Airport as a node in multimodal transport systems

Rubén Alcolea

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IMHOTEP

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Airport as a node in multimodal transport systems

We are leading two SESAR ER4 projects looking at how new big data sources (e.g., data from personal mobile devices) can be leveraged to describe, model and forecast passenger behaviour and assess intermodal solutions

TRANSIT

Travel Information Management for Seamless Intermodal Transport

Strategic agent-based travel demand models

NOMMON, aena, EUROCONTROL, ENAC, ETH zürich

IMHOTEP

Integrated Multimodal Airport Operations for Efficient Passenger Flow Management

Short-term prediction of passenger flows for RT decision-making

NOMMON, Cranfield University, Isdefe, Technische Universität Dresden, aena, aimsun, Amsterdam University of Applied Sciences, EMT, Lyon City Airport

TRANSIT vs IMHOTEP

	TRANSIT	IMHOTEP
Project focus	Strategic planning focus Door-to-door journeys	Operational focus Airport terminal processes & access/egress
Modelling approach	Large-scale agent-based models of long-distance travel behaviour Modelling horizon: 1 year Impact assessment at national level	Detailed modelling of every airport subprocess Modelling horizon: 1 day Impact assessment at airport level
Decision support tools	Tool to analyse new intermodal concepts: infrastructure, services, etc.	Tool for RT decision making (incl. coordination with other modes)

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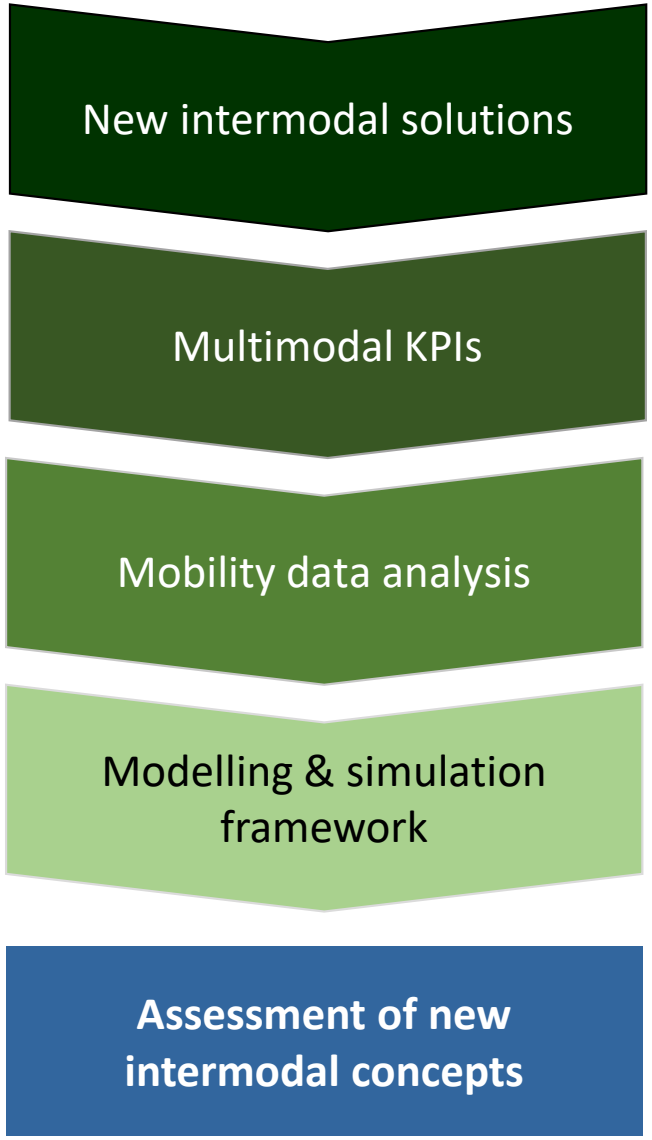
Motivation

Policy context	Increased emphasis on facilitating information sharing across all stakeholders along the transport chain
	The EC is developing a set of Intelligence Transport Systems (ITS) specifications, many of them containing data sharing obligations
	Opportunities to leverage the value of ATM data to improve coordination with other modes have received relatively little attention
New opportunities to analyse intermodal concepts	New data sources (e.g., mobile phone records)
	New transport modelling approaches

It is the right moment to investigate

How **intermodal solutions** and **passenger information services** enabled by the sharing of information between **ATM and other transport modes** can improve the quality, efficiency and resilience of the door-to-door passenger journey

