



Big Data Analytics for the Study of Intermodal Passenger Behaviour

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- Technology-based company based in Madrid, founded in 2012
- 30 people team, ~2.5 M€ turnover
- Information, quantitative analysis and decision support tools for the planning and management of transportation systems
- Research-intensive organisation: R&D spending around 50% of revenue
- Business Units:
 - Kineo Mobility Analytics
 - Aviation
 - Transport & Mobility

The need for better travel behaviour data

The planning and management of transport systems requires accurate, reliable and updated information on transport supply and travel demand. While high-quality transport supply information is increasingly available, travel demand data is in most cases the big unknown

Travel surveys

- High cost
- Time consuming
 - ⇒ Small samples
 - ⇒ Quality of information
 - ⇒ Outdated information
 - ⇒ Information not fully adapted to the problem

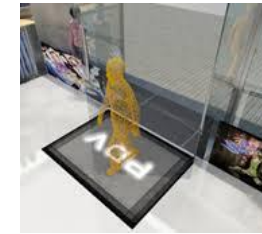
...so, for decades, we have developed a lot of theory to fill these gaps

Opportunities

Mobile devices



Sensors



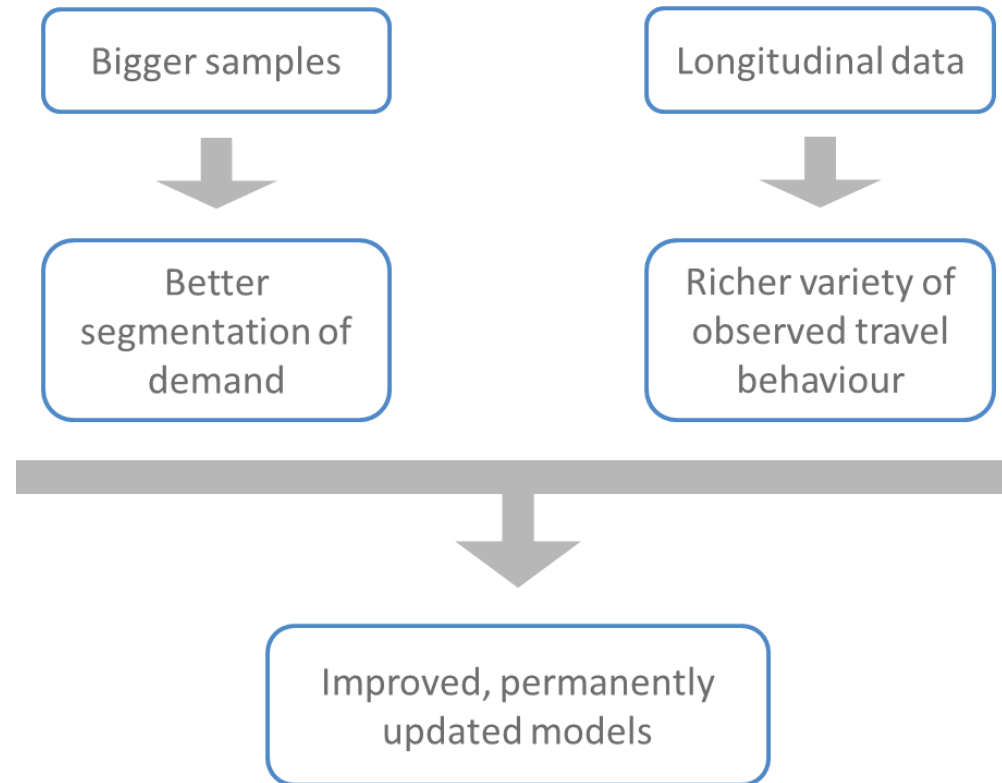
Geolocation data

Passive data collection

“Objective” data

Longitudinal data - permanently updated

New big data sources allow us to produce high-quality travel demand information, and they more and more integrated into transport planning and traffic management



So what about aviation?

The vision of a passenger-centric air transport system

Flightpath 2050: passenger-centric air transport system thoroughly integrated with other transport modes, with the goal of taking travellers from door to door predictably and efficiently

- Admittedly, air transport operations have so far lacked a passenger-oriented perspective, with performance objectives and decision criteria not necessarily taking into account the ultimate consequences for the passenger
- Understanding travel behaviour is an essential enabler for realising the vision of a passenger-centric air transport system. However, research has so far been constrained by the limited availability of mobility data:
 - Typically cross-sectional (static) demographic and economic datasets
 - Small samples
 - Assumptions about the permanence of behavioural traits over time... which is **more and more questionable**: rapid technology evolution, impact of COVID-19, etc. are leading to increasingly fast changes in travel behaviour

Study of passenger behaviour

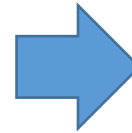
Traditional approach



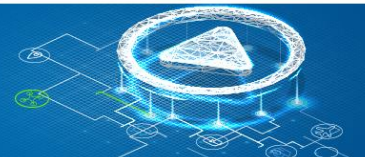
Travel surveys



Aviation passenger
intelligence solutions



New opportunities



Big data and travel behaviour

- New, citizen-centric data sources are beginning to be successfully exploited in other areas of transportation: what are the opportunities for improving decision-making in air transport?
- How can different passenger-centric geolocated data coming from smart personal devices be analysed and combined with more traditional demographic, economic and air transport databases to extract relevant information about passengers' behaviour and inform decision making processes?



