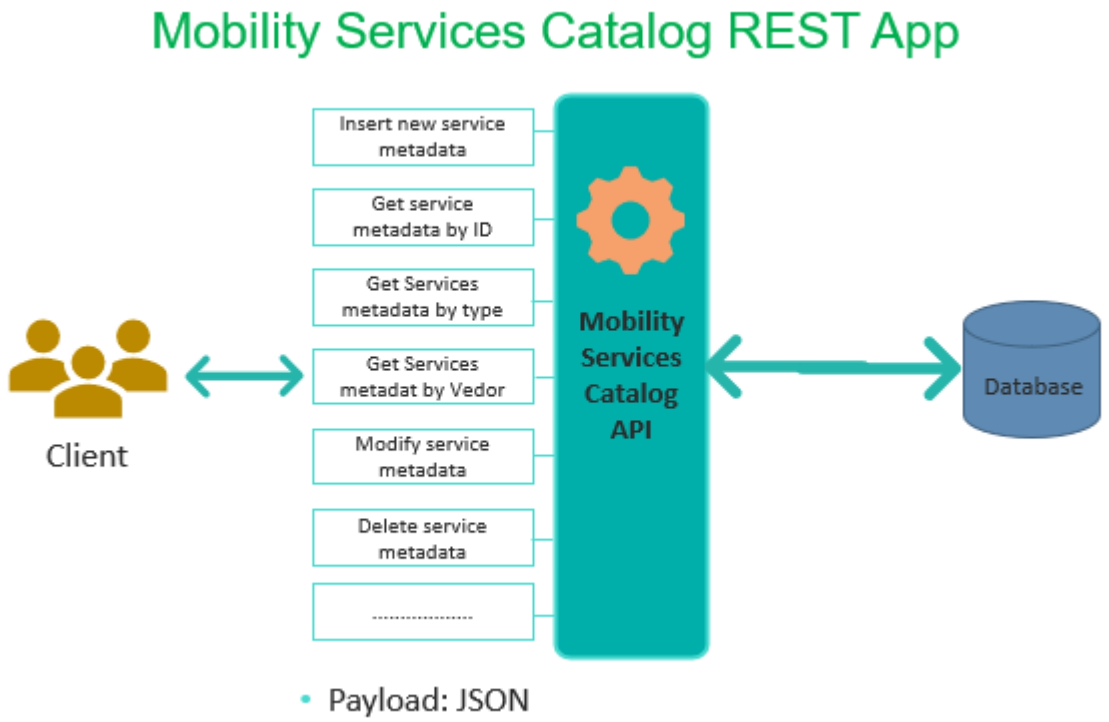
Metadata harvesting flows



Service catalogue

1. Mobility datasets (including data API/service)
2. Mobility services
    1. Routing
    2. Geocoding
    3. Traffic
    4. ….

HERE developer suite, Navitia suite, OpenStreetMap APIs, CARTO Maps, enRoute chouette, Fluctuo data flow, Google Maps, Mapbox, Apple Mapkit, GeoTab ignition, Inrix API, Okina, Otonomo, Populus, PTV, Remix data platform, SharedStreets, Tom Tom, Vianova, TIER mobility, Cubic transportation, TransiTool, etc.



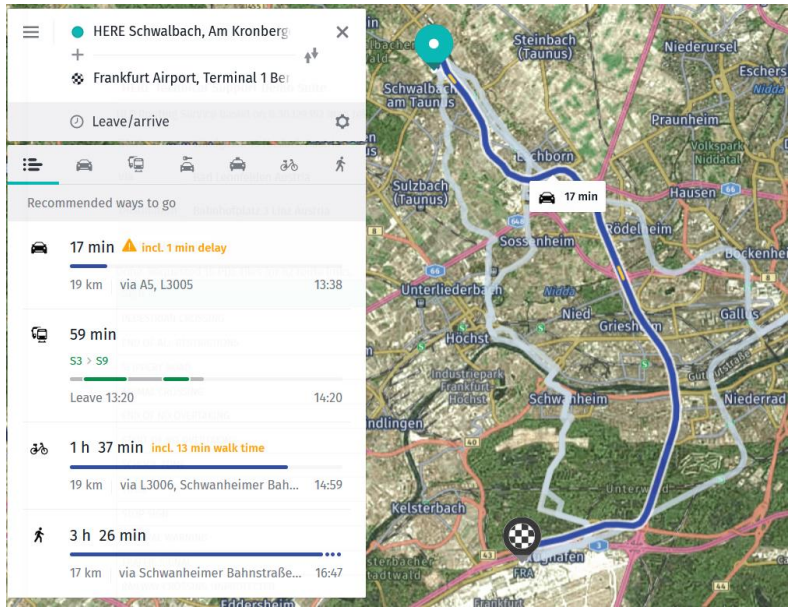
Interoperability of data

- Mobility data
  - Public transport (TRANSMODEL, NeTEx, SIRI, OJP, GTFS, GTFS-RT)
  - New mobility (MDS, GBFS)
  - Road traffic (DATEX II)
- Metadata (DCAT, DCAT-AP, CSW)
- Data on the web (REST, XML / JSON, OpenAPI)
- Semantic web and Linked Open Data (RDF, SPARQL, OWL, JSON-LD)
- Spatial data (OGC WMS, WFS, API Features, OpenStreetMap, Shape, etc.)

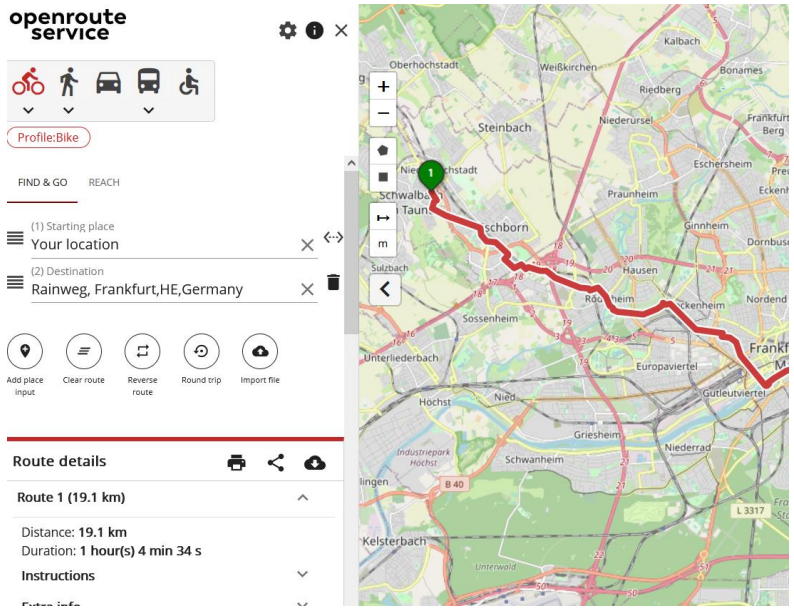
Interoperability of services

Location-based services and their interfaces play an important role to enable consumers to use mobility data for their individual use-cases. However, **services and their interfaces lack interoperability.**

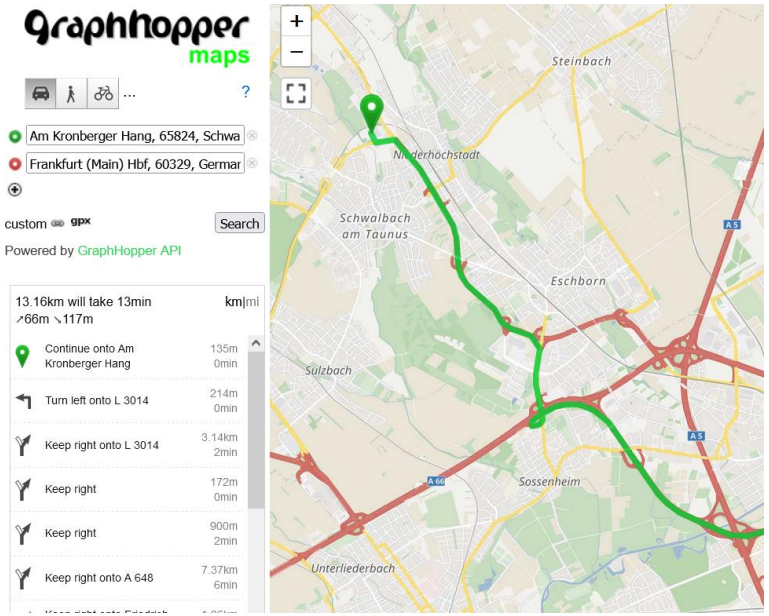
HERE routing



OpenRouteService



graphhopper



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Data access

DURING MOBILITY DATATHON AND HACKATHON

+ participants preferred tools

Desktop / SaaS tools

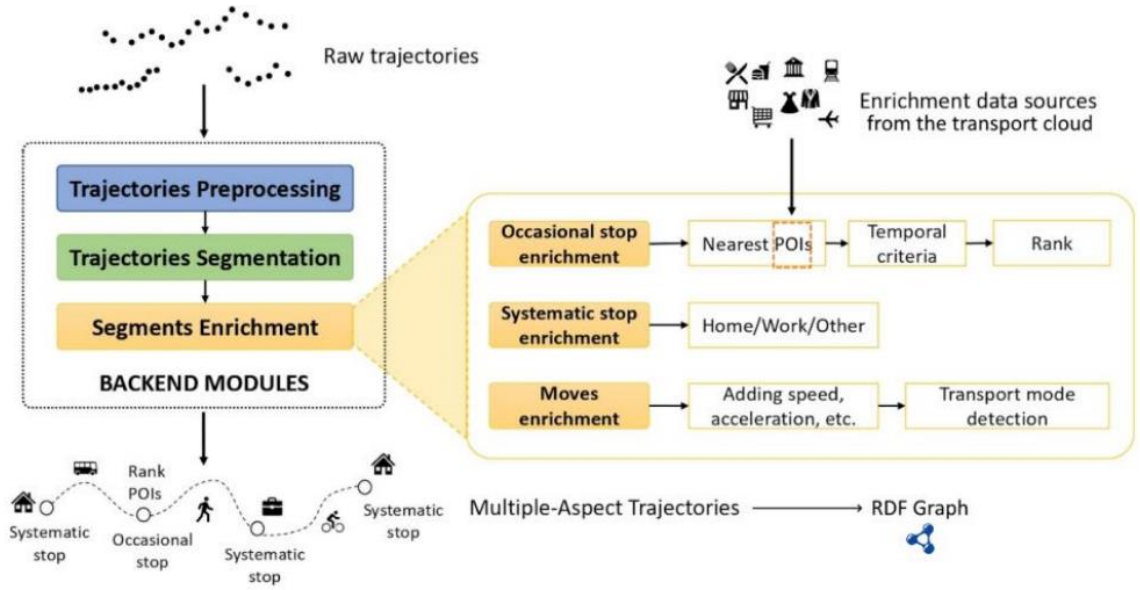
Navitia

+ on-demand services on the MDL catalogue

Service APIs

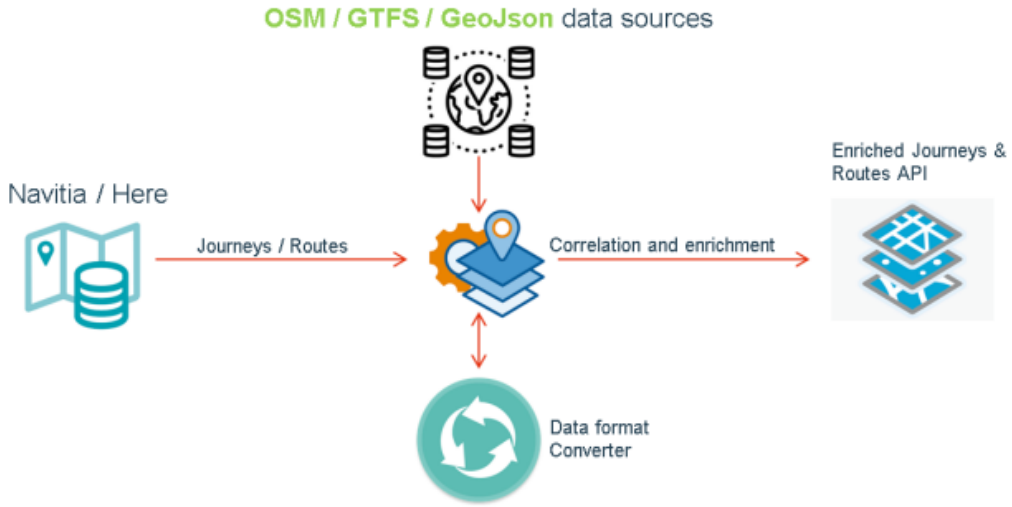
Data processors

SEMANTIC ENRICHMENT OF MOBILITY DATA



A multiple aspect trajectory expresses movement data that is heavily semantically enriched with dimensions (i.e., aspects) representing various types of semantic information (e.g., stops, moves, weather, traffic, events, and points of interest)

GEO ENRICHMENT OF MOBILITY DATA



The mobility data mashup API is a Rest API that consumes a target API and enriches it with additional attributes extracted from a source API and produces the same format as the target API.

Data anonymisation methods

SWAP LOCATIONS

permuting the locations in trajectories among other trajectories

SWAP MOB

swapping segments of trajectories with other trajectories

MICROAGGREGATION

partitioning the data set into disjoint clusters containing each at least k similar trajectories and aggregate by replacing them with the cluster centroid

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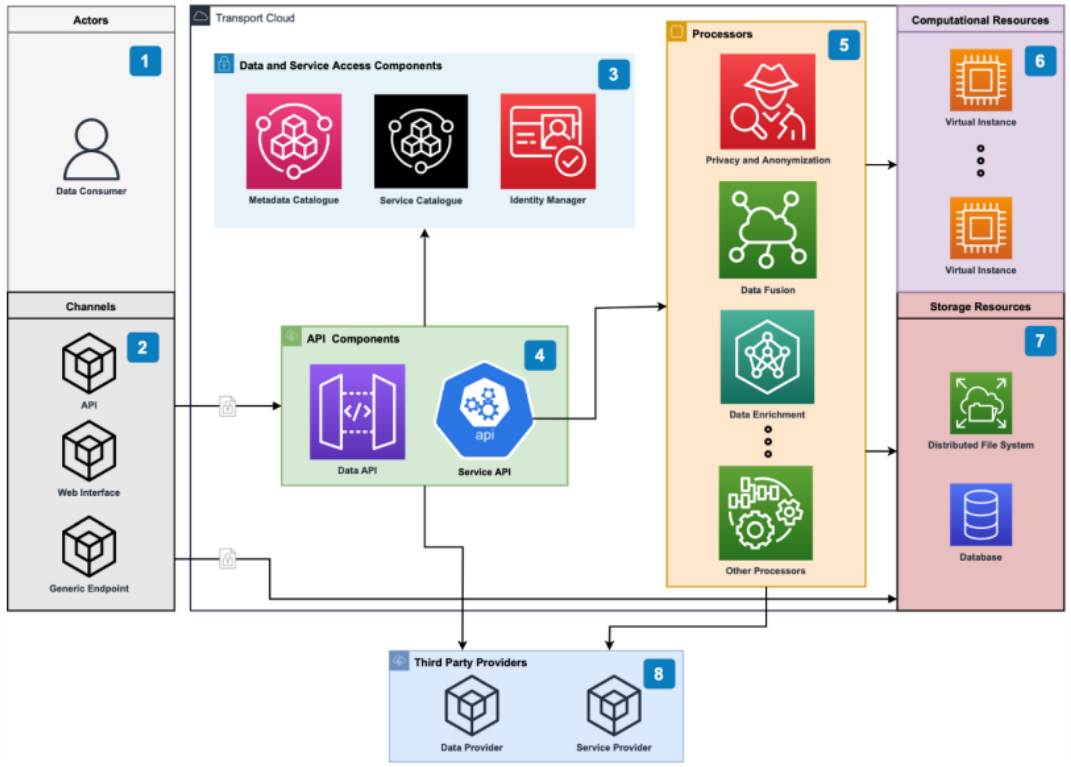
The Transport Cloud



Transport Cloud architecture

CLOUD FEDERATION

The elicited architecture covers cloud federation, governance and use cases requirements by using established standards and components.

METADATA AND SERVICE CATALOGUES

A set of software catalogue systems reviewed on their capabilities are integrated into the Transport Cloud, easing data findability and accessibility.

PRIVACY AND ANONYMISATION

Anonymization mechanisms allow that personal mobility data can still be collected, analyzed and shared with privacy guarantees.

DATA ENRICHMENT

The Transport Cloud includes a toolbox for data set enrichment, containing so-called processors which give the ability to create novel data and services.

Key take-aways (at this stage!)