Objectives



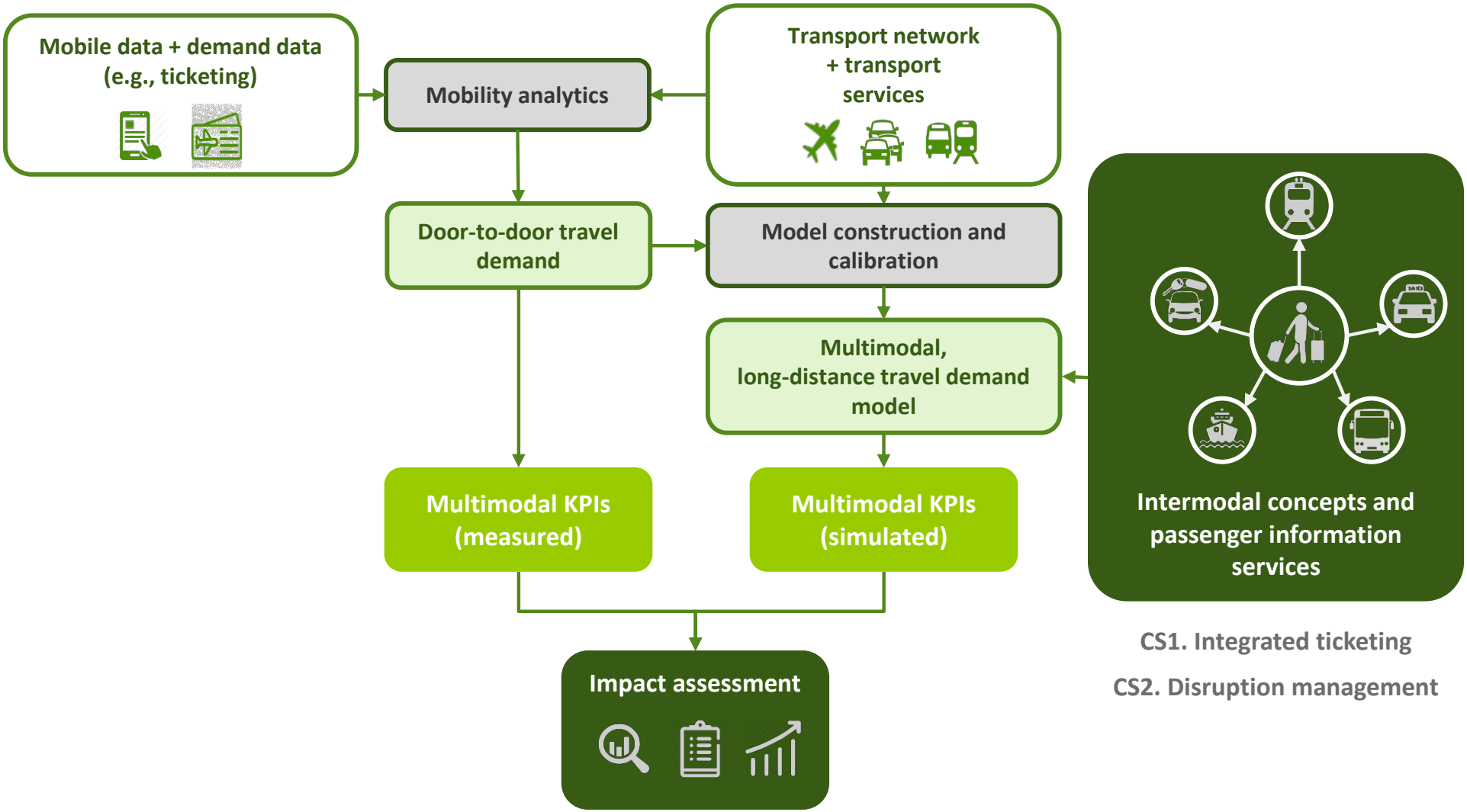
Solutions based on information sharing and coordinated decision making between air transport and other transport modes

Performance framework to evaluate the door-to-door passenger journey

New methods to reconstruct different stages of long-distance multimodal trips

Framework for the analysis of long-distance travel behaviour

Project concept



CS1. Integrated ticketing

CS2. Disruption management

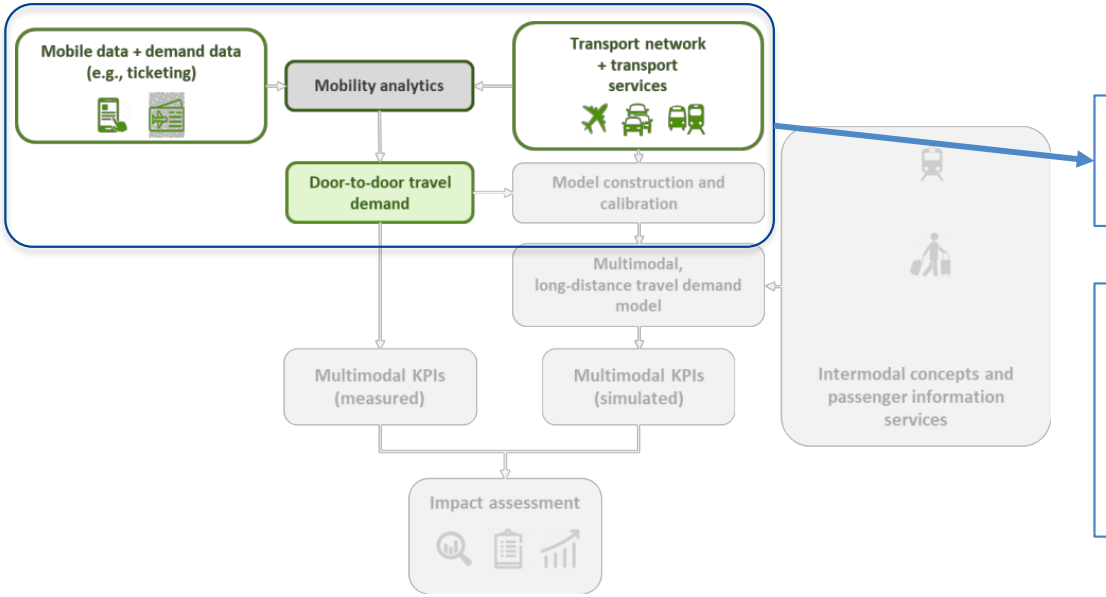
Multimodal performance framework

- **Ground Transport - No common framework** has been found
- **ATM - Very clear, widespread structure** based on ICAO framework (SESAR, SES…)
  - This framework has been adapted and extended to account for **passenger door-to-door trip**

Adaptations	Definition
Additive	Multimodal KPI derived by **adding** the value of a KPI in the different legs of the journey Example: Total Travel Time
Weakest Link	Multimodal KPI derived by **finding the minimum or maximum** KPI value in all the journey legs Example: Overall Capacity
Door-to-Door (D2D)	Multimodal KPI derived by considering the **whole trip chain** Example: Travel Time Variance

Deliverable D2.1 http://www.nommon-files.es/transit/TRANSIT-D3.1_Multimodal_Performance_Framework_01.01.00.pdf

Describing mobility: reconstructing multimodal trips



To obtain D2D travel demand, the reconstruction of long-distance trips is needed

In TRANSIT, this is done through the analysis of data from anonymised **mobile phone records** and their fusion with other data sources, building on results from previous SESAR projects such as BigData4ATM