Passenger-centric Big Data Sources for Socioeconomic and Behavioural Research in ATM

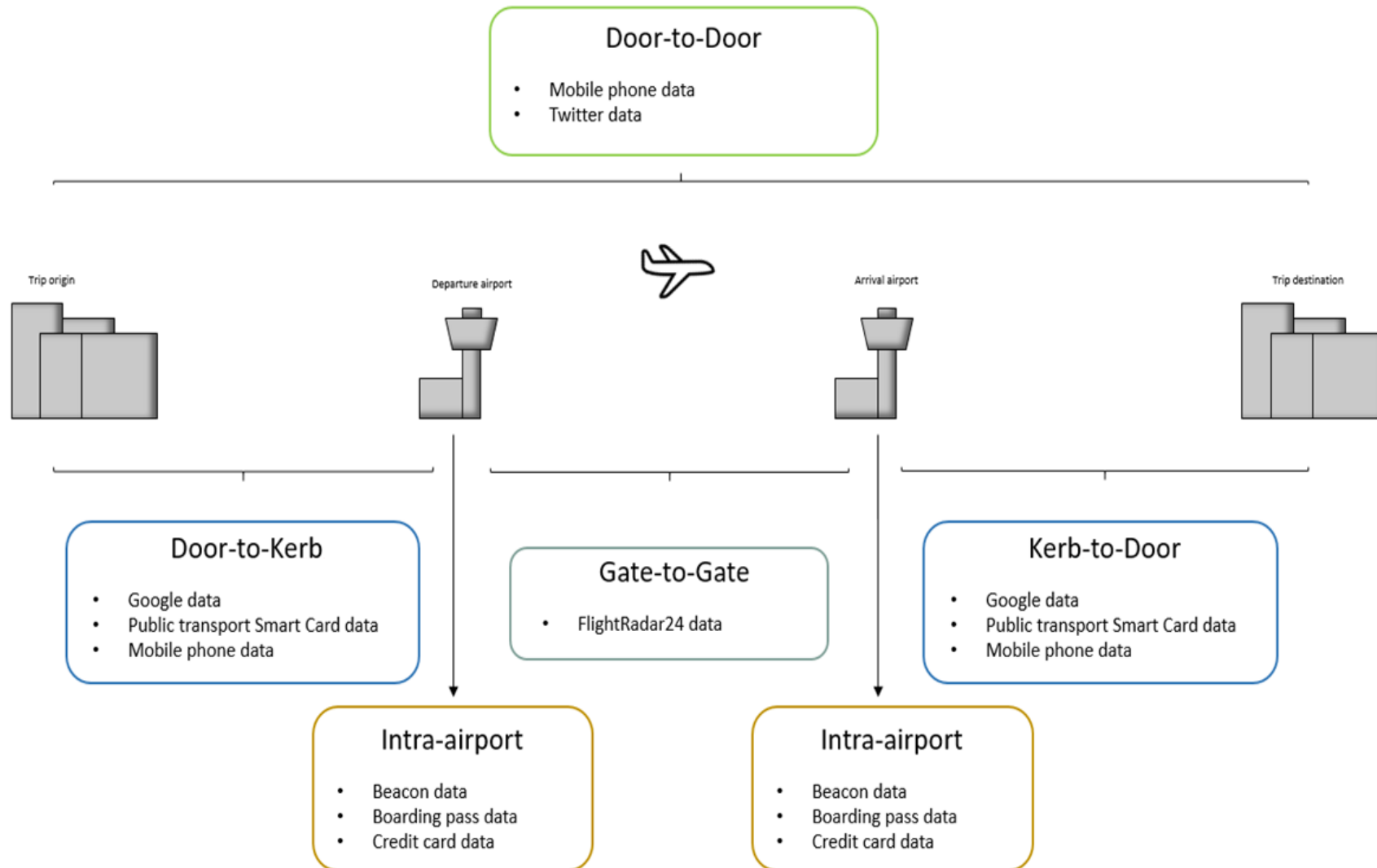
- NOMMON



SESAR Digital Academy – Artificial Intelligence