- Improving mobility data sharing with the European level in mind is more complex, due to :
  - different languages (sounds trivial but is not! – think about metadata)
  - different contexts (geographical, societal, legal, commercial, etc.)
  - sometimes different softwares (e.g. journey planners, metadata catalogues)
- Still a long way to go for making mobility data FAIR
  - the lack of service interoperability is still problematic (e.g. journey planners and MaaS)
- Solutionism (i.e. providing a solution to users before their true problems have been identified) should be avoided …
- … but scalability, replicability and sustainability must be anticipated (including for business/cooperation models)

Thank you for listening

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MobiDataLab is funded by the EU under the H2020 Research and Innovation Programme (grant agreement No 101006879)

SYN+AIR´s Smart Contracts Framework–
Methodologies and Data-based Technology Solutions for Improved European Mobility

Ismini Stroumpou/Sparsity Technologies (3rd party of UPC), Project Coordinator

EUROPEAN PARTNERSHIP

Co-funded by the European Union

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Problem Statement

Joana wants to travel from Barcelona to Brussels and wants to have a door2door seamless journey

Ideal situation is:

1. Single ticket at a reasonable price
2. Real time information
3. Low waiting time at the interchanges
4. Re accommodation in case of disruption

Transport Service Providers (TSPs) need to collaborate/agree on:

1. Share data e.g., schedules, traveler's ID, assistance-PRM etc.
2. Pricing scheme / Revenue sharing
3. Responsibility sharing

This is the objective of SYN+AIR: to allow TSPs to collaborate in a simple and efficient way by using **SYN+AIR's Smart Contracts Framework**

SYN+AIR's Smart Contracts Framework

EUROPEAN PARTNERSHIP

Co-funded by the European Union

What is the Smart Contracts Framework?

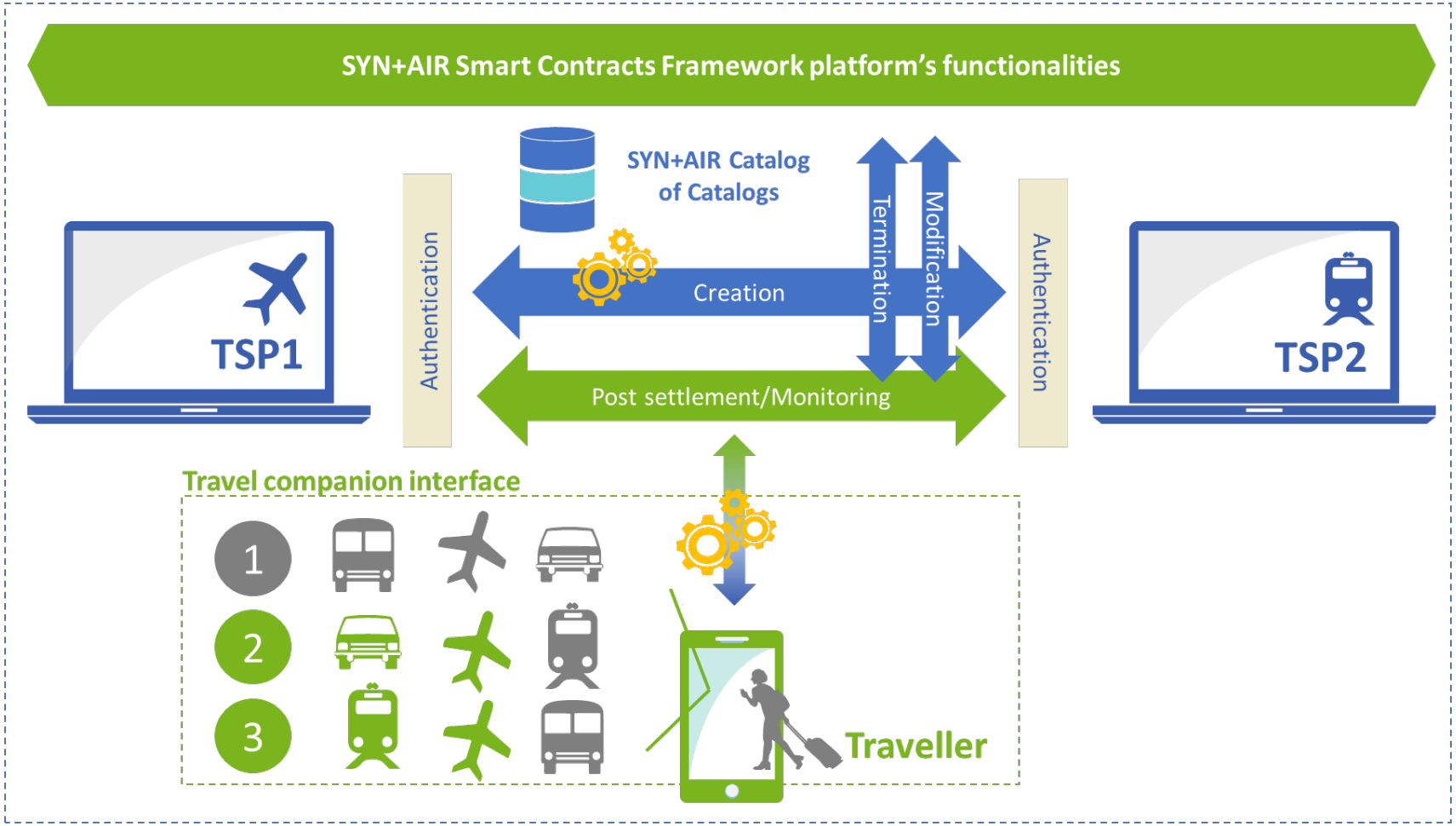
A **business process** that defines data exchange rules among TSPs that share the common goal of getting the passenger to the destination through a multimodal chain of trips

- provides a **centralized hub** for **contracts management** via a web platform (named SYN+AIR platform) that allows TSPs to create, modify, terminate, and validate signed contracts (both data **sharing agreements** and **smart contracts**).
- the storage of TSPs' data and, all the data sharing processes are executed **outside** of the SYN+AIR platform.

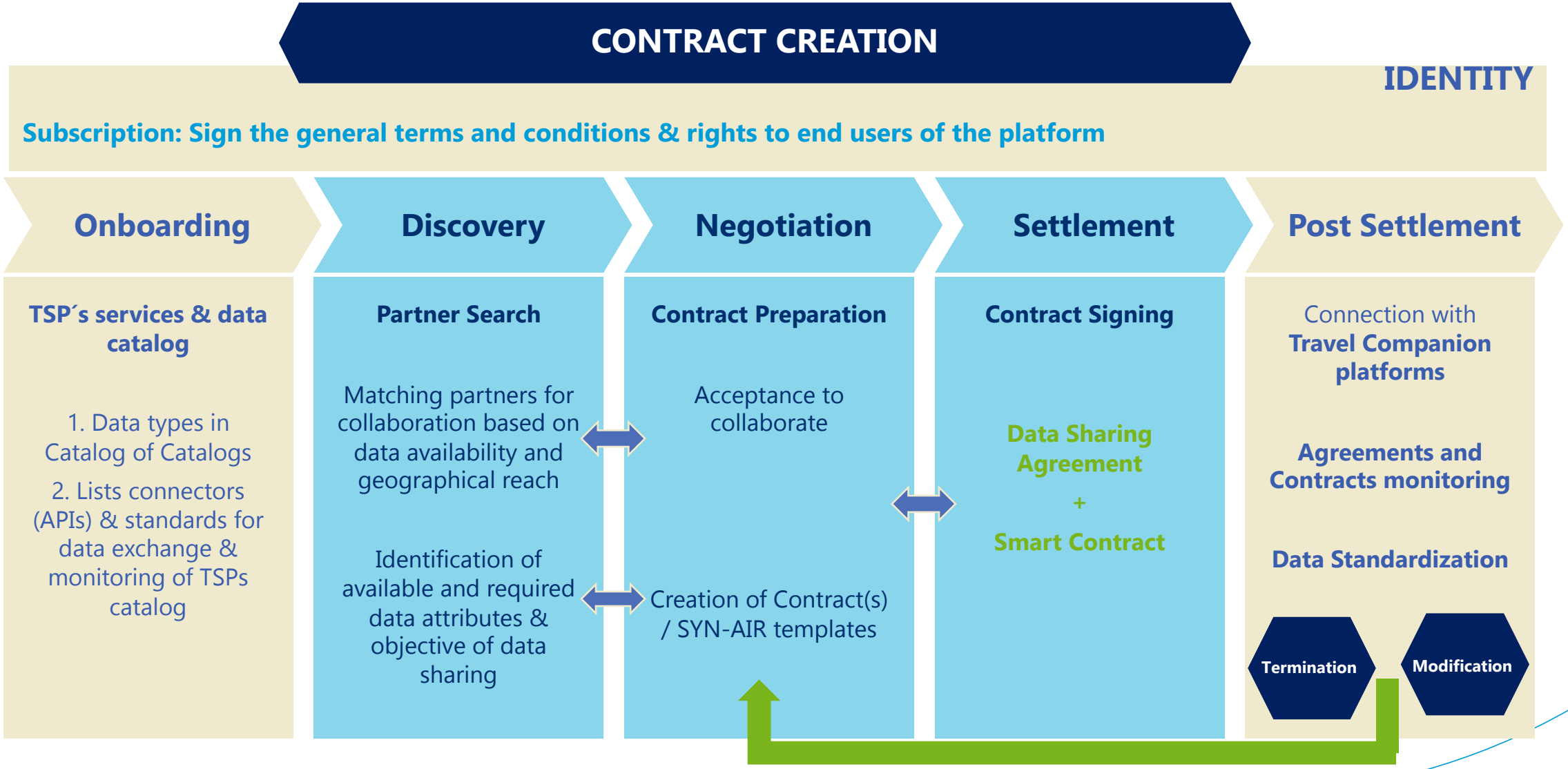
Proposed solution-"Backend"

Components/Actors/Functionalities

Central point to manage the contracts between the TSPs, facilitated by a web platform



Proposed solution (Steps that a TSP need to follow)



Registration

1. **General terms and conditions**

1. under what conditions the SYN+AIR platform is provided;
2. the **rights and obligations of TSPs** when using the SYN+AIR platform;
3. **the (by default) rights and obligations of TSPs when processing the Data** being shared by the means of **Data Sharing Agreements**;
4. **the (essential) rights and obligations of TSPs** deriving from **Smart Contracts.**

2. **User agreements**

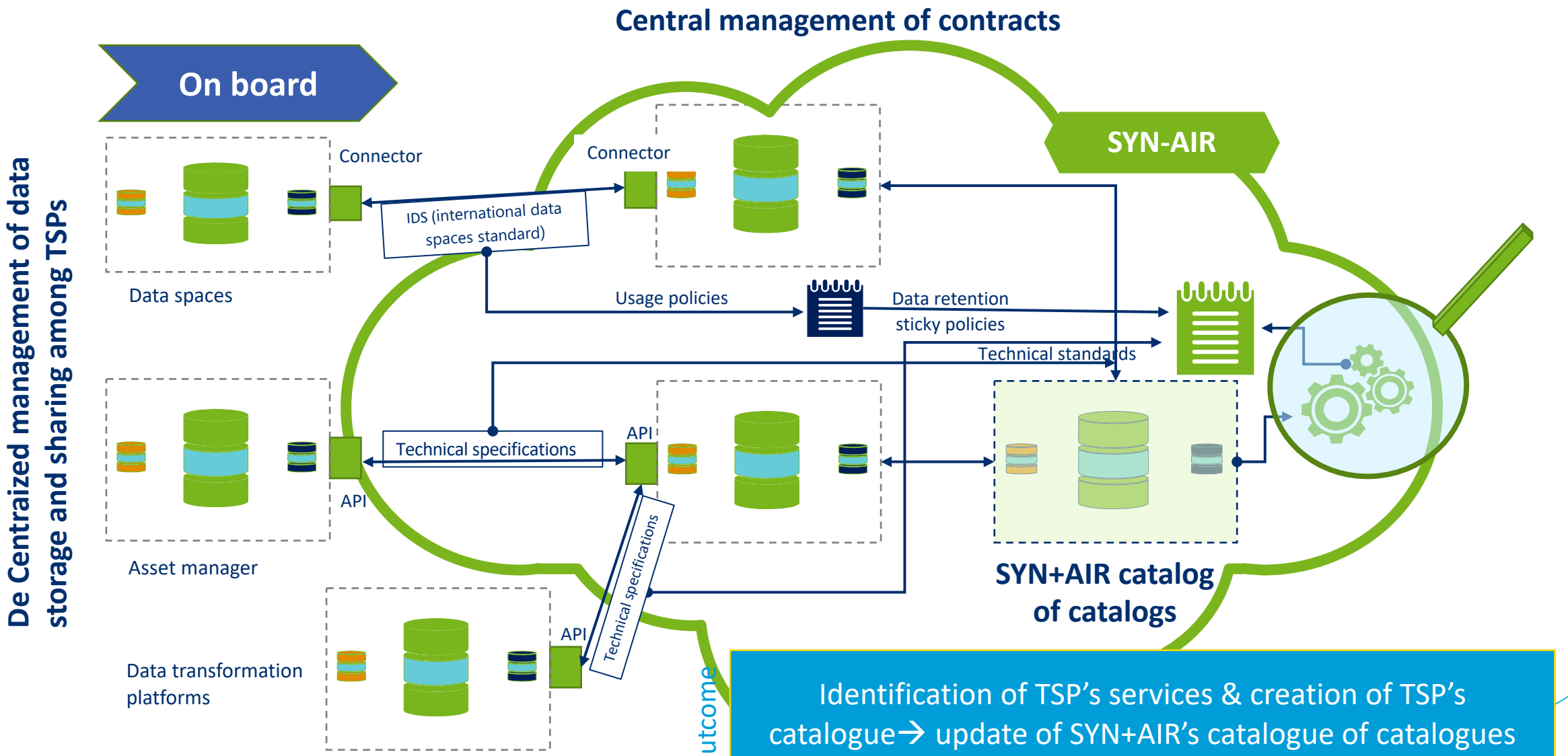
Designation of authorized users (3 types) of SYN+AIR platform

1. Duly authorized and entitled to act on behalf of the legal entity (i.e., director or the CEO)→ sign the Data Sharing Agreements and the Smart Contracts;
2. Administrative Representative: to negotiate the terms of the DSA and of the SC on behalf of the TSP;
3. **Technical Representative**: to create and maintain the TSPs' data catalogue(s) in the SYN+AIR platform.

Outcome

Accepted terms & conditions, Assign authorized users of platform

On board


Central management of contracts
On board
SYN-AIR
De Centraized management of data storage and sharing among TSPs
Connector
Connector
IDS (international data spaces standard)
Data spaces
Usage policies
Data retention
sticky policies
Technical standards
Technical specifications
API
API
Asset manager
API
Technical specifications
Data transformation platforms
SYN+AIR catalog of catalogs
Outcome
Identification of TSP's services & creation of TSP's catalogue→ update of SYN+AIR's catalogue of catalogues

Discovery-Creation of data matching mechanism

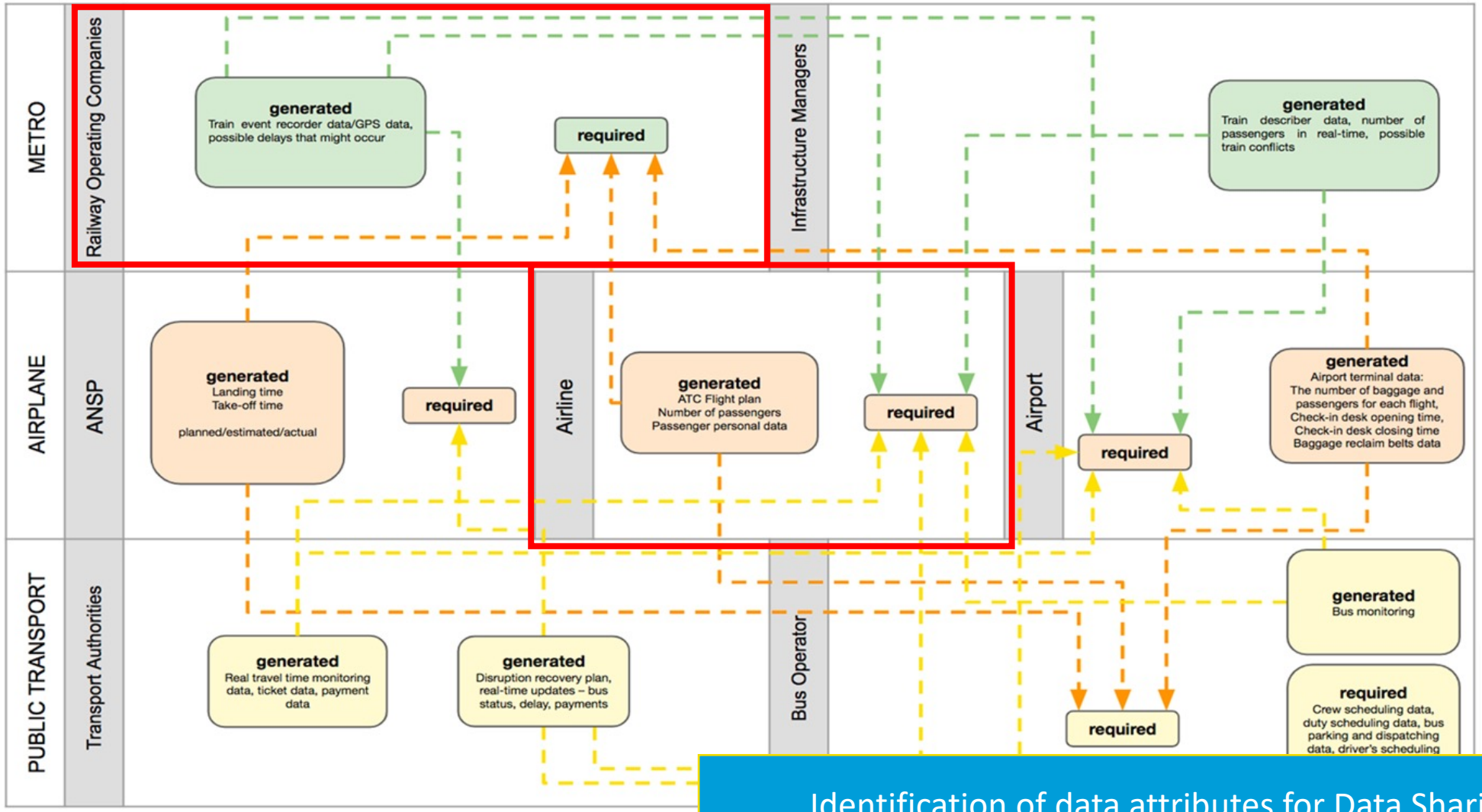
1. Identification of **data generated by each stakeholder per mode and the data that are required to be exchanged to have a seamless journey**
2. Creation of a model composed by different **Data Flow Diagrams** representing trip chains (aka alternatives that a traveller might have for going from A to B (door-to-door)