Describing mobility: reconstructing multimodal trips

Describing mobility: filling the gaps

Advantages of mobile data

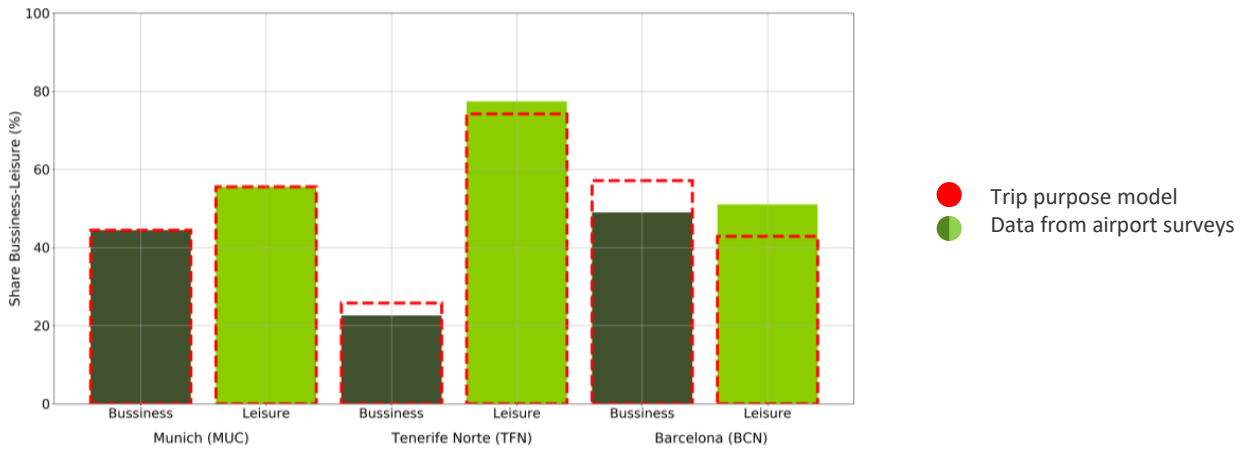
- Captures D2D trips
- Large sample of pax, compared to other methods (e.g., surveys)
- Allows for longitudinal analysis of individual travel behaviour

However, we lack

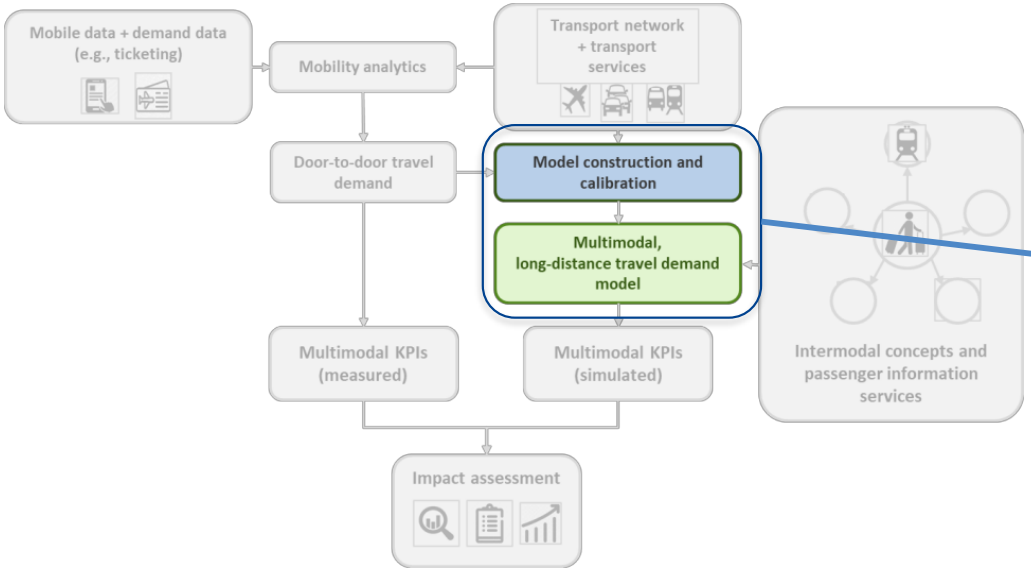
- Detailed Pax profile
- Trip purpose
- Modal choices

TRANSIT aims at improving this through a set of data fusion and machine learning methods

- Example of results of the machine learning trip purpose model developed in TRANSIT
- Trips from Madrid to 3 different destinations (Munich, Tenerife Norte and Barcelona)



Forecasting mobility: travel demand modelling



- Transport models have traditionally studied trip flows between transport zones
- In recent years, there has been an increasing interest on agent-based models, which recreate the behaviour of individual agents, providing a more **disaggregated and dynamic view**
- In TRANSIT, we are using a combination of **two agent-based models to recreate D2D trips**