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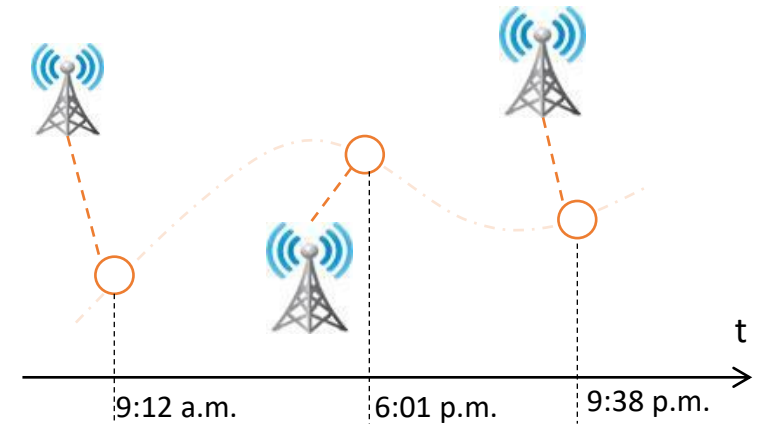


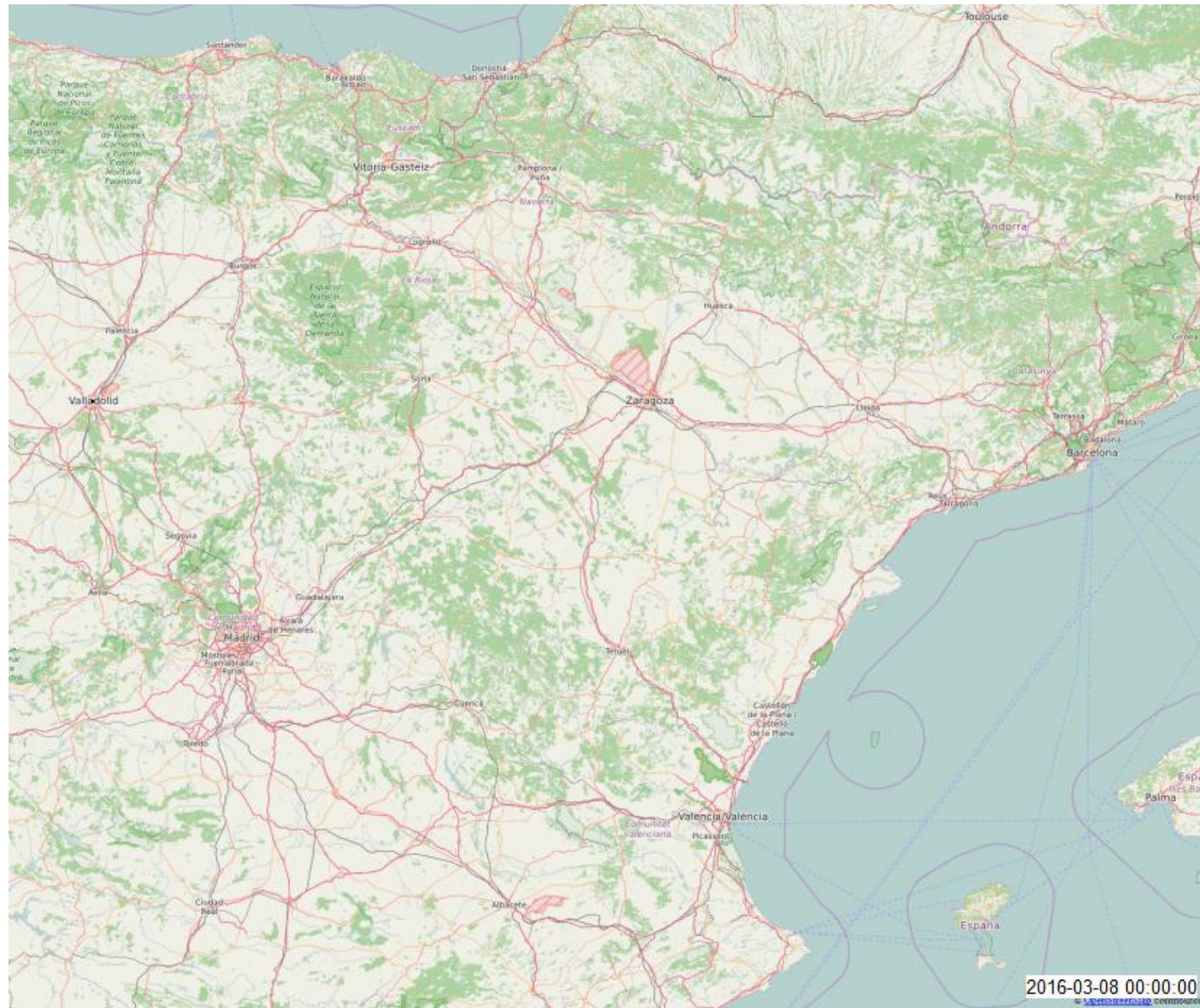
A snapshot of results: the example of mobile phone records