Air Transport as the main leg:
[Train → Airplane → Train],
[Metro → Airplane → Bus],
[Bus → Airplane → Uber/Taxi] and
[Uber/Taxi → Airplane → Metro]

Rail Transport as the main leg:
[Uber/Taxi → Train → Bus],
[Bus → Train → Uber/Taxi] and
[Metro → Train → Metro]

Maritime Transport as the main leg:
[Train → Ferry → Uber/Taxi],
[Uber/Taxi → Ferry → Train] and
[Bus → Ferry → Bus]

Discovery
Matching-example



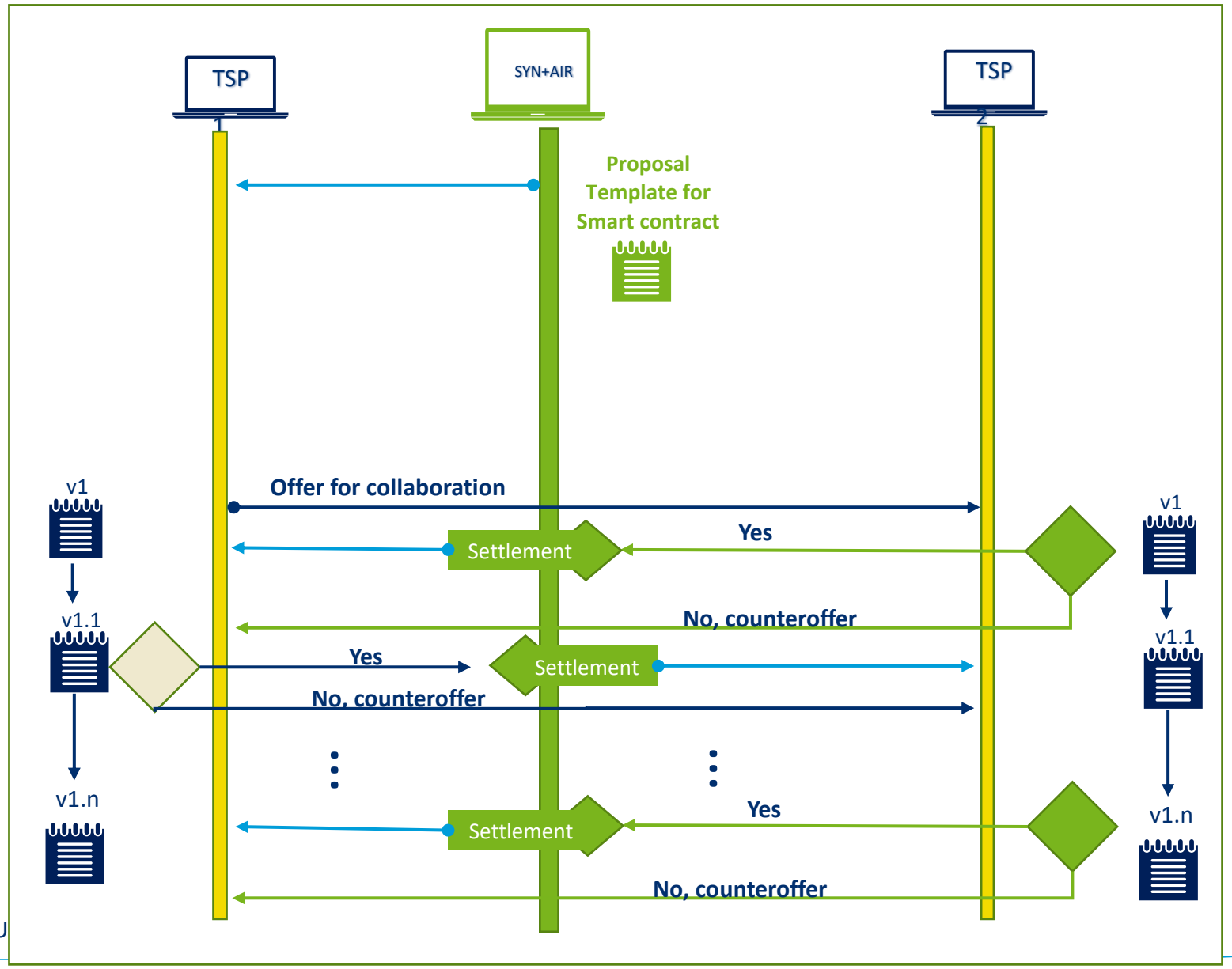
Outcome

Identification of data attributes for Data Sharing Agreements, Creation of negotiation templates

Discovery objectives of data sharing agreements per pair

TSPs pairs	Synchronization of timetables	Optimization of resources	Single Ticketing	Disruption recovery plans and real time updates	Reduce waiting time, reduce number of cars on the access roads	Increase car sharing
ANSPs + Railway operator				X		
Airline + Railway operator	X		X	X		
Airport + Railway operator		X		X	X	
ANSPs + Bus operator				X		
Airline + Bus operators	X		X	X	X	
Airline + Public Transport Authority			X	X		
ANSPs + Public Transport Authority				X		
Airline + Taxi or DRT				X		X
Airport + Taxi or DRT				X	X	X
Railway operator + MaaS operator			X	X	X	
Bus operator + Railway operator	X		X	X		
Ferry + Railway operator	X		X	X		
Ferry + MaaS operator			X	X	X	
Ferry + Public Transport Authority			X	X		
Port Authority + MaaS operator		X		X		
Ferry + Bus			X	X	X	
Ferry + Taxi or DRT			X	X		X
Port Authority + Railway operator		X		X		
Port Authority + Bus operator		X		X	X	

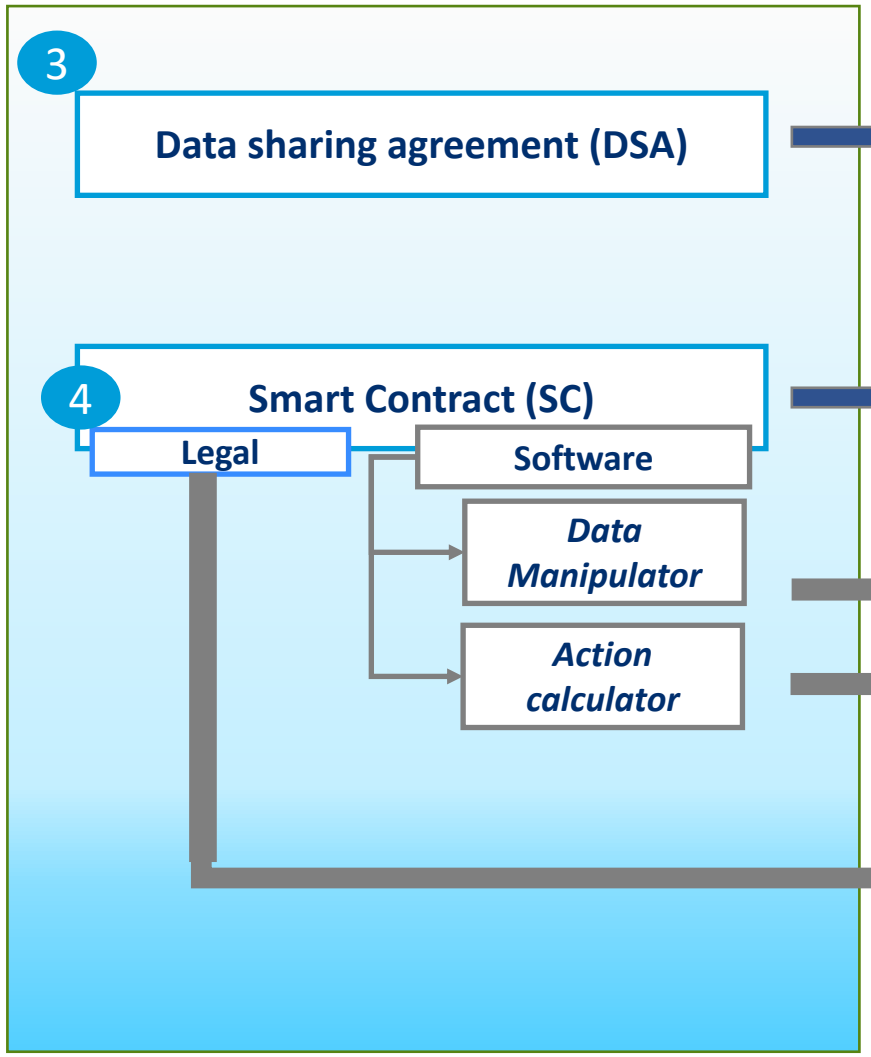
Negotiation process



Outcome

Data sharing agreement(s) & smart contract

Negotiation/Settlement-legal layer



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.

Based on "external smarter contract model" composed of **a legal part and a software part**, 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.

Code that activates the triggers for data sharing

Operational consequences linked to use of data

Legal consequences linked not respect of the actions

A **Trigger** is a condition whose realization entails the necessary execution by a Party of (a) determined Action(s).

An **Action** is a contractual obligation that must be respected by a Party in the event a Trigger is realized

Negotiation/Example of Smart contract template

Legal part

SC Activation datetime: 01-09-2022 00:00:00

SC Termination datetime: 01-09-2023 00:00:00

Obligations

Until modification or termination of this SC, both parties have the following obligations.

Obligations of both parties:

- Deliver actions dictated by the software part which, in summary, are to:
  - Inform other party and Travel Companion (TC)
  - Calculate and take operational decisions when asked
  - Reimburse passengers fully, partially or with voucher depending on the situation

Obligations of TSP1: Coordinate trips with TSP2's flights

Obligations of TSP2: ...

Revenue sharing: The single-ticket's price will cost XX% more/less than the sum of the prices of the separated tickets. Each party will receive their corresponding share of the price using a percentage/pre-determined/other approach for price estimation.

Action – Responsibility sharing:

action_1 – legal consequence

...

action_32 - legal consequence

Signature

Legal Representative of TSP1, Legal Representative of TSP2

Software part

Data Manipulator: As in all templates

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Action Calculator: Calculates required actions by the parties. It is grouped by scenarios and phases. Actual code below