Model of daily travel

Passenger decisions in 1 day

MATSim

Paris

Madrid

Long-distance travel model

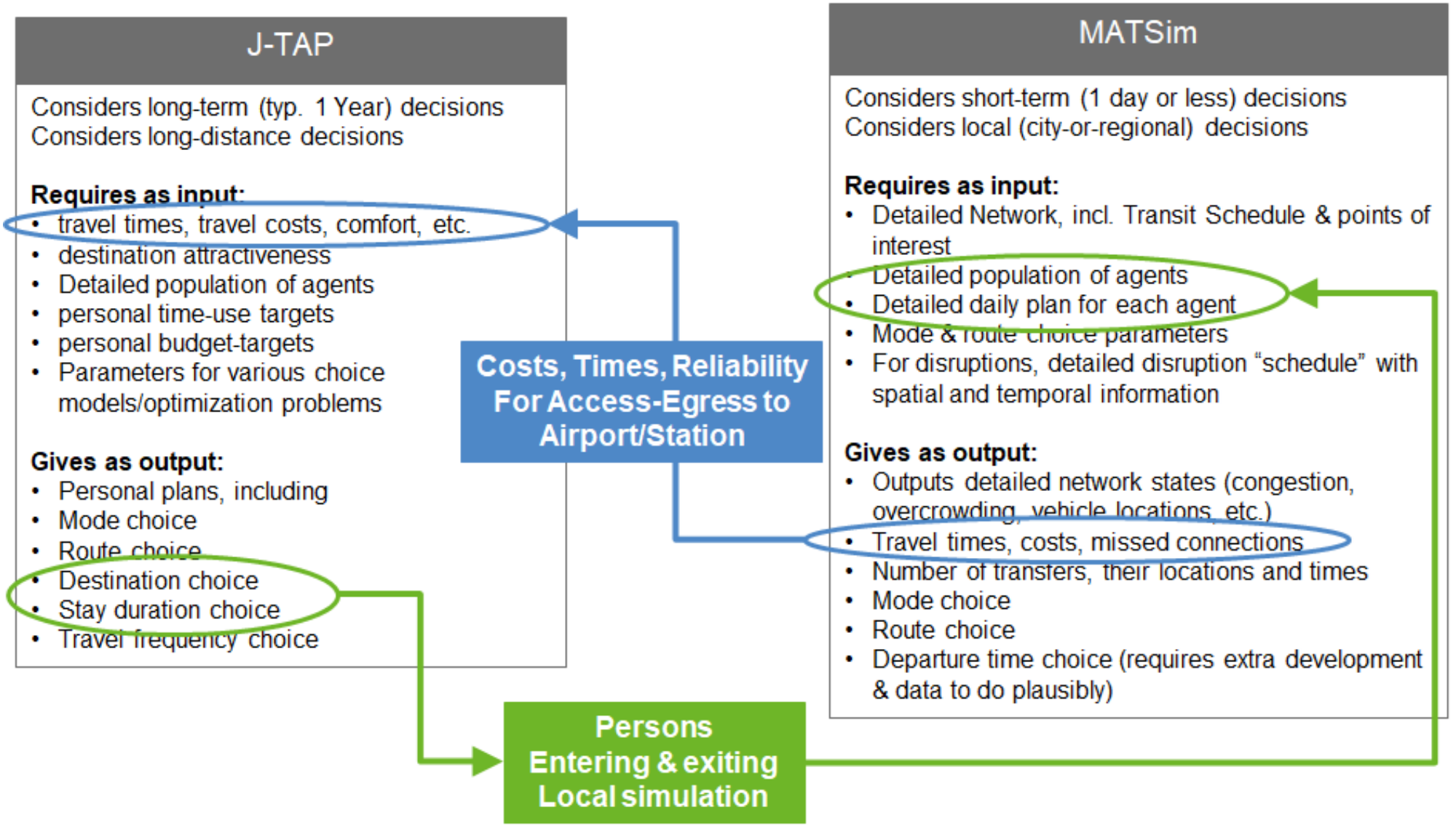
Passenger decisions in 1 year

J-TAP

France

Spain

TRANSIT models



Snapshot of results: impact of COVID-19 on airport access modes

Methodology

- Comparison of passenger behaviour for multimodal trips accessing Madrid-Barajas Airport during one week in June 2020 vs the same period in 2018
- Use of anonymised mobile phone data to reconstruct D2D multimodal chains

NUTS-3 unit	Modal share June 2018	Modal share July 2020	Change in train access legs
Toledo	16.3%	0.1%	-99.4%
Valladolid	21.9%	3.3%	-96.9%
Cádiz	35.8%	12.3%	-99.4%
Sevilla	**42.2%**	11.5%	-98.3%
Zaragoza	16.9%	5.7%	-89.9%
Salamanca	14.0%	3.2%	-96.3%
Cuenca	36.6%	0.0%	-100.0%
Barcelona	27.5%	4.5%	-98.5%
Ciudad Real	19.3%	**13.1%**	-87.9%
Guadalajara	10.3%	0.0%	-100.0%
Total	*16.0%*	*2.0%*	*-96.2%*

Conclusions

- There was a train frequency reduction which impacts the D2D travel time for air-rail options
- Health risk perception of public transport modes
- The corridors with frequent high-speed train services (e.g. Toledo-Madrid) before the crisis were particularly affected

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Background and motivation

Context

Airport landside access can account for a **significant part of the total door-to-door travel time**, and it is therefore a vital part of the competitive position of airports and airlines

In the case of **airport landside access**, intermodality refers to **the integration of the airport with the access modes** that connect the airport with its catchment area

EU Policies

They put an emphasis on digitalisation as a key enabler of intermodality, facilitating:

- Information sharing
- Coordination of decision-making along the transport chain

In this context…

IMHOTEP's vision is to have a set of interconnected platforms and services that will enable:

- Common situational awareness and real-time decision-making between airports and ground transport modes
- The provision of information and recommendations to travelers

Project objectives

Concept of Operations

Concept of operations for the extension of airport collaborative decision-making to ground transport stakeholders

Data collection, analysis and fusion methods

Provide a comprehensive view of the passenger trajectory through the integration of different types of high-resolution passenger movement data

Predictive models and decision support

Forecast airport's passenger flow within the day of operations and assess the operational impact on both airport processes and the ground transport system, therefore enabling real-time collaborative and decision-making

Validation of proposed concept and new methods and tools

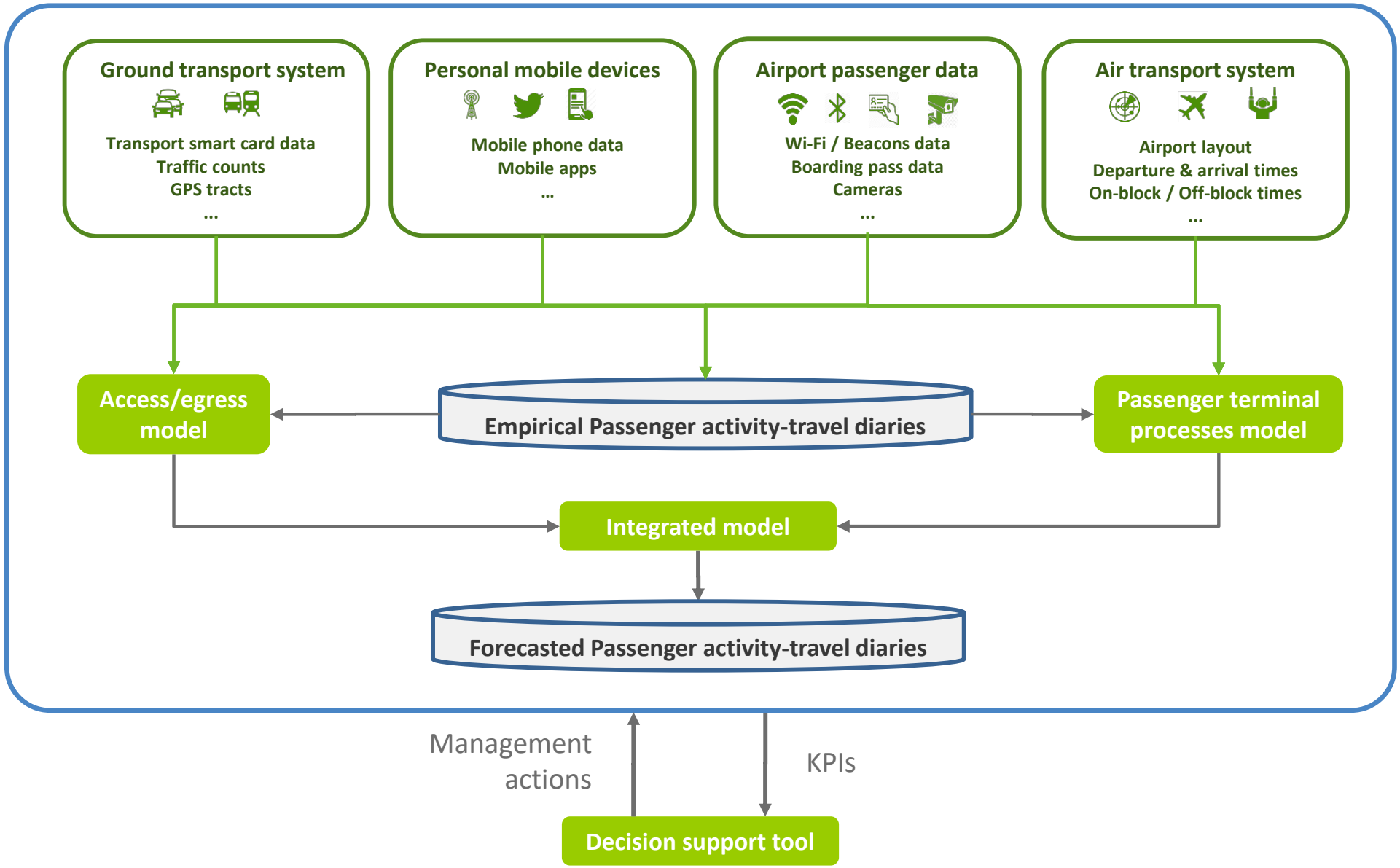
Case studies conducted in direct collaboration with airports, local transport authorities and transport operators to:

- Validate IMHOTEP predictive models and decision support tools
- Evaluate the benefits of the IMHOTEP Concept of Operations

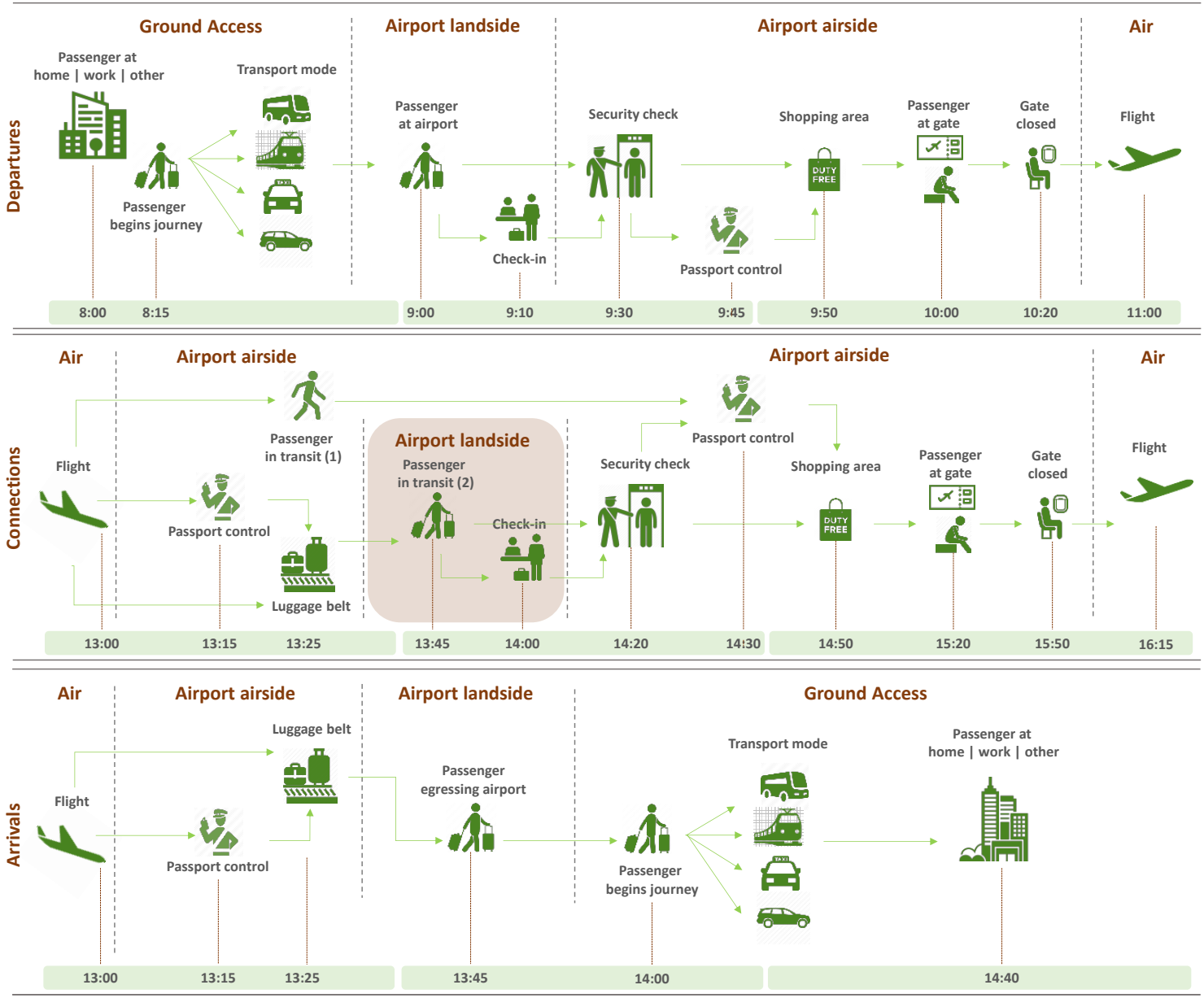
IMHOTEP platform

Platform used by airport and ground transport operators to access situational awareness and actively updated by both of them with operational data