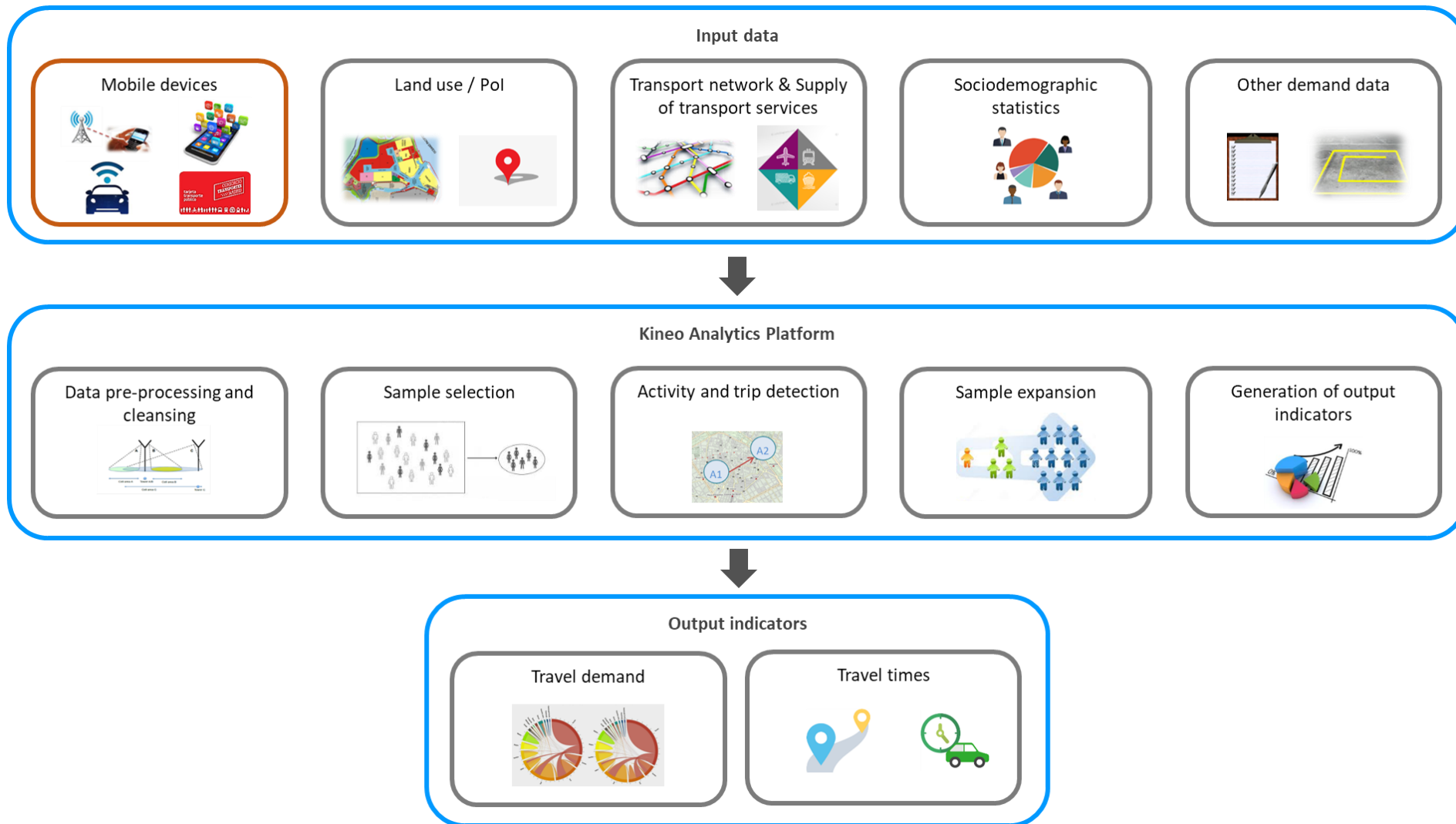
The data

Anonymised mobile phone data provided by Orange Spain

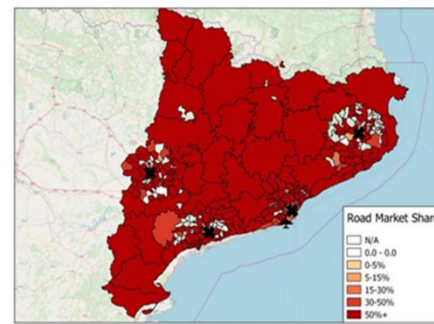
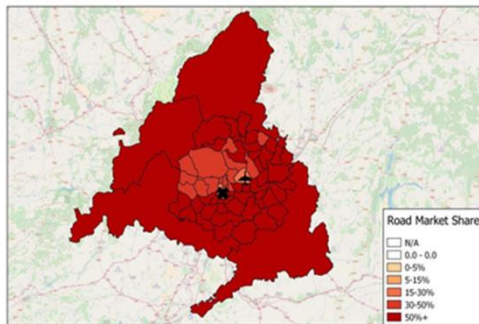
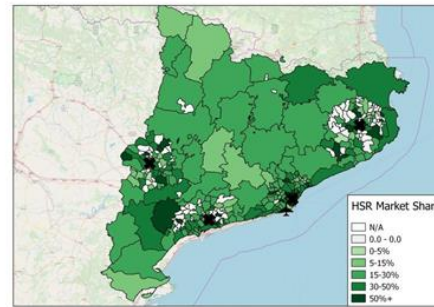
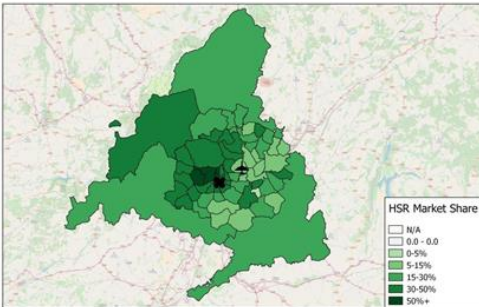
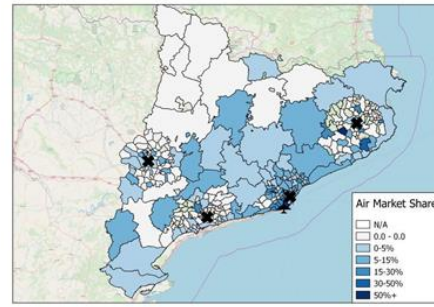