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        ČĮ ŃĬŅŅĬĿĲĬŅ ĬĬĿĬĬĻŅ ŅĶĿĲĻĬŃÒĶĬĿĬÒZ
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              ĬĬÒĶŃĿĬĮRZ ĒĒĒR ĬĬĿĬĬĻ ÕŃÓŅ ŃĬŅÒ ŃĮ ÒĴĬ ÒĶĬĿĬÒ ŎĶÒĴ ĜĜĒ ŅĶĶŁĬŃŅŅĬŁĿÒ
    ČĮ ŃĴĬŅĬ ĶŅ ĕĒĬĬÒĶĬĬĻĕZ
        ČĮ ŃĬŅŅĬĿĲĬŅ ĬĬĿĬĬĻŅ ŅĶĿĲĻĬŃÒĶĬĿĬÒZ
              ĬĬÒĶŃĿĬĮSZ ĒĒĒQ ĬĬĿĬĬĻ ÕŃÓŅ ŃĬŅÒ ŃĮ ÒĴĬ ÒĶĬĿĬÒ ŎĶÒĴ ĜĜĒ ŅĶĶŁĬŃŅŅĬŁĿÒ
              ĬĬÒĶŃĿĬĮTZ ĒĒĒR ĬĬĿĬĬĻ ÕŃÓŅ ŃĬŅÒ ŃĮ ÒĴĬ ÒĶĬĿĬÒ ŎĶÒĴ ĜĜĒ ŅĶĶŁĬŃŅŅĬŁĿÒ
        ČĮ ĮĻĶĲĴÒ ĶŅ ĬŃŅĬĬÒĬĬ ÒŃ ĬĬ ĬĬĻĬŃĬĬ ĮŃŅ ĬÒ ŁŅŅÒ Ĝ ĴŃÓŅŅZ
              ĬĬÒĶŃĿĬĮUZ ĒĒĒR ĶĬĮŃŅŁ ŃĬŅŅĬĿĲĬŅ ÓĶĬ ÒĴĬ ĒĂ
              ĬĬÒĶŃĿĬĮVZ ĒĒĒR ĲĶÒĬ ŎŃÓĬĴĬŅ ÒŃ ŃĬŅŅĬĿĲĬŅ ÒŃ ĬĶĬĬ ĶĬ ÒĴĬ ĬĶŃŃŃŃÒ
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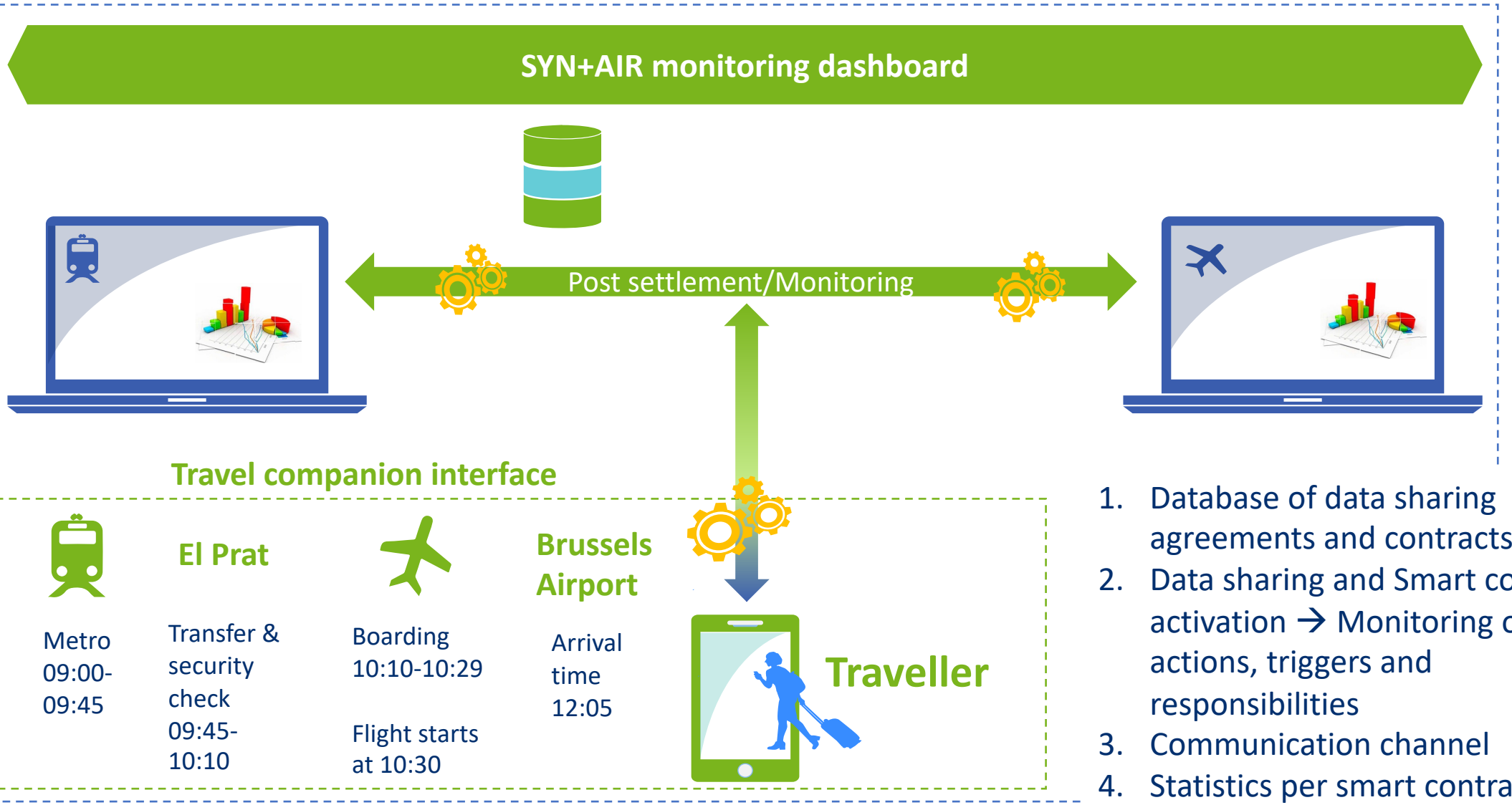
              ÒŃ ĬŃŃĶÓĬ ĬĿĬ ÕĬĶÒĂ ČĮ ÕĬŅZ
                    ĬĬÒĶŃĿĬĮXZ ĒĒĒR ŅĶĶŁĬŃŅŅĬ ŅŃŁĬĬĴĬŃ
              ČĮ ĿŃZ
                    ĬĬÒĶŃĿĬĮYZ ĒĒĒR ŅĶĶŁĬŃŅŅĬ ĮŃĻĻÕ ĬĿĬ ĶĿĮŃŅŁ ĒĒĒQ ÒŃ ĬĬĿĬĬĻĬ ÒĴĬ
                    ÒĶĬĬĬÒ ĬĻŅĬŃĴĬŅĬ
        ČĮ Ĭ ĬĶŅŅÓŃÒĶŃĿ ĴĬŃŃĬĿŅ ŎĴĶĬĴ ŅĬĶÓĻÒŅ ĶĿ Ĭ ÒŃĬĶĿ ĬĬĻĬŎ ÒĴĬÒ ÕĶĻĻ ŁĬĿĬ ÒĴĬ
        ŃĬŅŅĬĿĲĬŅ ŁĶŅŅ ÒĴĬĶŅ ĮĻĶĲĴÒ ĬĿĬ ÒĴĬ ŃĬŅŅĬĿĲĬŅ ĶŅ ĿĬ ĬŅĬĬĬZ
              ĬĬÒĶŃĿĬĮQPZ ĒĒĒQ ĶĬĮŃŅŁ ĒĒĒR
              ĬĬÒĶŃĿĬĮQQZ ĒĒĒR ĬĬĬĶĬĬ ĶĮ ĶÒ ĶŅ ŅŃŅŅĶĬĻĬ ÒŃ ĬĬĻĬŎ ÒĴĬ ĮĻĶĲĴÒŃ ČĮ ÕĬŅZ
```

¹ The Data Manipulator will always be listening for triggers like this

Post settlement/monitoring



1. Database of data sharing agreements and contracts
2. Data sharing and Smart contracts activation → Monitoring of actions, triggers and responsibilities
3. Communication channel
4. Statistics per smart contract

Next steps & conclusions

Co-funded by
the European Union

Next Steps & conclusions

The SCF is a co-created **concept** with TSPs and mobility stakeholders.
Each step performed by TSPs to sign a data sharing and/or a smart contract will pave the way towards a better travel experience

The next steps are:

1) **To develop and test SYN+AIR´s platform**
2) Test and assess the platform by **¨translating¨** a real data sharing contract e.g. between a airline and a railway operator and upgraded to also to create a smart contract to accompany the data sharing
3) Demonstrate to TSPs that data sharing can unlock new opportunities
4) To engage and use results from other EU initiative such as MobiDataLab, Data4PT, Catena-X, NAPCORE etc.

To achieve seamless D2D transport collaboration is mandatory at all levels

Identify where MobiDataLab findings can be used

Q & A

For more information you can always download our deliverables from the project website http://syn-air.eu/

sesar JOINT UNDERTAKING

synair.

THANK YOU FOR YOUR ATTENTION

EUROPEAN PARTNERSHIP

Co-funded by the European Union

SOBIGDATA
RESEARCH INFRASTRUCTURE

European Research Infrastructure for Big Data and Social Mining

Luca Pappalardo

ISTI-CNR, Pisa

www.sobigdata.eu

Why SoBigData RI

Responds to the rising demand for cross-disciplinary data-driven research and innovation

- Democratising the benefits of data science and Big Data within an ethical framework that harmonizes individual rights and collective interest
- Focus on **Social Mining** to understand and model complex social phenomena
- Open Data ecosystem: adequate means for accessing big social data together with algorithms for extracting knowledge from them

- *Social mining is a toolbox aimed at understanding and modelling complex social phenomena and their evolution.*

- *Combines* ***data-driven and model-driven analytic approaches*** *(network science, data mining, and AI): “what is” and “what if.”*

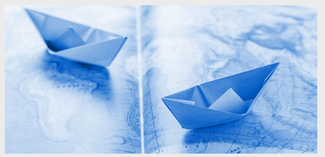
Exploratories

*Vertical **contexts** fostering tangible progress towards grand societal challenges*

Societal Debates and Misinformation Analysis

Demography, Economy and Finance 2.0

Sustainable Cities for Citizens



Migration Studies

Social Impact of AI and explainable machine learning

Sports Data Science

Network Medicine

Disaster response and recovery

Societal and industrial impact of Next-Generation Internet and beyond 5G networks

Sustainability and management of future networks and Cyber- Physical systems

Pervasive intelligence modeling for future society

Sustainable Cities for Citizens

- **Models for flows generation**
  - A Deep Gravity model for mobility flows generation. Nature communications
    Nature communications 2021

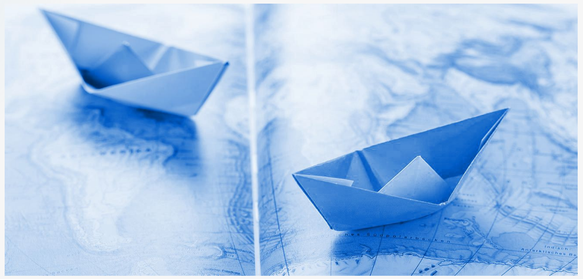
- **Mobility Analytics for official statistics**
  - Evaluation of home detection algorithms on mobile phone data using individual-level ground truth
    EPJ data science, 10. 2021

- **Mobility and COVID-19**
  - Living in a pandemic: changes in mobility routines, social activity and adherence to COVID-19 protective measures
    Scientific reports, 2021

- **Urban impact of AI**
  - Connected Vehicle Simulation Framework for Parking Occupancy Prediction
    SIGSPATIAL 2022
  - How Routing Strategies Impact Urban Emissions
    SIGSPATIAL 2022