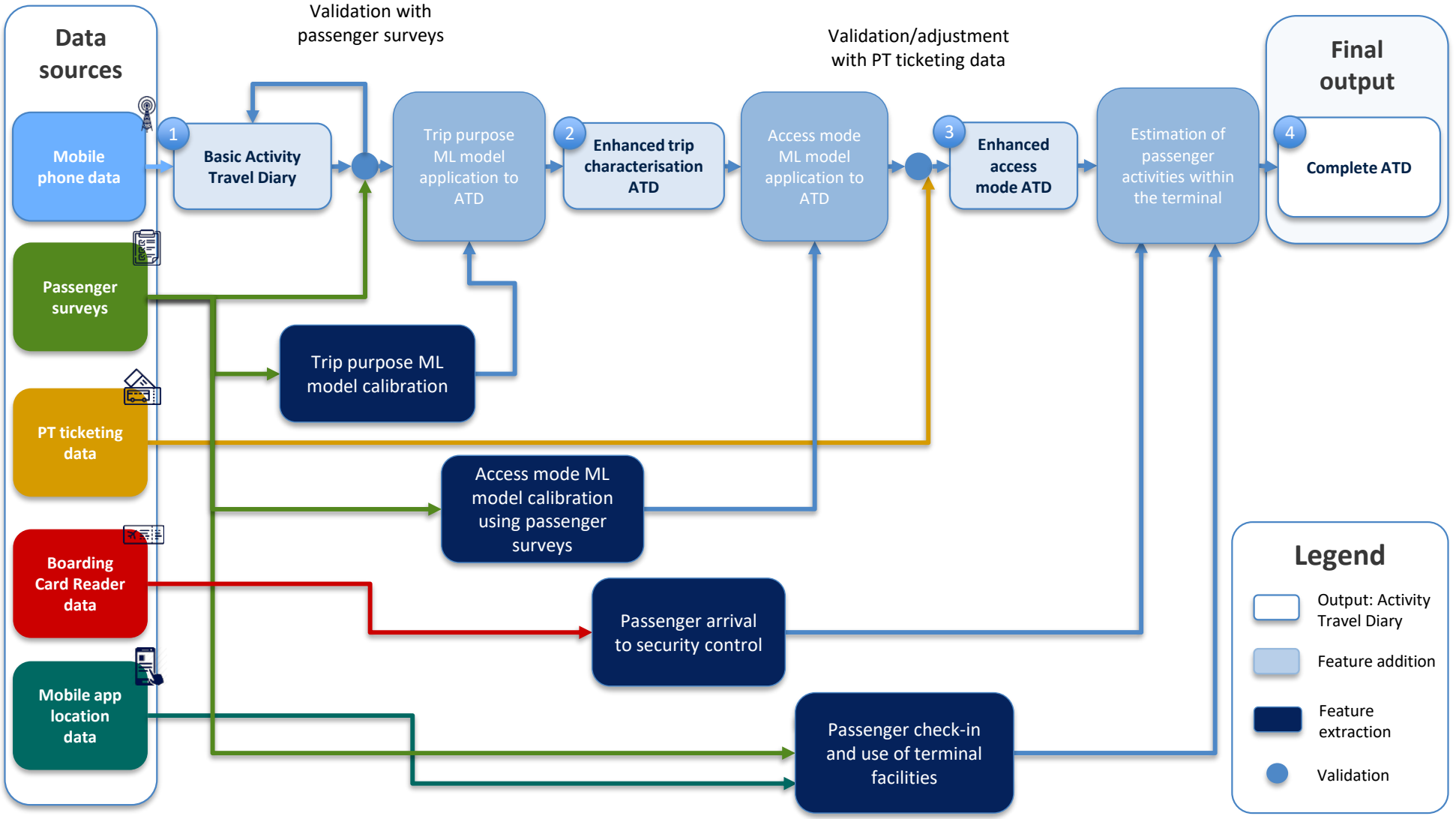
Project Concept



Passenger activity-travel diaries (ATD)



Passenger ATD reconstruction



Passenger ATD reconstruction: airport terminal

- Passenger location data extracted from mobile apps
- Reconstruction of passenger trajectories within airport terminal

Example with one week of data

Example of some representative trajectories

Project models & decision support tool

RT data

Historical passenger activity-travel diaries

RT data

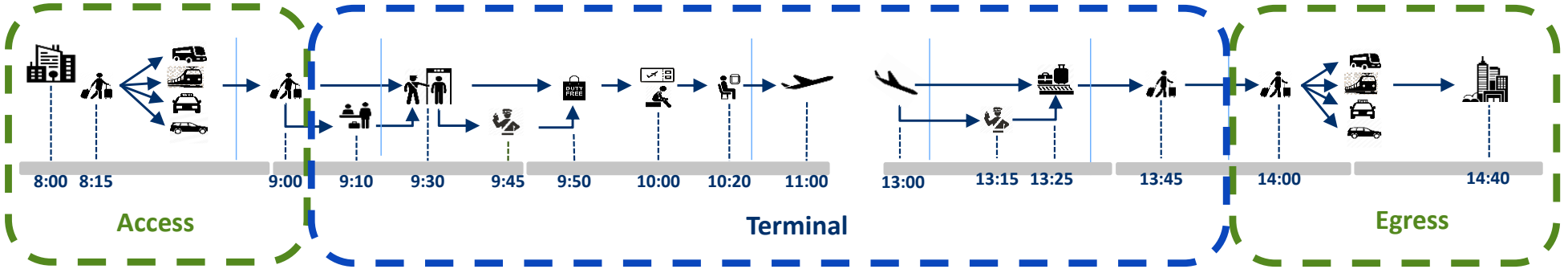
Airport access & egress model

Simulates the flows of passengers accessing and egressing the airport facilities

Terminal process model

Simulates the flows of passengers inside the airport terminal

Forecasted Passenger Activity-Travel Diaries



Visualisation & decision support tool

What-if analyses

Simulation of the impact of decision alternatives on KPIs

Snapshot of results: passenger mobility dashboard

- Data analytics needed to calibrate the simulation models
- Data sources: currently, airport passenger surveys; next step: passengers activity travel diaries