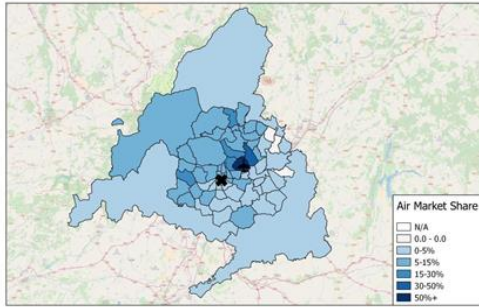
- Spatio-temporal data: time and cell tower to which the user is connected every time an event occurs
- Orange's clients + roamers that connect to Orange's network
- Sample of around 27% of the total population



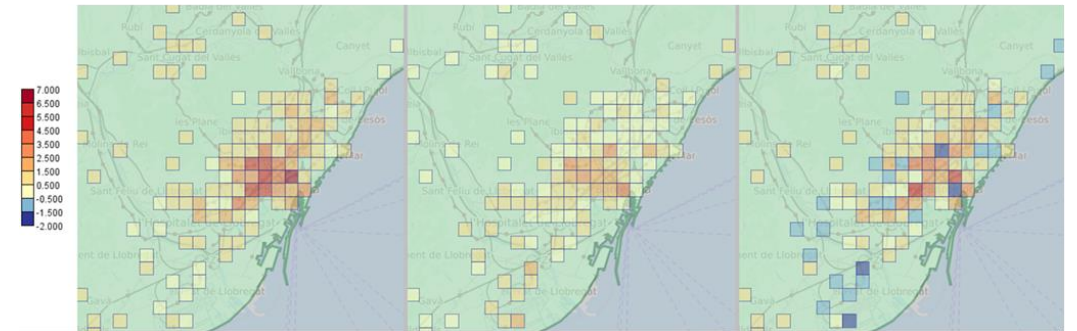
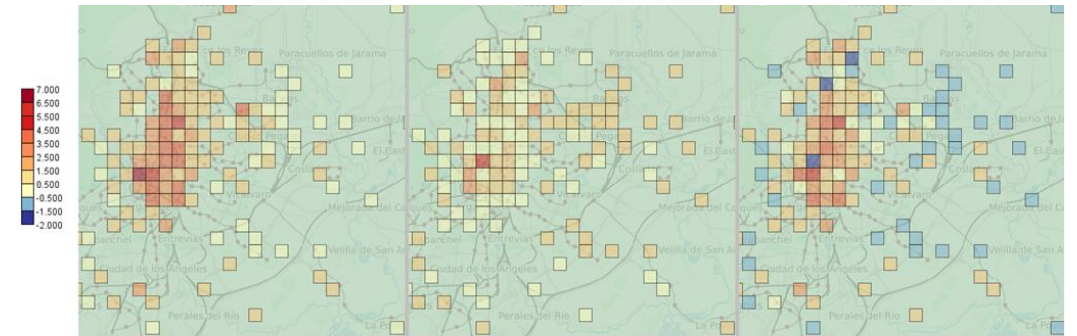