- **Estimation of CO2 emissions and pollution**
  - Gross polluters and vehicle emissions reduction
    Nature Sustainability 2022

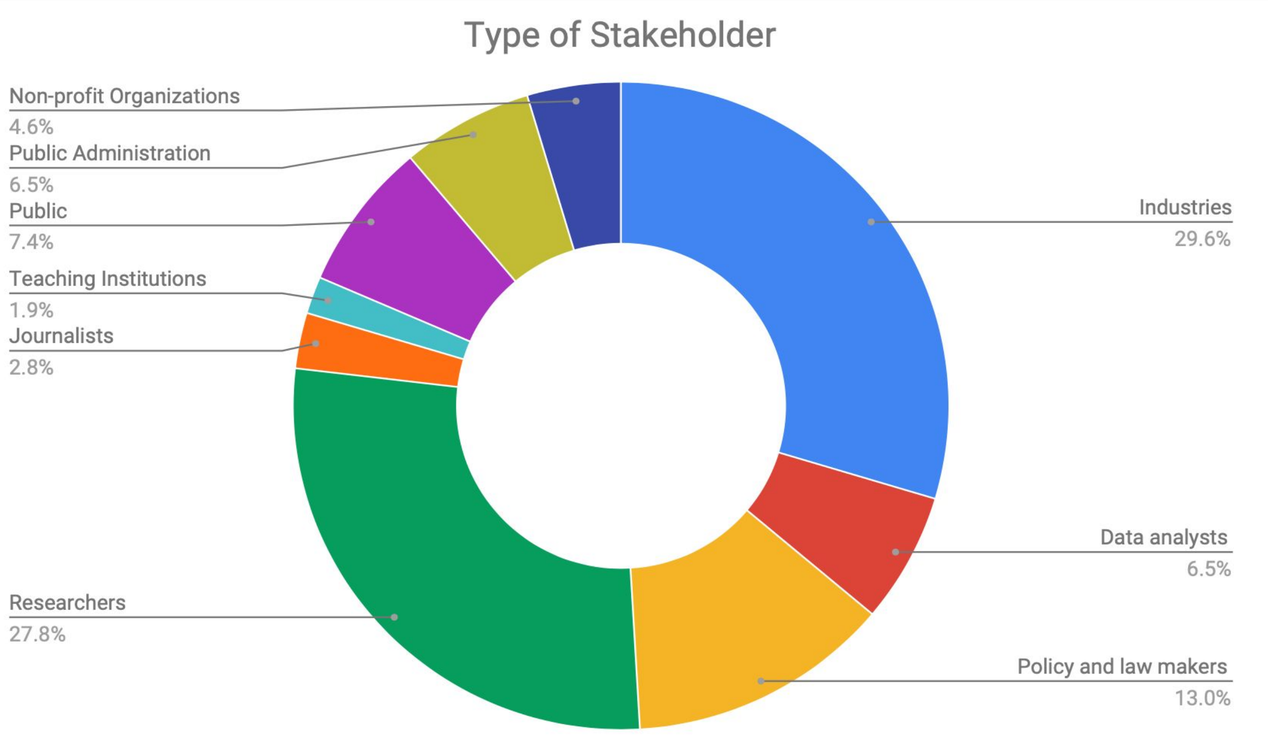
Migration Studies

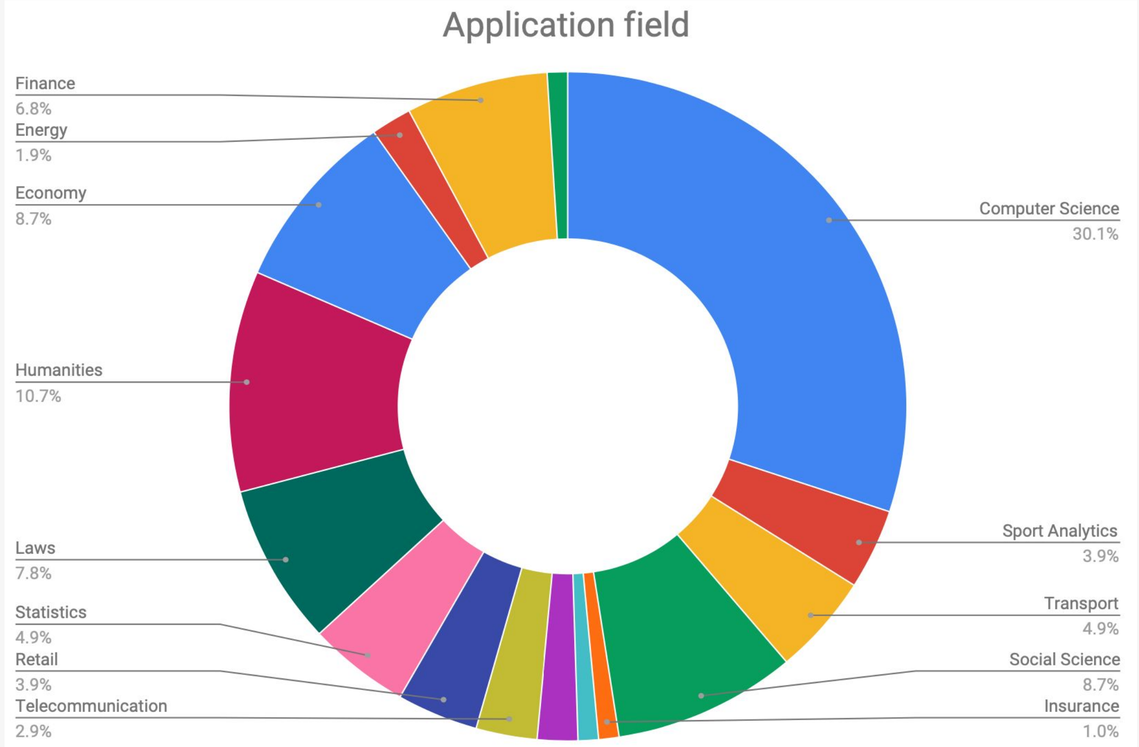


- **Detecting migration from social media**
  - Digital Footprints of International Migration on Twitter
    Intelligent Data Analysis, 274-286. 2020.
  - Human migration: the big data perspective
    International Journal of Data Science and Analytics, 1-20. 2020.
  - Home and destination attachment: study of cultural integration on Twitter
    Scientific reports, 2021

- **Measuring international migration and friendships**
  - Internal migration and mobile communication patterns among pairs with strong ties
    EPJ Data Science 2021
  - Turnover in close friendships.
    Sci Rep 2022
  - Dataset of Multi-aspect Integrated Migration Indicators
    Data paper under revision

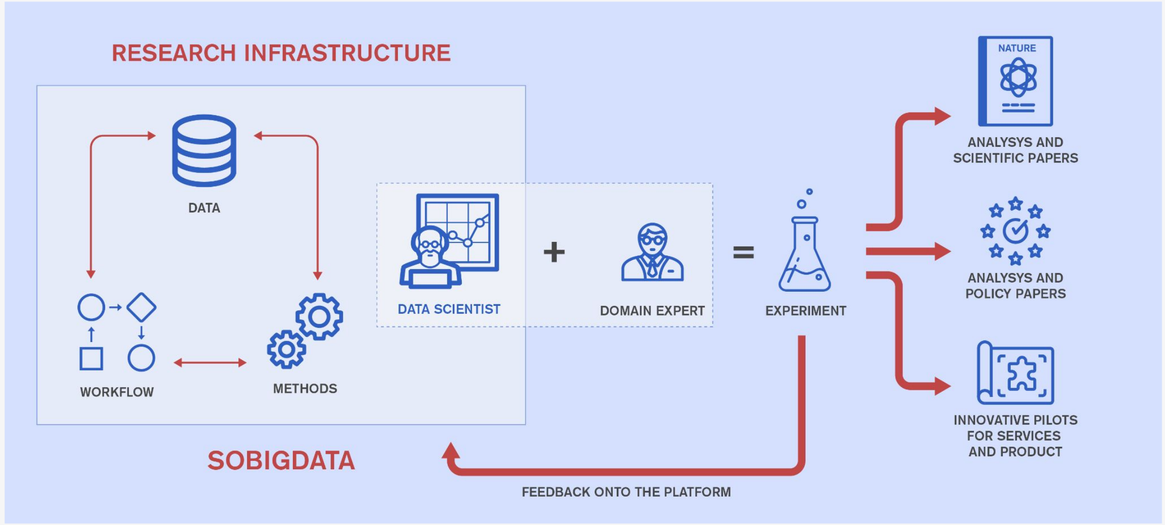
Multi-disciplinary panorama





Responsible Data Science principles

- to act as a Wind Tunnel for innovative and responsible data science science: a place to experiment, to train, to share ideas and to learn.
- to operationalize the ethical values within Big Data Analytics.
- **Responsible open Data Science is FAIR + FACT (ethics by design)**
- to transfer this view to industry and PA which are not always aware of the responsible data science pipeline and how to exploit its full potential in a sustainable way.



An “operational” Ethical and Legal framework

designed to function as a factory for sensing, understanding ethico-legal issues and data literacy in digital society:
guidelines and white papers related to Big Data and AI issues and **ethics based service** .

Operational ethical and legal board performs first-aid clearance of the experiments.

Services (Open Science tools)

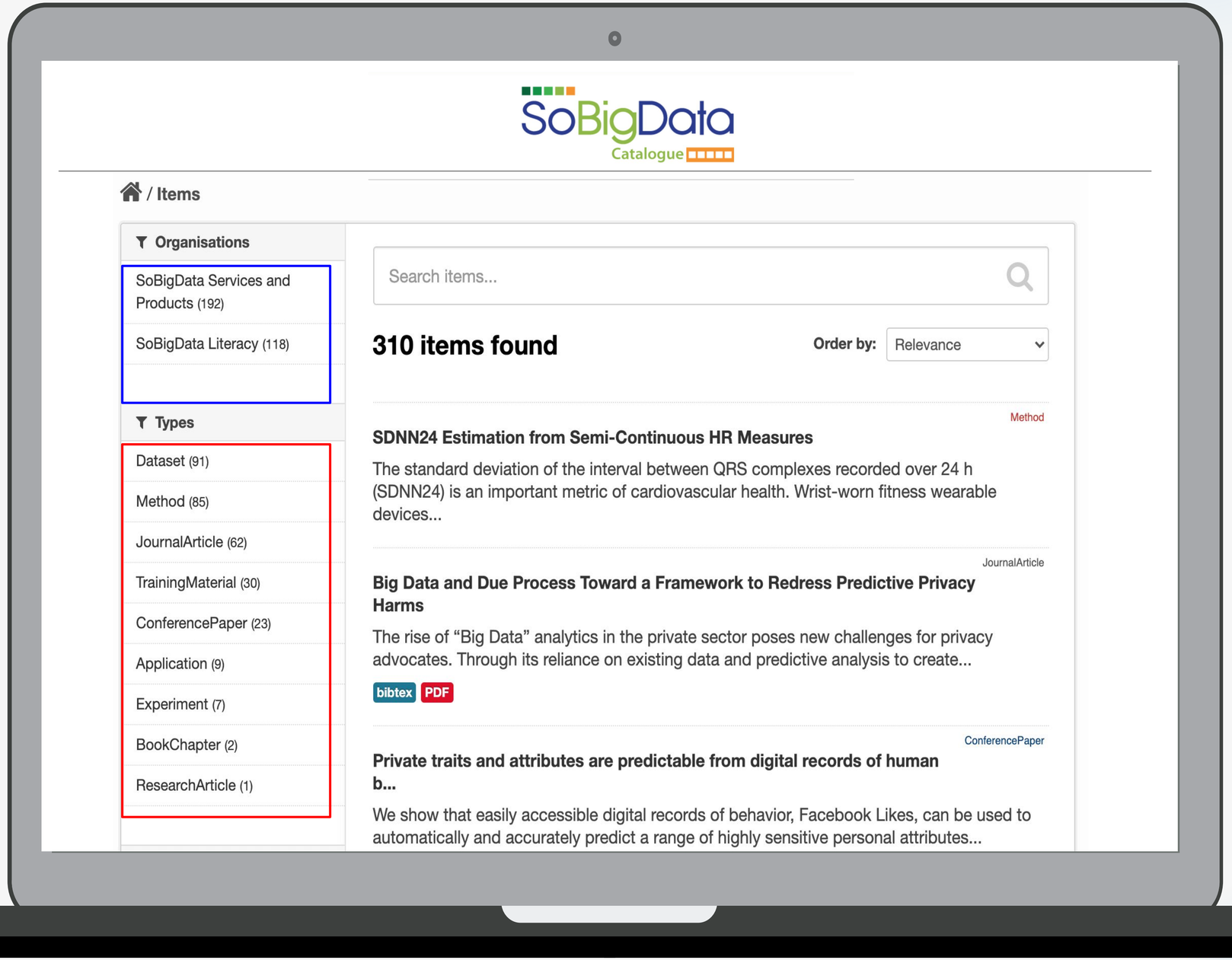
- **Virtual Research Environments**: Dedicated areas where users may share information and experiences focused on a specific topic. It has a dedicated shared workspace and may be equipped with dedicated computational resources
- **Workspace:** A cloud storage services which may be shared among users
- **Catalogue**: The Catalogue is a tool for finding and exploring Datasets, Methods, Applications, Experiments, and publications through different navigable views.
- **SoBigData Interactive Programming environment**: the users develop their methods on a Jupyter Notebook using cutting edge libraries developed by experts.
- **Methods Engine**: a cloud service to execute methods integrated in the RI exploiting the interconnection of servers (completely transparent to the final users).
- **Training Area**: A set of online modules for the responsible data scientist (work in progress)

Services (People and Facilities)

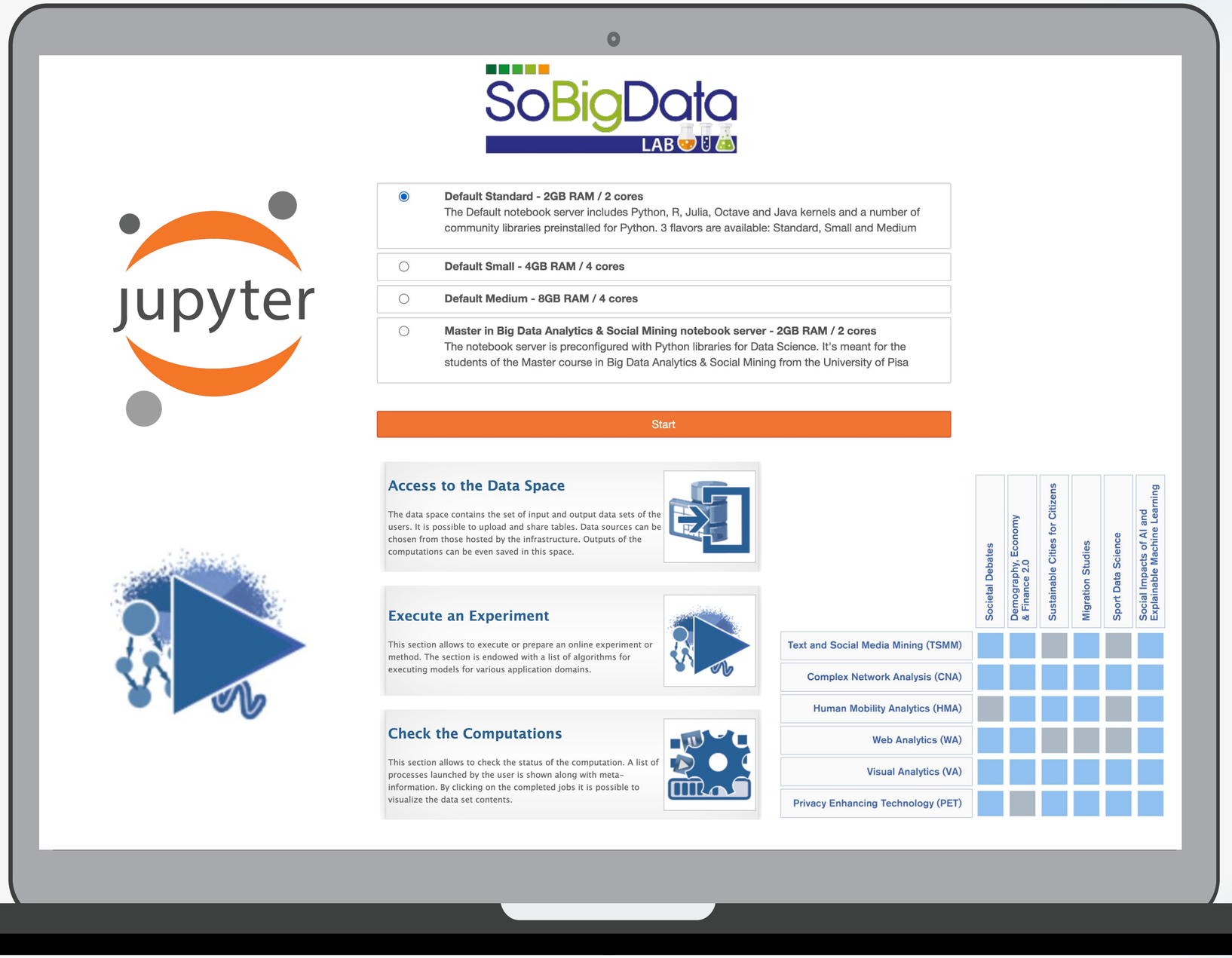
- **Transnational Access**: a mobility program to host researchers in our nodes

- **HPC Access**: access to high performance computing facilities owned or connected to one of our nodes

- **High level expertise**: Time and effort of the multi-disciplinary researchers distributed in our nodes.
  - Researcher
  - Legal and Ethical evaluations
  - Technology transfer (Training)



- *The Catalogue is a tool for finding and exploring Datasets, Methods, Applications, Experiments, and publications through different navigable views.*
- *FAIR and FACT principles are implemented through the metadata, identity management and accountability*



- ***SoBigData Interactive Programming environment:*** *the users develop their methods using cutting edge libraries developed by experts.*

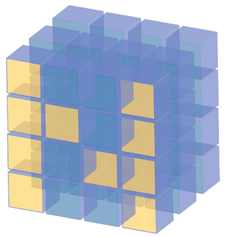
- ***SoBigData Method Engine*** *a cloud service to execute methods integrated in the RI exploiting the interconnection of servers (completely transparent to the final users).*


scikit
mobility

scikit mobility

pandas

$$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$$



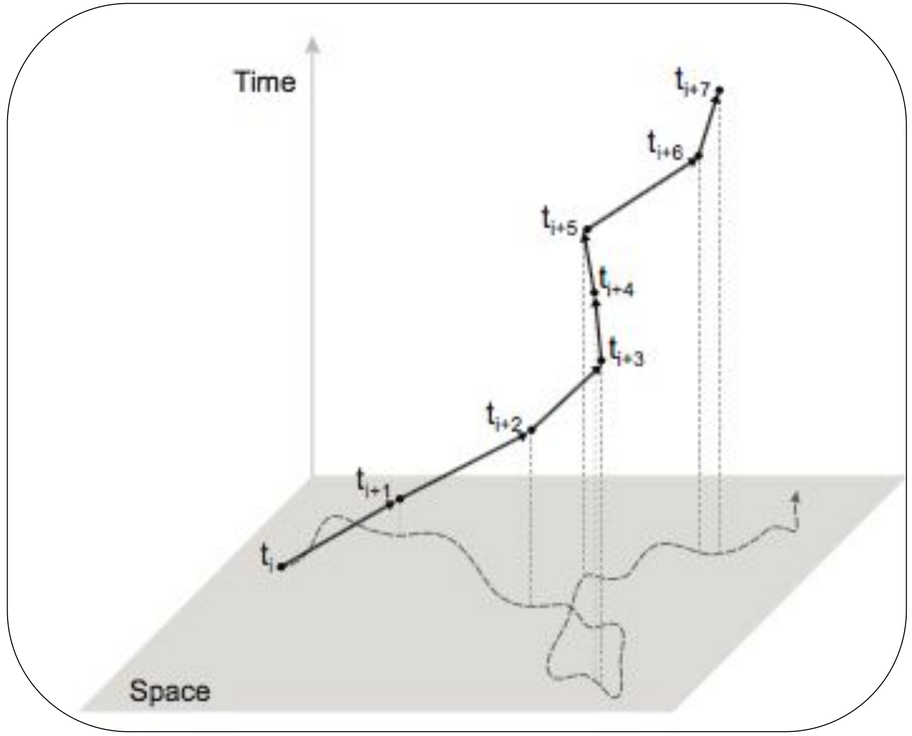
NumPy

SciPy

GeoPandas

folium

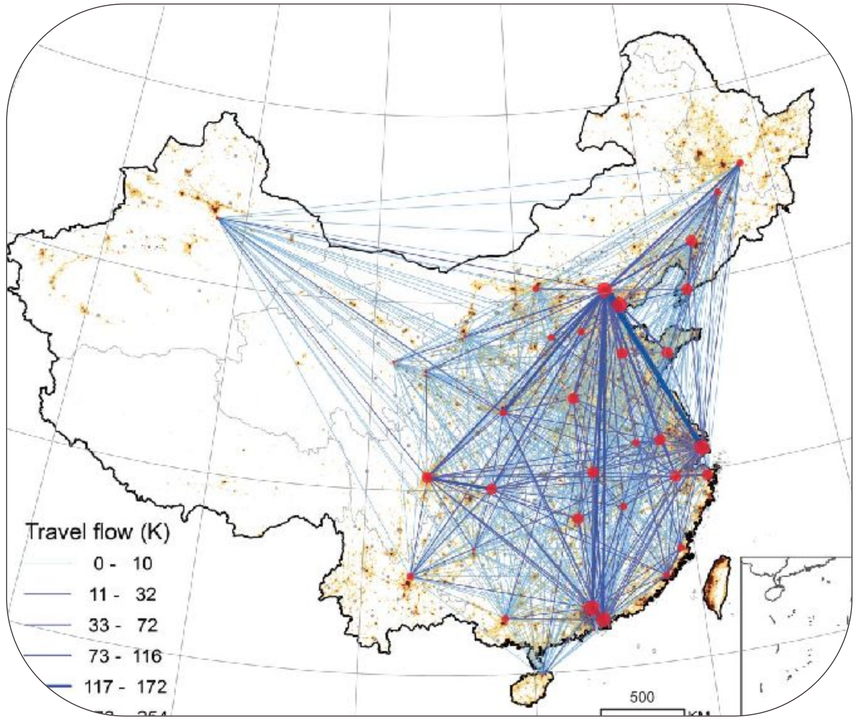
GeoPy



Trajectory

TrajDataFrame

	uid	datetime	lat	lng
0	1	2019-01-01 08:00:00.000000	46.397461	11.829286
1	1	2019-01-01 08:58:07.838255	46.479001	11.807456
2	1	2019-01-01 10:23:02.268305	46.479001	11.807456
3	1	2019-01-01 17:21:08.304837	46.506604	11.782809
4	1	2019-01-01 19:34:35.687601	46.515593	11.783268



Flows

Tessellation

	tile_id	population	geometry
51	36001	304564	POLYGON ((-73.933672 42.76071, -73.809603 42.7...
23	36003	48787	POLYGON ((-78.308611 42.086675, -78.3088390000...
18	36005	1397366	POLYGON ((-73.783519 40.881033, -73.74806 40.8...
57	36007	199346	POLYGON ((-75.850388 42.327731, -75.8437919999...
20	36009	79819	POLYGON ((-79.06070800000001 42.347917, -79.06...

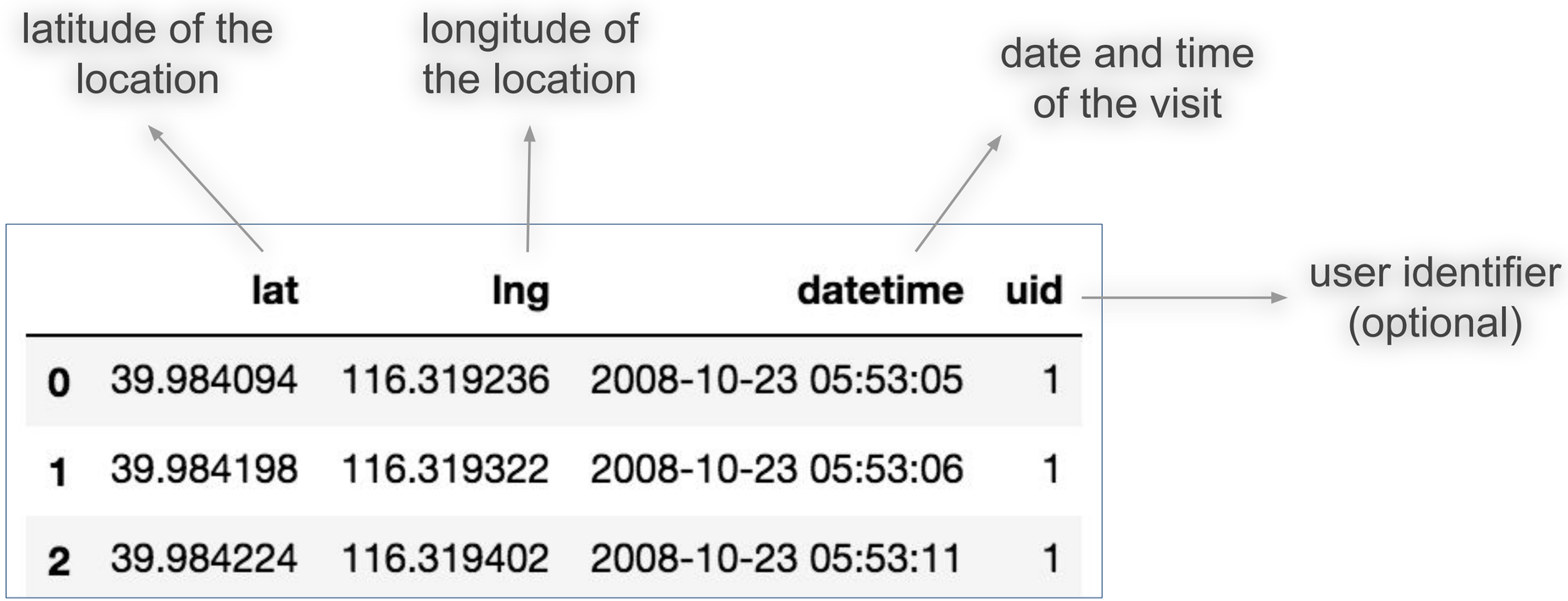
FlowDataFrame

	flow	origin	destination
0	121606	36001	36001
1	5	36001	36005
2	29	36001	36007
3	11	36001	36017
4	30	36001	36019