Pax nationality map

Trip purpose

Shopping area usage

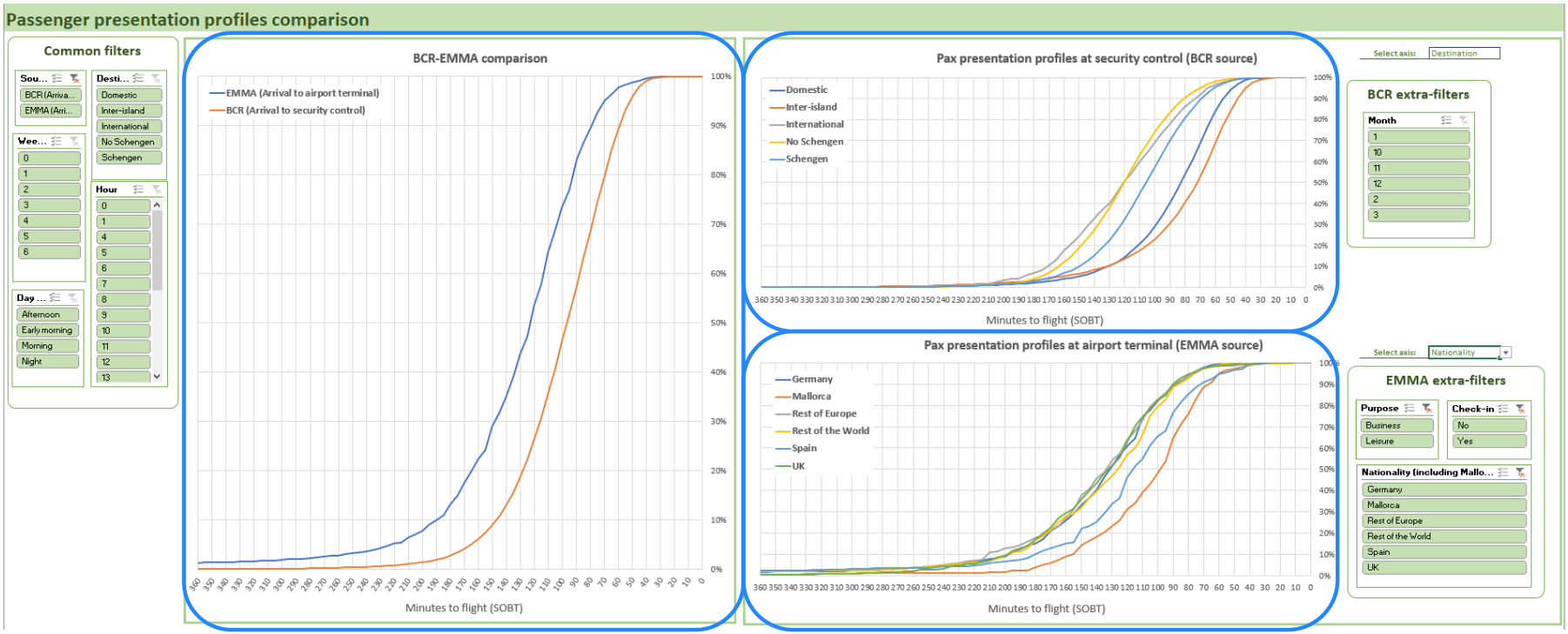
Access mode

Luggage & check-in method

Snapshot of results: passenger presentation profiles

- Pax presentation profiles categorised by passenger and trip characteristics
- Data source: airport passenger surveys and airport Boarding Card Reader data

Pax presentation profile at security control (BCR source)



Comparison of presentation profiles: security control vs airport terminal

Pax presentation profile at airport terminal (EMMA surveys)

More information

- TRANSIT website: www.transit-h2020.eu
- IMHOTEP website: www.Imhotep-h2020.eu

Thank you

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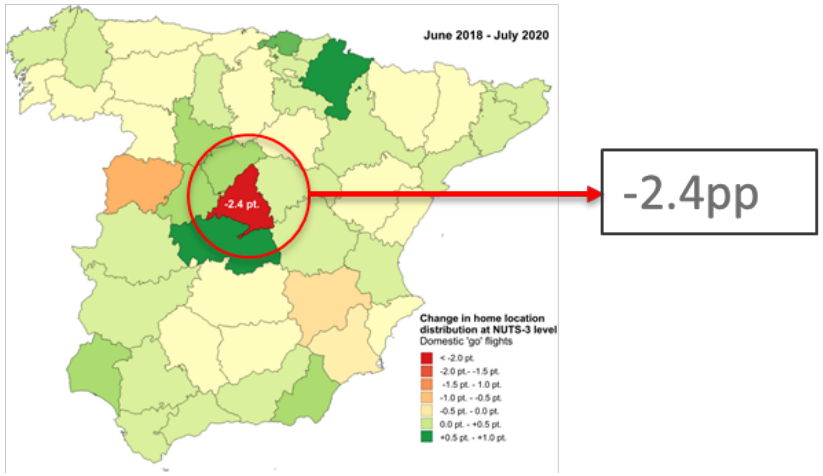
Snapshot of results: impact of COVID-19 on airport catchment area

Methodology

- Comparison of passenger behaviour for multimodal trips accessing Madrid-Barajas Airport during one week in June 2020 vs the same period in 2018
- Use of anonymised mobile phone data to reconstruct D2D multimodal chains

The proportion of Spanish resident passengers living in the Madrid region went up from **63.8% to 69.3%,** mostly due to the increased share of domestic flights during July 2020 period, which naturally have a more limited catchment area than international flights

Change in the distribution of the home location of international flights' passengers from June 2018 to July 2020



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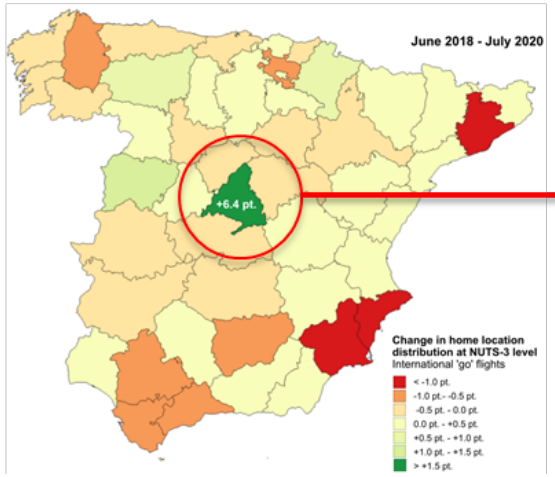
Change in the distribution of the home location of domestic flights' passengers from June 2018 to July 2020