Modal share



Catchment areas

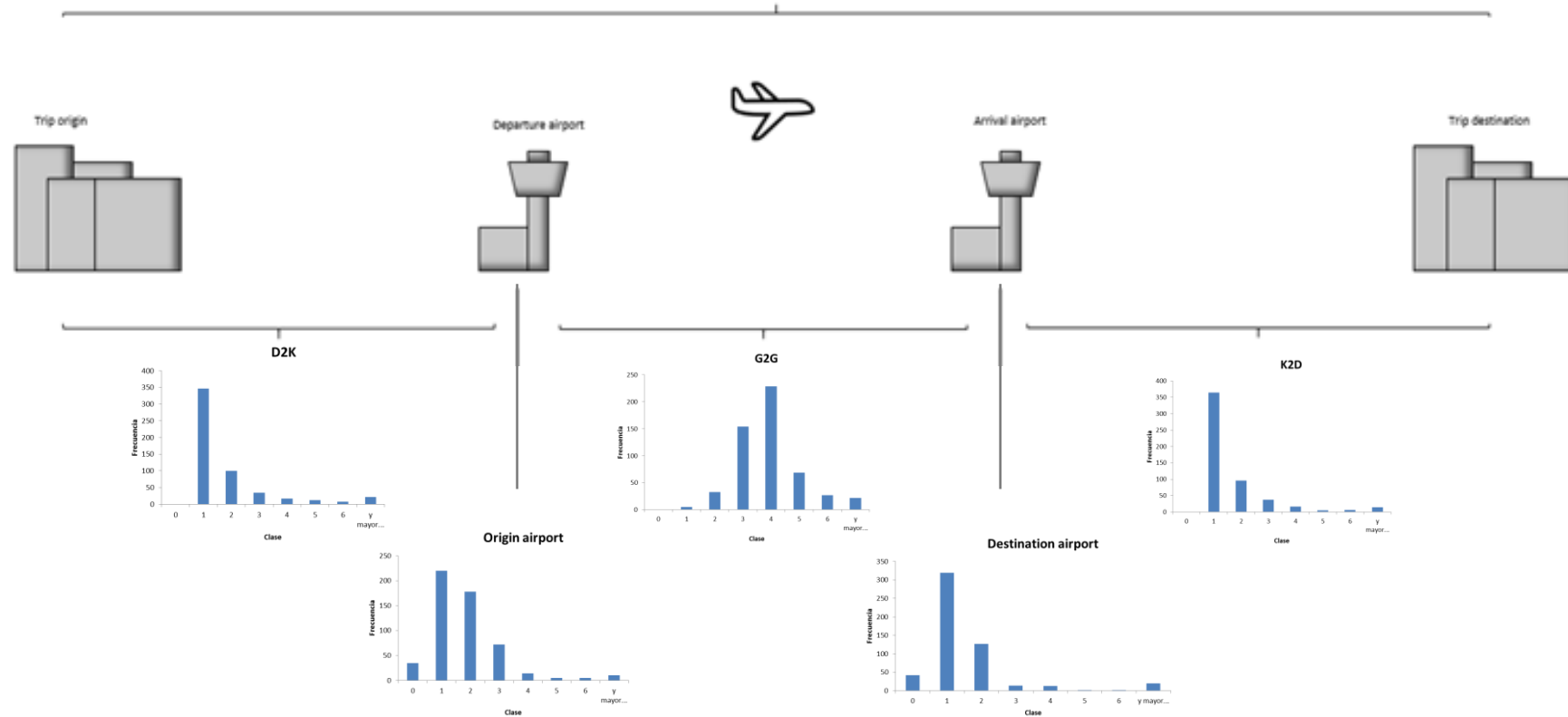


No Train trips

No Air trips