```
from skmob import TrajDataFrame

filename = 'data/geolife.gz'
tdf = TrajDataFrame.from_file(filename)      # load data

tdf.head(3)
```



	lat	lng	datetime	uid
0	39.984094	116.319236	2008-10-23 05:53:05	1
1	39.984198	116.319322	2008-10-23 05:53:06	1
2	39.984224	116.319402	2008-10-23 05:53:11	1

```
from skmob.preprocessing import detection, clustering

# detect stops and clusters
stdf  = detection.stay_locations(tdf, spatial_r_km=0.2)
cstdf = clustering.cluster(stdf, cluster_radius_km=0.1)

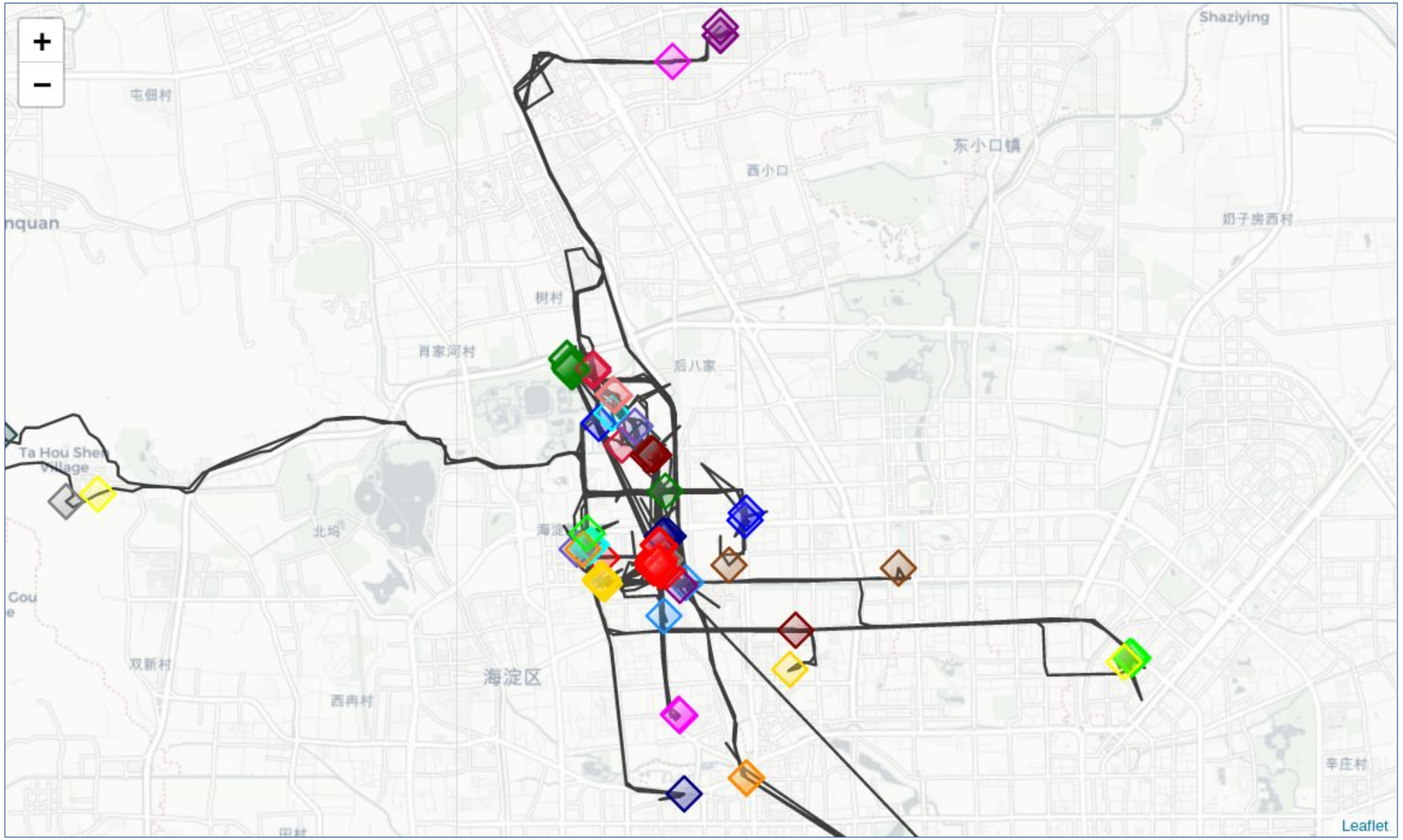

cstdf.head(3)
```

date of departure

identifier of cluster

	lat	lng	uid	datetime	leaving_datetime	cluster
0	39.978253	116.327275	1	2008-10-23 14:01:05	2008-10-23 18:32:53	0
1	40.013819	116.306532	1	2008-10-23 19:10:09	2008-10-24 07:46:02	1
2	39.978987	116.326686	1	2008-10-24 08:10:39	2008-10-24 09:48:57	0

```
map_f = tdf.plot_trajectory()    # plot trajectory
cstdf.plot_stops(map_f=map_f)    # plot clusters
```



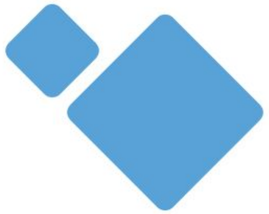
```python
from skmob.preprocessing import detection, clustering

# detect stops and clusters
stdf  = detection.stay_locations(tdf, spatial_r_km=0.2)
cstdf = clustering.cluster(stdf, cluster_radius_km=0.1)

cstdf.parameters
```

file path →

stop detection parameters →

cluster detection parameters →

```
{'from_file': 'data/geolife.gz',

'detect': {'function': 'stops',
  'spatial_radius_km': 0.2},

'cluster': {'function': 'cluster',
  'cluster_radius_km': 0.1,
  'min_samples': 1}}
```



skmob.**measures**

Statistics and mobility measures

statistics regarding
groups of individuals

Collective Measures

- `uncorrelated_location_entropy` (traj[, ...])
- `mean_square_displacement` (traj[, days, ...])
- `visits_per_location` (trajs)
- `homes_per_location` (traj[, start_night, ...])
- `visits_per_time_unit` (traj[, time_unit])
- `origin_destination_matrix` (traj[, ...])

statistics regarding
single individuals

Individual Measures

`radius_of_gyration` (traj[, show_progress])
`k_radius_of_gyration` (traj[, k, show_progress])
`random_entropy` (traj[, show_progress])
`uncorrelated_entropy` (traj[, normalize, ...])
`real_entropy` (traj[, show_progress])
`jump_lengths` (traj[, show_progress, merge])
`maximum_distance` (traj[, show_progress])
`distance_straight_line` (traj[, show_progress])
`waiting_times` (traj[, show_progress, merge])
`number_of_locations` (traj[, show_progress])
`home_location` (traj[, start_night, ...])
`max_distance_from_home` (traj[, start_night, ...])
`number_of_visits` (traj[, show_progress])
`location_frequency` (traj[, normalize, ...])
`individual_mobility_network` (traj[, ...])
`recency_rank` (traj[, show_progress])
`frequency_rank` (traj[, show_progress])

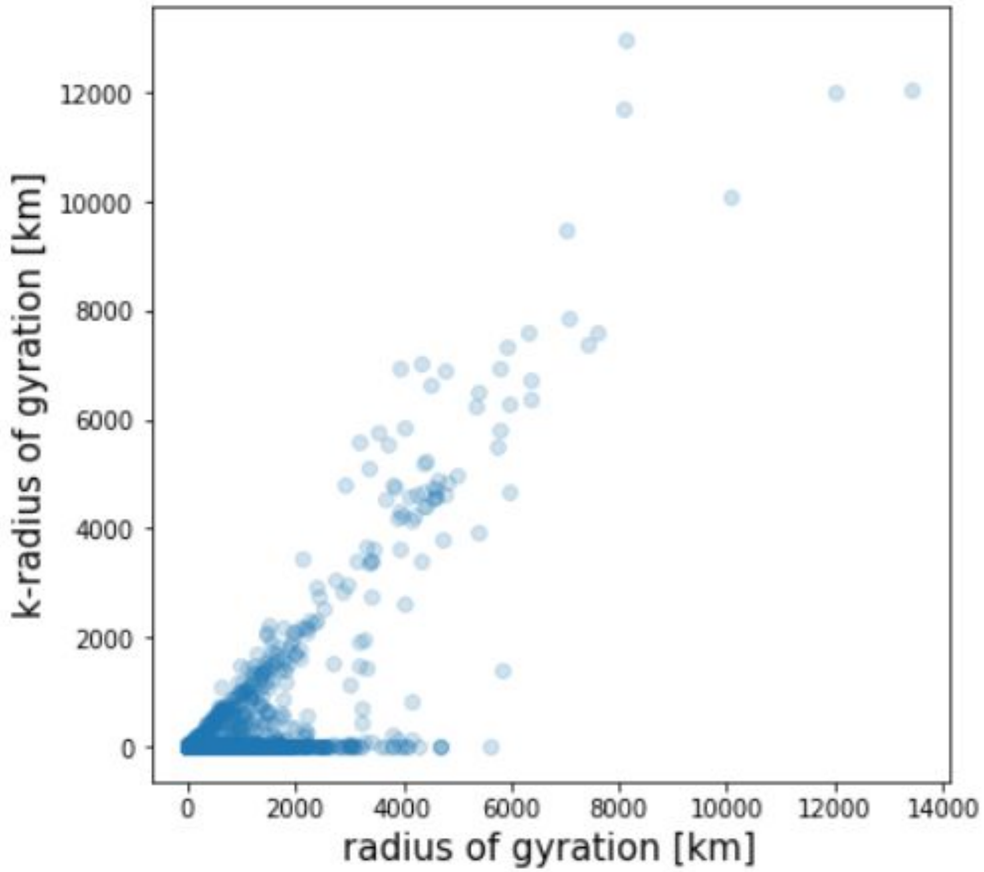
```
from skmob.measures.individual import radius_of_gyration,
k_radius_of_gyration

# compute radius and k-radius
rg_df = radius_of_gyration(tdf)
krg_df = k_radius_of_gyration(tdf, k=3)
```

	uid	radius_of_gyration
0	0	1564.436792
1	1	2467.773523
2	2	1439.649774
3	3	1752.604191
4	4	5380.503250

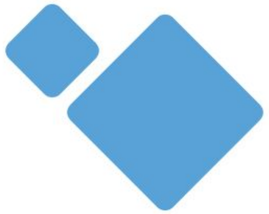
	uid	3k_radius_of_gyration
0	0	7.730516
1	1	3.620671
2	2	6.366549
3	3	10.543072
4	4	3910.808802

```
# merge the two dataframes
rg_krg_df = pd.merge(rg_df, krg_df, on='uid')
```

	uid	radius_of_gyration	3k_radius_of_gyration
0	0	1564.436792	7.730516
1	1	2467.773523	3.620671
2	2	1439.649774	6.366549
3	3	1752.604191	10.543072
4	4	5380.503250	3910.808802



Pappalardo, L., Simini, F., Rinzivillo, S. et al. Returners and explorers dichotomy in human mobility. Nat Commun 6, 8166 (2015). https://doi.org/10.1038/ncomms9166



skmob.**models**

Generative models

Collective models

Gravity, Radiation

Individual models

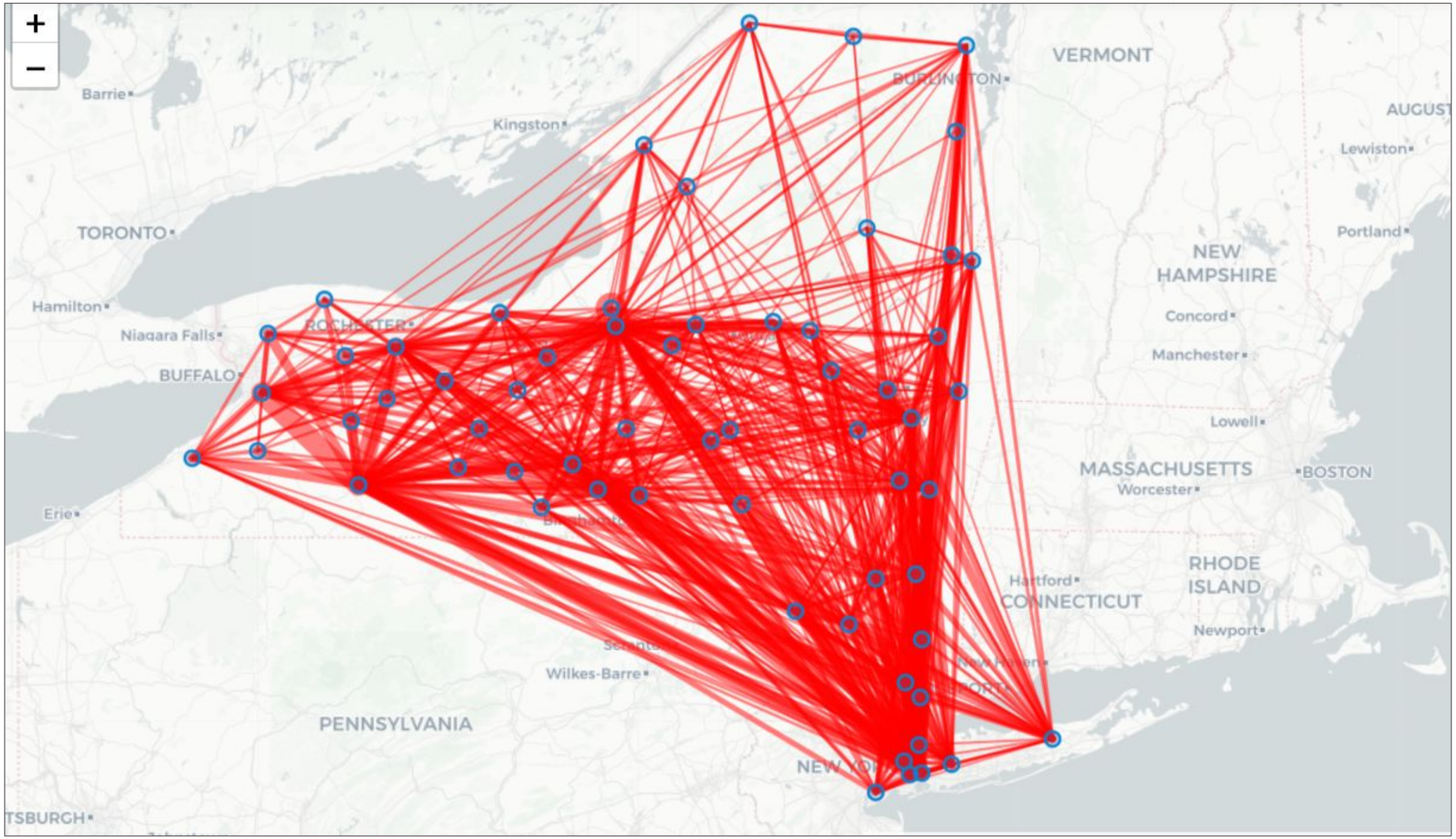
EPRs

```
.fit()      # fit model's parameters from data

.generate()  # generate synthetic trajs/fluxes
```

```
from skmob.models import Gravity

# load a spatial tessellation
tsl = GeoDataFrame.from_file("NY_counties.geojson")

# instantiate a singly-constrained gravity model
gravity = Gravity(gravity_type='singly constrained')

# load flow data and fit the model
fdf = FlowDataFrame.from_file("NY_flows.csv",
tessellation=tsl)

gravity.fit(fdf, relevance_column='population')
print(gravity)
```

```
Gravity(name="Gravity model", deterrence_func_type="power_law",
deterrence_func_args=[-1.763643891368663], origin_exp=1.0,
destination_exp=0.590625613013072, gravity_type="singly constrained")
```

```
g_fdf = gravity.generate(tsl)
g_fdf.plot_flows(min_flow=300) # plot the generated flows
```

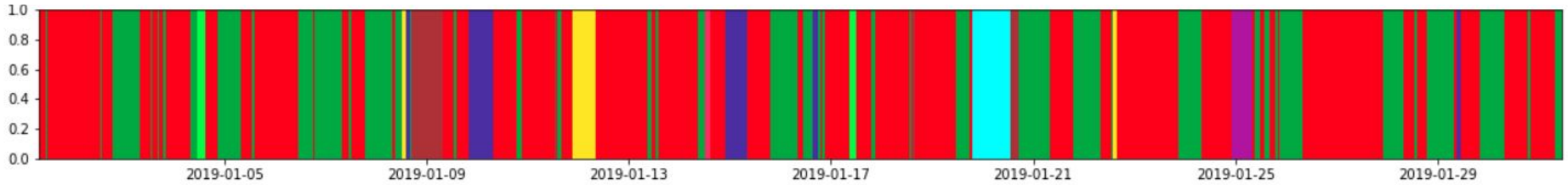


```python
from skmob.models.epr import Ditras
from skmob.models.markov_diary_generator import MarkovDiaryGenerator

# instantiate model
...
ditras = Ditras(...)

tessellation = gpd.GeoDataFrame.from_file("data/NY_counties_2011.geojson")
start_time = pd.to_datetime('2019/01/01 08:00:00')
end_time = pd.to_datetime('2019/02/01 08:00:00')