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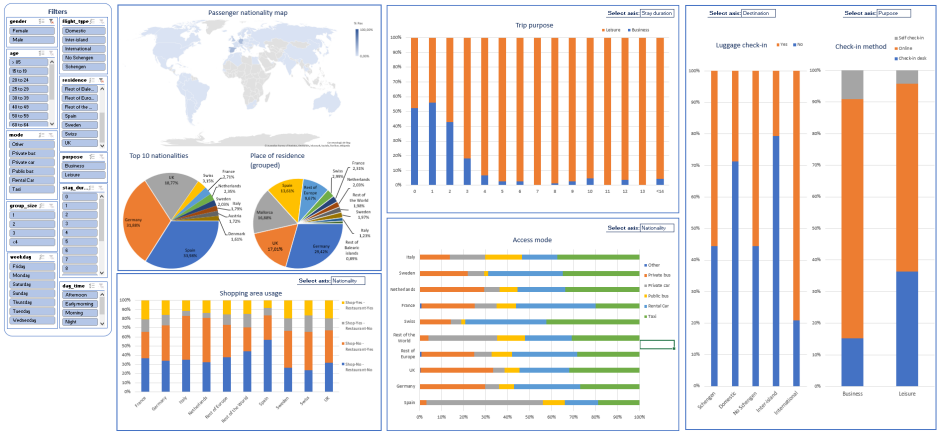
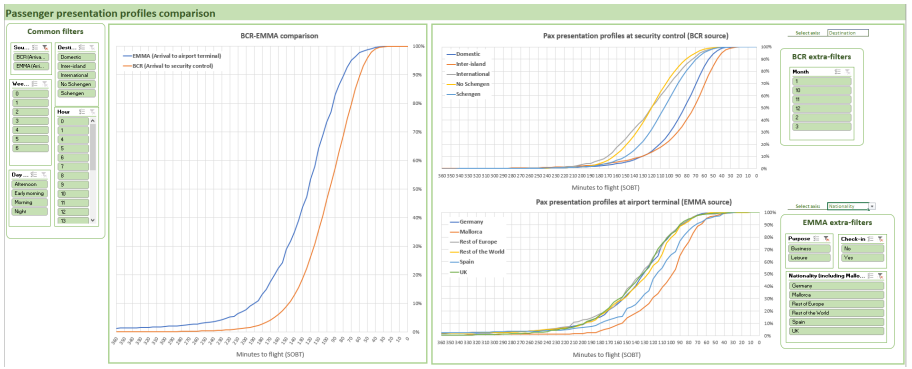
Snapshot of results: passenger mobility dashboard

- Data analytics work needed to calibrate the simulation models
- Data source:
  - Currently - airport passenger surveys and airport Boarding Card Reader data
  - Next step – passengers activity travel diagrams



Passenger mobility dashboard

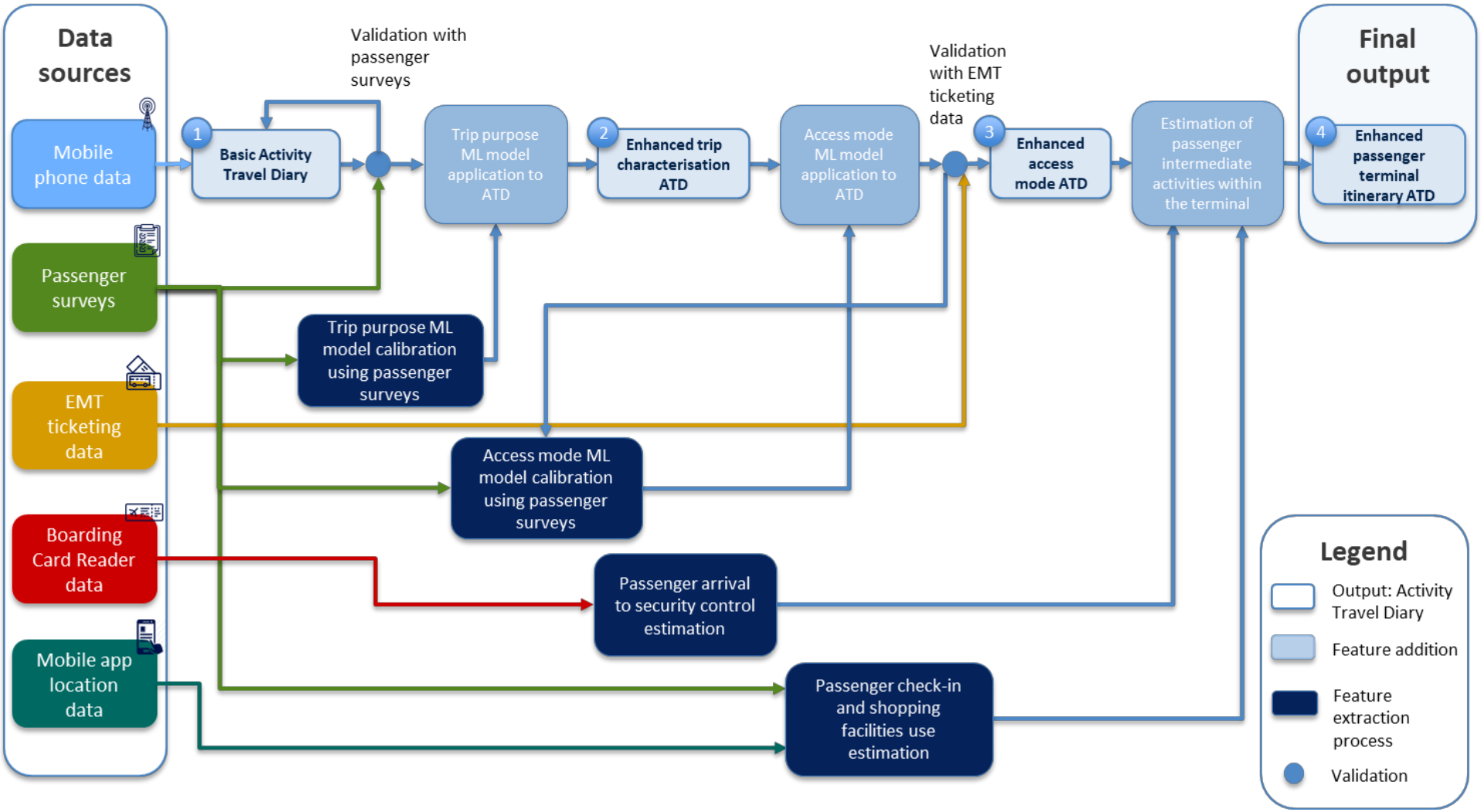
- Provides information on trip purpose, access mode, shopping area usage, etc



Passenger presentation profiles

- Provides information on passenger arrival times at the airport and security control categorised by passenger profile and trip characteristics

Passenger Activity Travel Diary (ATD) reconstruction approach



Snapshot of results: airport occupancy