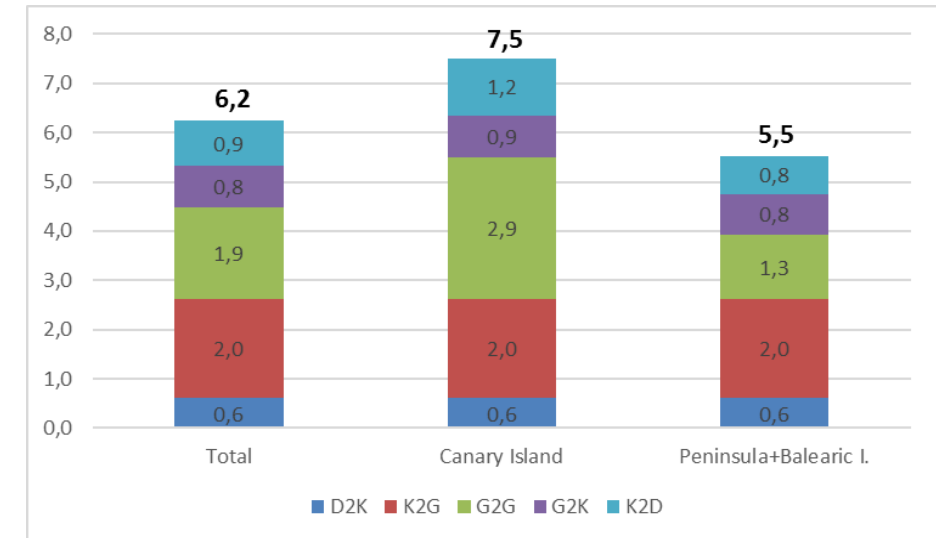
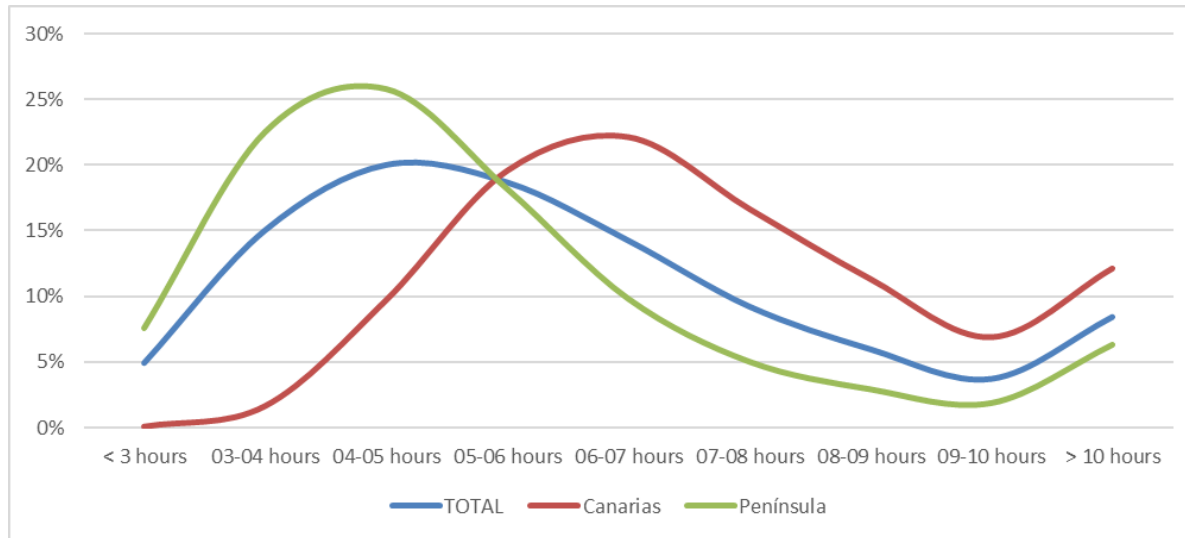
[No Train trips - No Air trips]