# generate the trajectory of one agent
tdf = ditras.generate(start_time, end_time, tessellation, n_agents=1)

tdf.head(3)
```

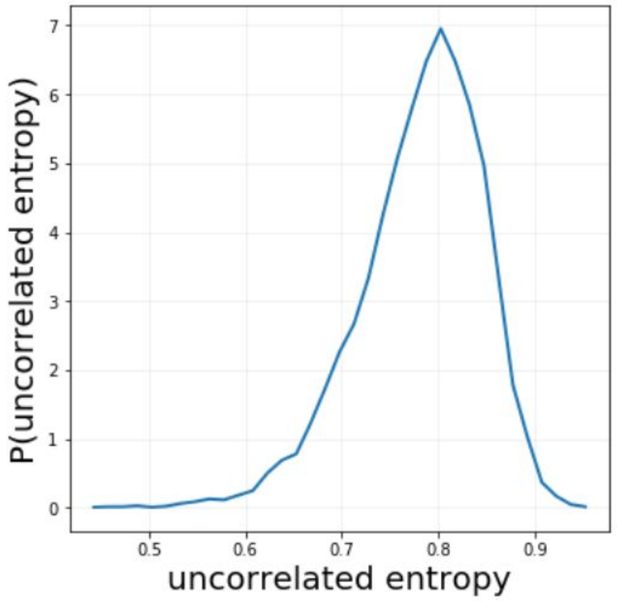
	uid	datetime	lat	lng
0	1	2019-01-01 08:00:00.000000	42.587412	-74.314766
1	1	2019-01-01 08:43:10.663092	42.587412	-74.314766
2	1	2019-01-01 09:05:19.433161	42.228184	-75.924827

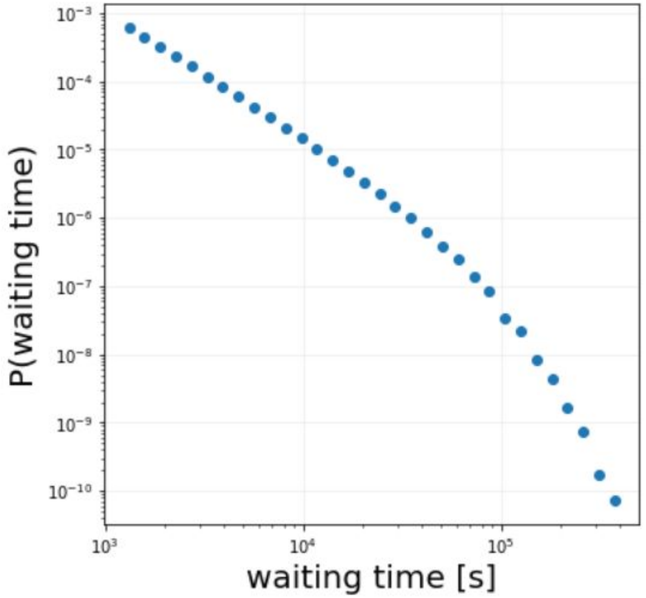
TrajDataFrame

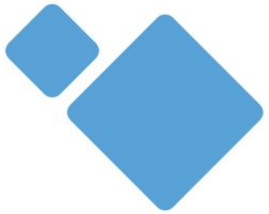
```
# plot diary
clustering.cluster(detection.stops(tdf)).plot_diary(user=1)
```




```
ue_df = uncorrelated_entropy(tdf, normalize=True)    # compute unc entropy
wts = waiting_times(tdf, merge=True)   # compute waiting times
```







skmob.**privacy**

Privacy risk assessment

A Privacy Perspective

Mobility info is sensitive

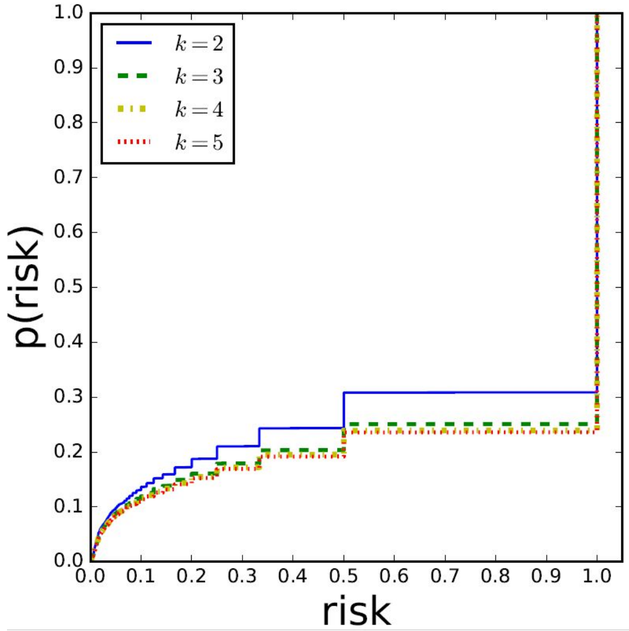
locations visited can be used to infer religion, health issues, habits, preferences

```python
from skmob.privacy import attacks

filename = 'data/privacy_toy.csv'
tdf = TrajDataFrame.from_file(filename)

loc_att = attacks.LocationAttack() # instantiate attack
risk_df = loc_att.assess_risk(tdf) # assess privacy risk
risk_df.head(3)
```

user identifier

re-identification risk

	uid	risk
0	1	0.333333
1	2	0.500000
2	3	0.333333

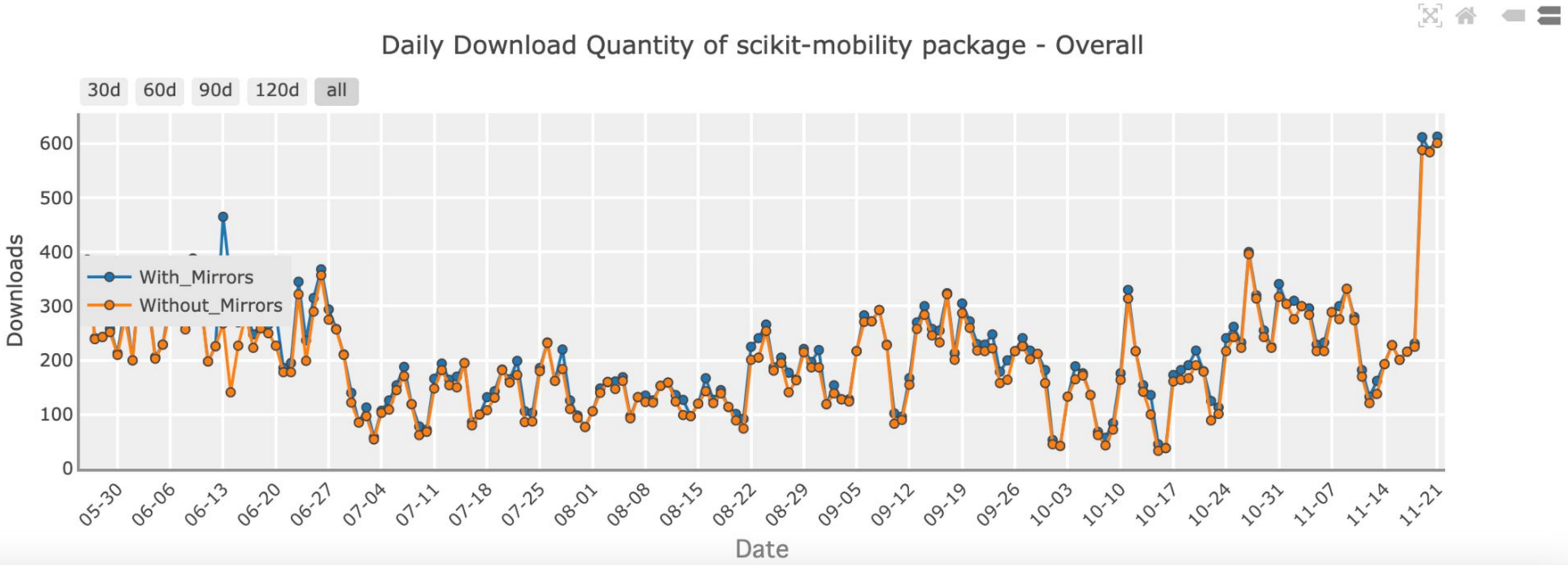


New features

- More (and more efficient) preprocessing algorithms (e.g., home location detection, trajectory splitting, compression)
- New spatial tessellation functions
- More collective and individual models
- Segregation models and routing algorithms

PyPI page
Home page
Author: skmob Developers
License: new BSD
Summary: A toolbox for analyzing and processing mobility data.
Latest version: 1.3.1
Required dependencies: folium | geojson | geopandas | h3 | pandas | pooch | powerlaw | python-igraph | requests | scikit-learn | statsmodels | tqdm

Downloads last day: 601
Downloads last week: 2,643
Downloads last month: 8,311



Thanks - and stay tuned!

Impact on scientific communication	
97+	Journal papers
155+	Conference papers
2	Book chapters
1	Monograph
120	Pilot projects developed with companies

Users community	
10,500+	VA users
94+	TA users
900+	Trainees
5500+	Audience

Project community	
135+	Researchers including PHDs
Available resources	
101	Unique big datasets
123	Social mining methods and apps
1mln	Peak access to applications

www.sobigdata.eu

info@sobigdata.eu

Photos: Unsplash | Ryan Parker, Mario Calvo, Paul Fiedler

The RECIPROCITY project

Accelerating replication for smarter and cleaner mobility

Marcell Romsics

Our mission

RECIPROCITY aims at transforming European cities into climate-resilient and connected, multimodal nodes for smart and clean mobility through an innovative four-stage replication approach

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°101006576

Why? Responding to European mobility challenges

CHALLENGES

Urbanization, climate change, digitalisation, etc.

Complexity of replication

Support **Europe's efforts** to transform cities into climate-resilient, connected multimodal nodes for **smart and clean mobility** through **replication**.

KEY QUESTION

How can the results of mobility pilot projects be used to implement smart city strategies and community initiatives more efficiently, faster and on a larger geographic scale?

SOLUTION

Equip a **wide range** of different **cities** and **municipalities** with the necessary **tools, knowledge** and **contacts** to **accelerate** the process of **replicating existing innovative mobility solutions**.

RECIPROCITY

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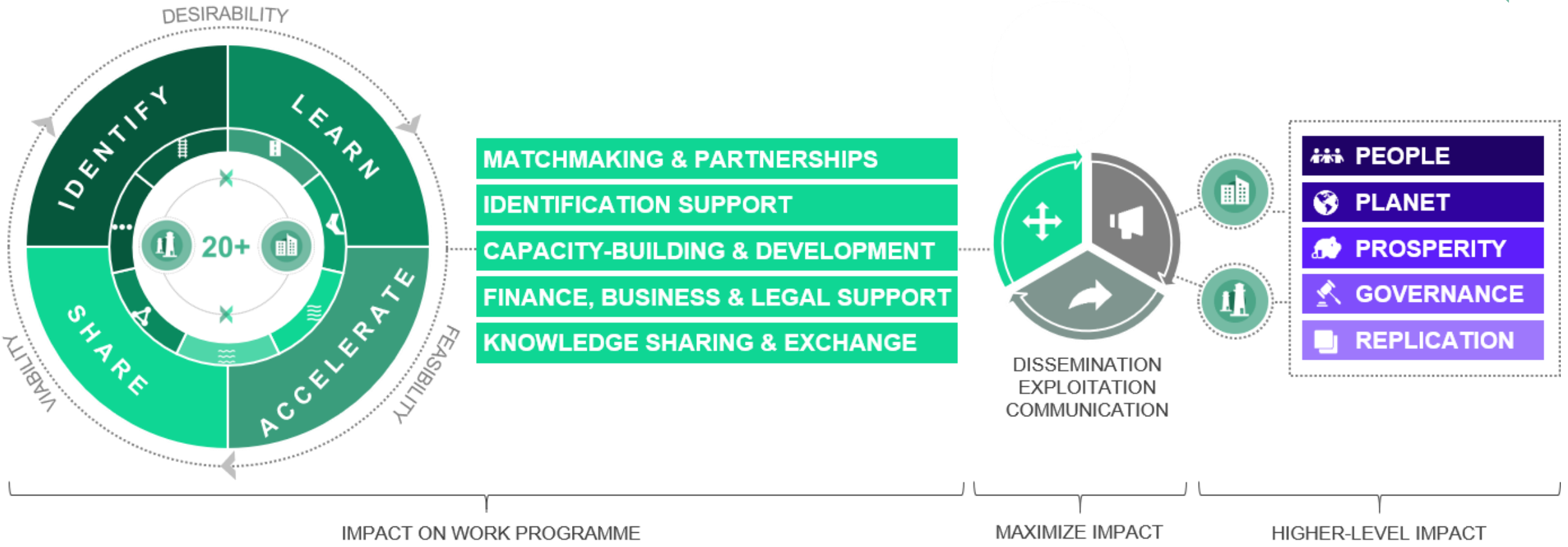
How? The RECIPROCITY concept



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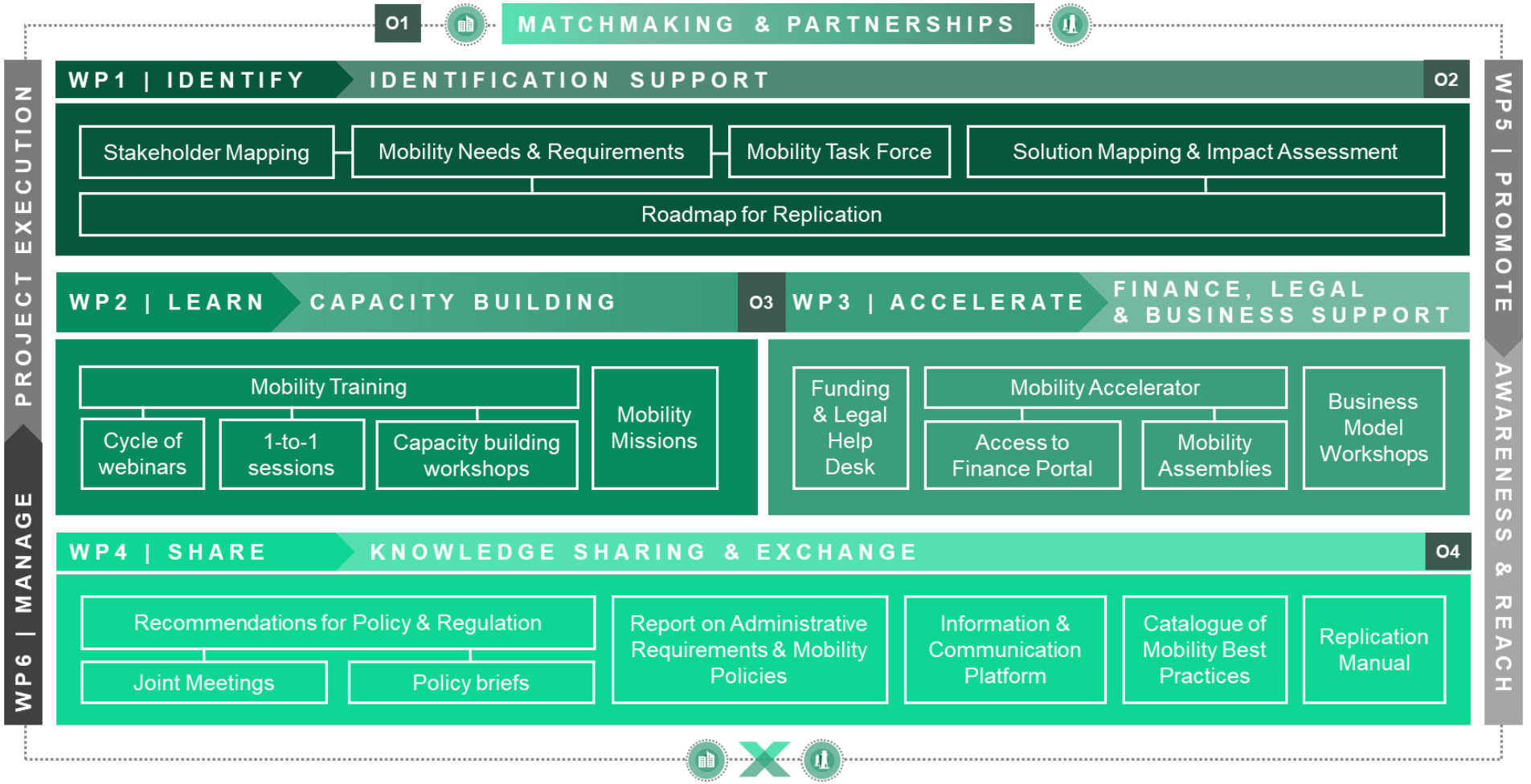
How? Innovative four-stage replication framework



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°101006576

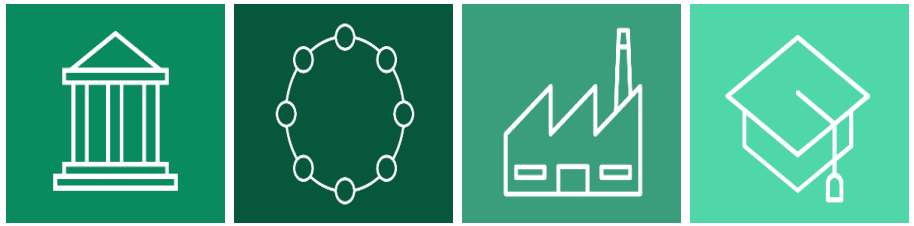
Who? Targeting stakeholders from the quadruple helix

ECOSYSTEM

30+ cities & **municipalities** from **Europe & H2020 countries**:

- More than 25 Mio. people
- 16 European countries
- Coverage of 72.5 km²
- 10+ cities going though rapid social & economic change
- Rural, peri-urban & urban cities and areas
- Lighthouse & follower cities

STAKEHOLDERS



Policy Civil society Industry Academia

1000+ quadruple helix stakeholders

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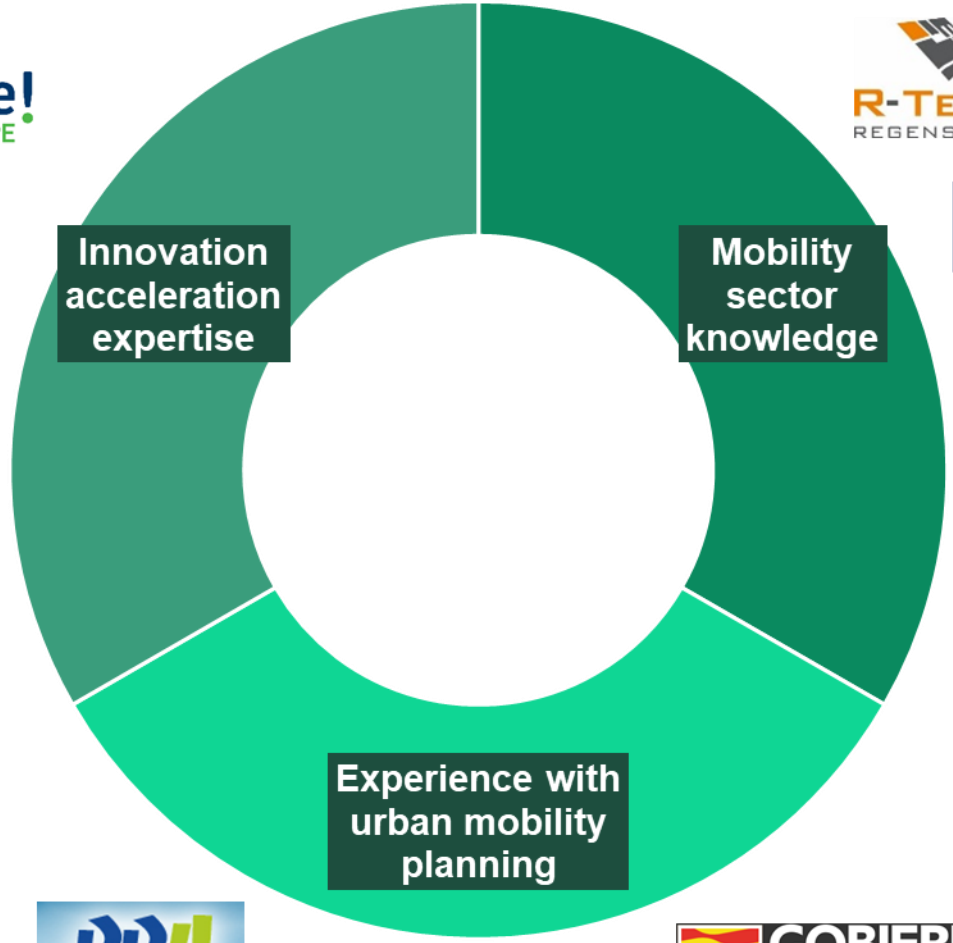
Project partners and overview

10 Partners

9 Countries

32 Months

1.5M€



Greenovate! EUROPE

R-TECH REGENSBURG

next move
collaboration is the driver

ERRIN European Regions Research and Innovation Network

ZONE CLUSTER

İSTANBUL OKAN ÜNİVERSİTESİ

business upper austria

RRA PLZEŇSKÉHO KRAJE

GOBIERNO DE ARAGON

Helsinki-Uusimaa Regional Council

RECIPROCITY

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RECIPROCITY benefits

Better, smarter and cleaner mobility for all

Reduced greenhouse gas emissions and better air quality

Prosperity for all regions

Improved local governance and transnational collaboration

Wide-scale replication despite different backgrounds

RECIPROCITY

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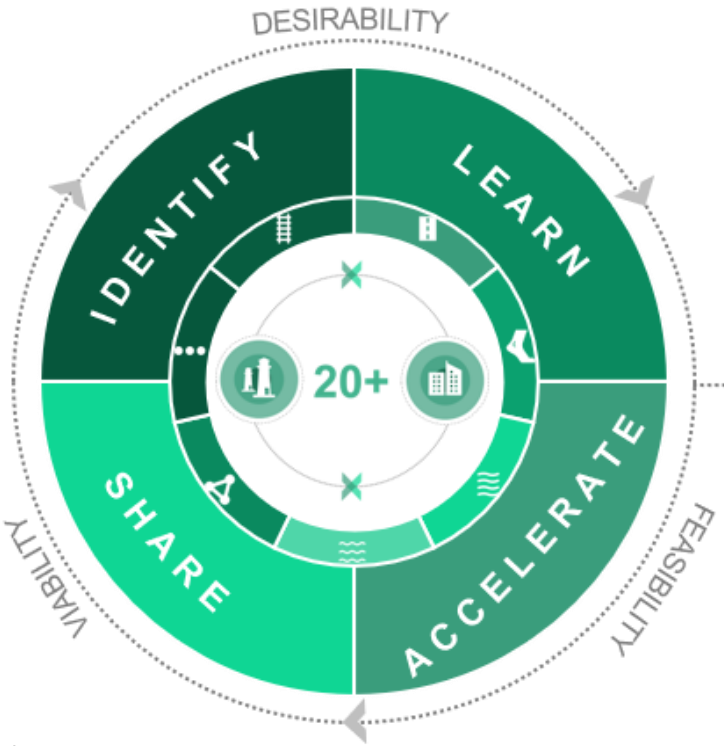
The RECIPROCITY concept



Mobility needs?
Challenges?
Drivers?
Requirements?
Current projects?

IDENTIFY

- 260 stakeholders identified
- 65 interviews conducted
- 10 mobility workshops organized with a total of 420 participants
- 47 use-cases for smart mobility solutions identified
- 3 supra-regional Mobility Roadmap Workshops organized

IMPACT ON WORK PROGRAMME

MAXIMIZE IMPACT

HIGHER-LEVEL IMPACT

RECIPROCITY

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Single Trafic Model

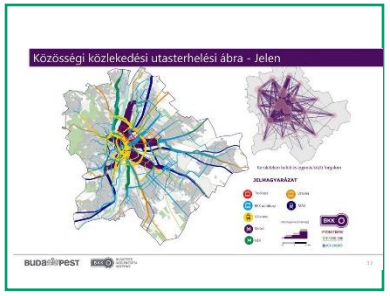
(Use Case #43)

Description / usage numbers

This is a model that includes public and continuously maintained data on total transport in the capital. These up-to-date traffic count information and statistics help the transport development projects taking place in Budapest and provide uniform, representative data for them. This Single Traffic Model is now a great help in preparing investments, during preliminary feasibility studies.

The Single Trafic Model is based on the all-transport model concept and provides a unified modeling basis for transport development planning: thanks to the software-independent design of the model, it can be accessed and used by any design company, continuously developed and improved through new developments related to various design tasks.

Pictures, diagrams etc. *(if available and useful)*



Source (picture): bkk.hu

Responsible RECIPROCITY project partner: ZONE Cluster

External partners involved: Centre for Budapest Transport

City/village/region & country:

X	urban	X	peri-urban	X	rural
	tourism	X	everyday		commuter

technological readiness (TRL) [1-9]	9
simplicity to replicate [1=hard,... 5=easy]	3

Facts & figures *(if available and not confidential; add more if useful), e.g.*

- Costs for implementation & for operation (yearly):
- External expertise needed:
- Duration of implementation (from concept to finished project): 18 Months
- Website (only in hungarian): https://bkk.hu/downloads/747/9PA0CvHFqmgjdE8NJDAPVQ==

RECIPROCITY

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°101006576

document not confidential

BKK FUTÁR

(Use Case #42)

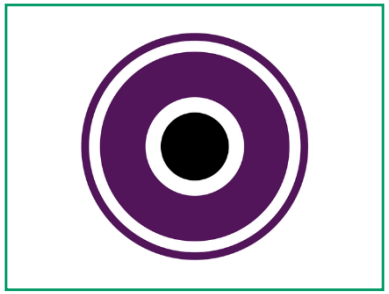
Description / usage numbers

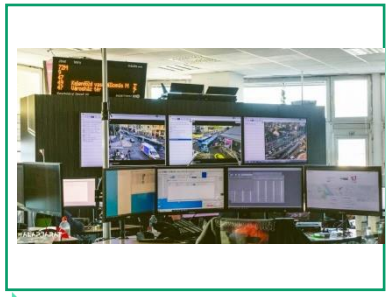
The BKK FUTÁR system has two user groups: users of public transport and those who maintain it.

An interface available to users on the Internet, with virtually any online connection, consisting of a map and a trip planner. This allows public transit users to get up-to-date travel information.

In addition, the Centre for Budapest Transport, which maintains the public transport of Budapest, can monitor various vehicles and intervene in the operation of the system and network when necessary.

Pictures, diagrams etc. *(if available and useful)*





Source (picture): bkk.hu

Responsible RECIPROCITY project partner: ZONE Cluster

External partners involved: Centre for Budapest Transport

City/village/region & country:

X	urban	X	peri-urban		rural
X	tourism	X	everyday	X	commuter
technological readiness (TRL) [1-9]					9
simplicity to replicate [1=hard,... 5=easy]					3

Facts & figures *(if available and not confidential; add more if useful), e.g.*

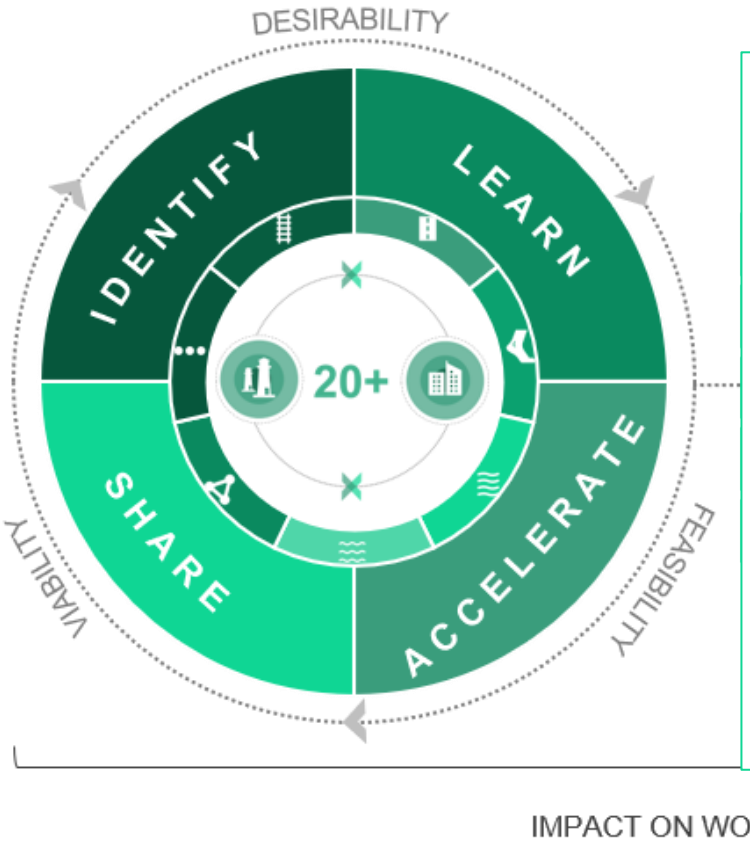
- Costs for implementation & for operation (yearly):
- External expertise needed:
- Duration of implementation
  (from concept to finished project): 12 Months
- Website: https://futar.bkk.hu/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°101006576

What comes next?

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°101006576

The RECIPROCITY concept



LEARN

Two Mobility Missions - Travel Vouchers can be applied for

- Linz, 28.-31.03.2023 (co-located with Assembly)
- 24.-26.05.2023, Istanbul

Mobility Training Programm

- Webinars
- Capacity Building Workshops
- 1:1-Sessions – next matchmaking event on Horizon Europe Calls : 23/11, 28/11, 02/12 2022

IMPACT ON WORK PROGRAMME

MAXIMIZE IMPACT

HIGHER-LEVEL IMPACT

RECIPROCITY

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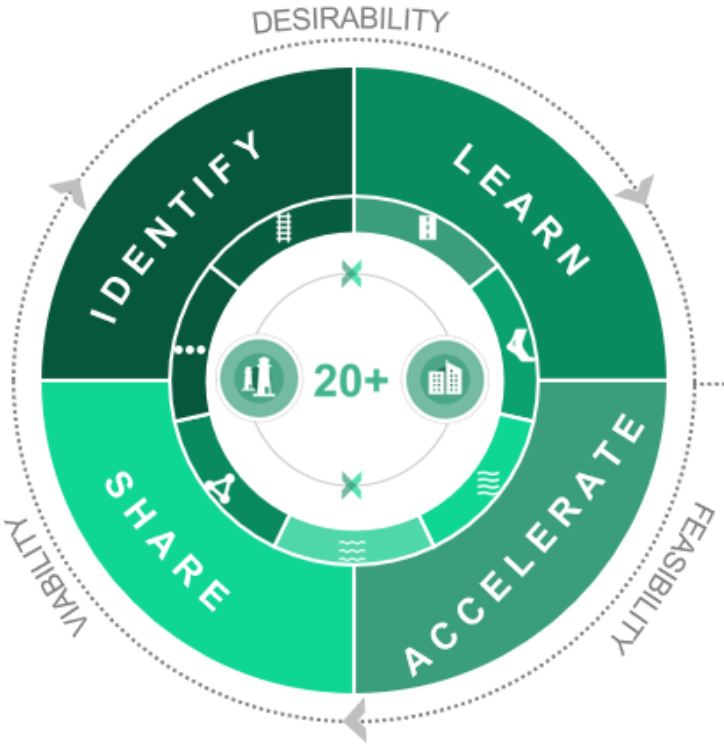
The RECIPROCITY concept



ACCELERATE

Three Mobility Assemblies

- 30.11.-01.12.2022 Annual POLIS Conference, Brussels
- 28.-31.03.2023, Futureforum Linz, March 2023 (co-located with Mission)

Funding & Legal Helpdesk

- One-stop shop for financial and legal questions – send us enquires

IMPACT ON WORK PROGRAMME | MAXIMIZE IMPACT | HIGHER-LEVEL IMPACT

RECIPROCITY

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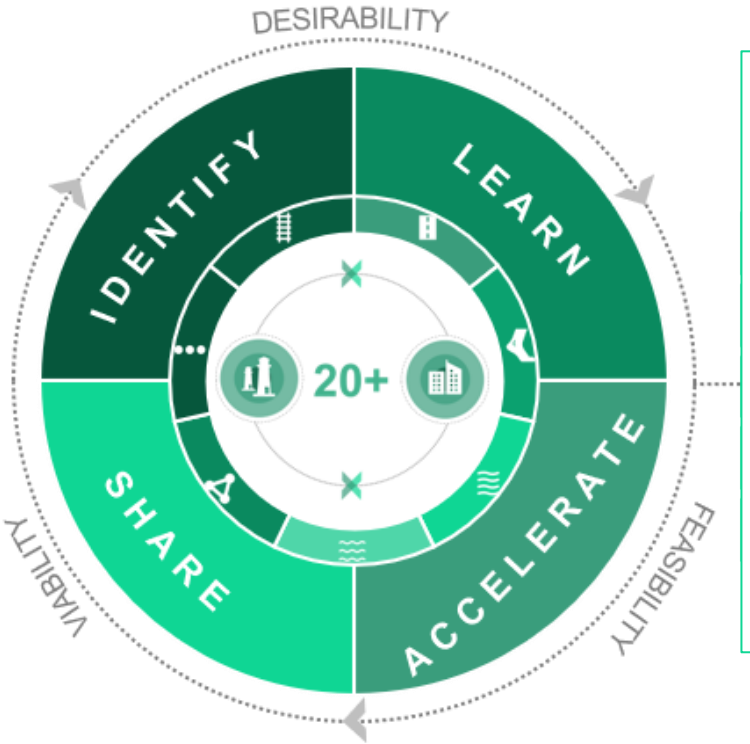
The RECIPROCITY concept



SHARE

Online Information & Communication Platform

- Knowledge Center:
  - repository for all the recommendations, reports and outputs of the project (eg. Replication manual, generated business model patterns);
  - access to financial and legal expertise;
- Matchmaking tool.

IMPACT ON WORK PROGRAMME

MAXIMIZE IMPACT

HIGHER-LEVEL IMPACT

RECIPROCITY

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Thanks for your attention. Any questions?

Marcell Romsics

ZONE Cluster

marcell.romsics@zonecluster.eu

Connect with RECIPROCITY!

RECIPROCITY_EU

RECIPROCITY project

www.reciprocity-project.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°101006576

Q&A

Methodologies and Data-based Technology Solutions for Improved European Mobility

These projects have received funding from the European Union's Horizon 2020 research and innovation programme

organised by MOBIDATALAB
Labs for prototyping future mobility data sharing solutions in the cloud

supported by synair. SoBigData++ RECIPROCITY

Interested? Connect!

Methodologies and Data-based Technology Solutions for Improved European Mobility

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Methodologies and Data-based Technology Solutions for Improved European Mobility

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MOBIDATALAB

Labs for prototyping future mobility data sharing solutions in the cloud

synair.

SoBigData++

RECIPROCITY

THANK YOU FOR JOINING!

mobidatalab.eu

MobiDataLab is funded by the EU under the H2020 Research and Innovation Programme (grant agreement No 101006879)