Door-to-door travel times



Trips from the Canary Islands to peninsular Spain

Door-to-door travel times

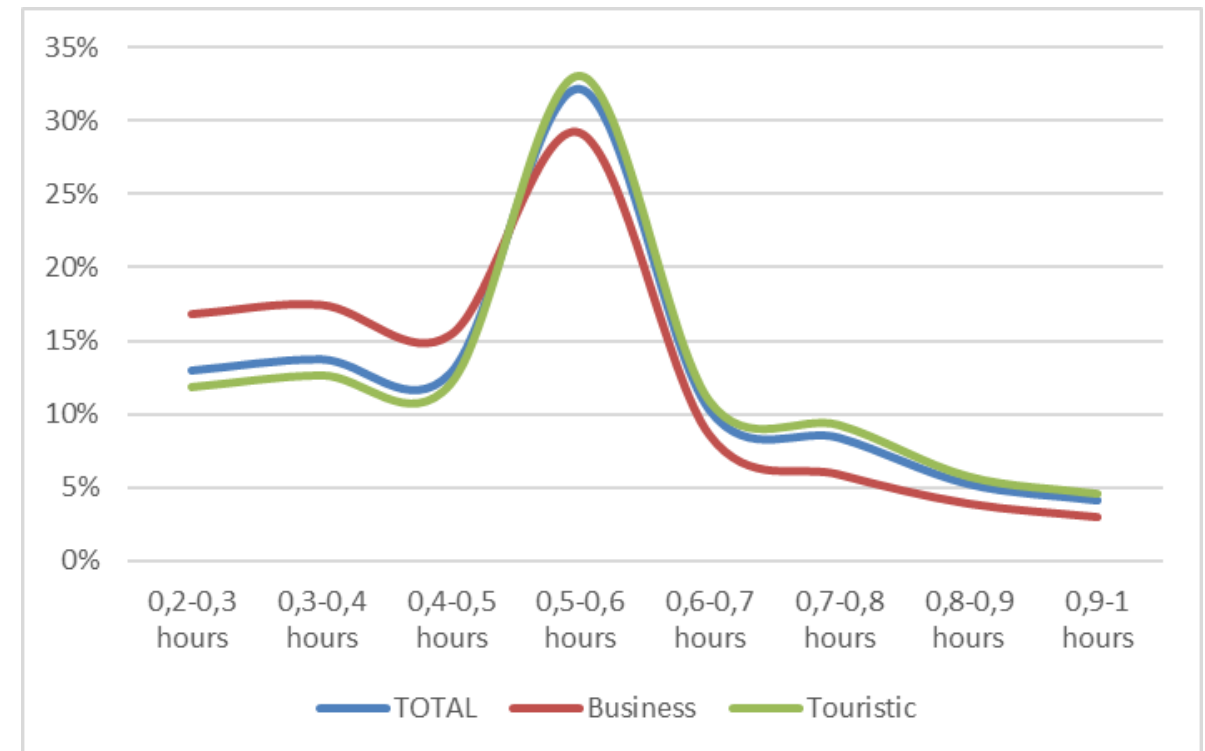


Trips arriving in Madrid from the rest of Spain: D2D travel time

- ❑ Half an hour to arrive to the airport
- ❑ 2 hours at departing airport
- ❑ Less than 1 hour at destination airport
- ❑ Almost 1 hour to reach final destination

Door-to-door travel times

AIRPORT	K2G TIME
JEREZ	1,5
FEDERICO GARCIA LORCA/GRANADA-JAEN	1,5
ASTURIAS	1,6
ALMERIA	1,7
VIGO	1,7
BARCELONA/EL PRAT	1,7
GRAN CANARIA	1,8
SANTIAGO	1,8
IBIZA	1,9
SAN SEBASTIAN	1,9
LA PALMA	2,0
LANZAROTE	2,1
TENERIFE NORTE	2,1
PALMA DE MALLORCA	2,1
VALENCIA/MANISES	2,2
TENERIFE SUR/REINA SOFIA	2,2
ALICANTE-ELCHE	2,3
A CORUNA	2,3
SEVILLA	2,4
FUERTEVENTURA	2,4
MALAGA/COSTA DEL SOL	2,4
MENORCA	2,4
BILBAO	2,5
SANTANDER SEVE BALLESTEROS	2,8



Trips arriving in Madrid from the rest of Spain: time at origin (left) and destination (right) airports

Other relevant projects

Leisure/business passenger identification: fusion with survey data

Leisure trips proportion depending on go-return date in EMMA MAD 2018 survey

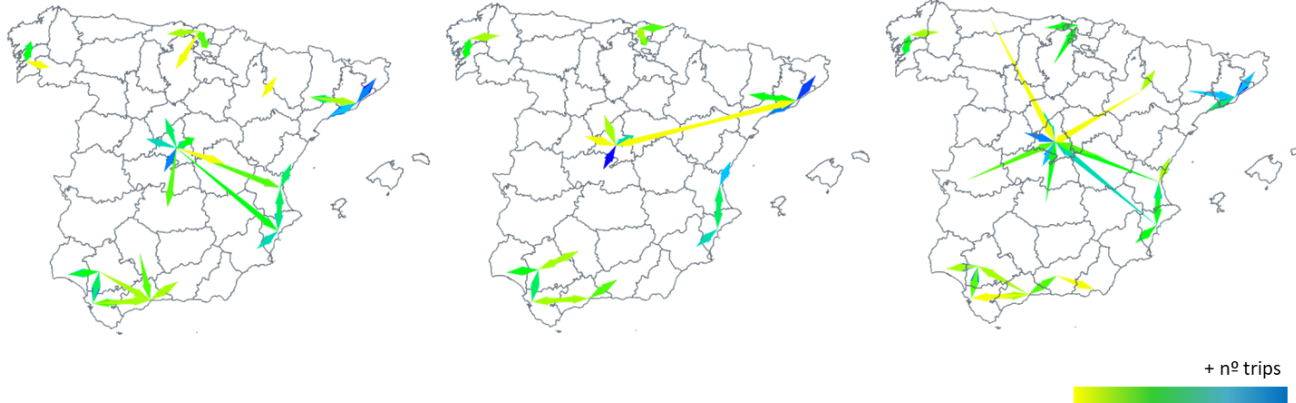
		Return date													
		Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	
Go date	M	30%	10%	21%	31%	35%	60%	66%							
	Tu		11%	11%	21%	42%	55%	74%	80%						
	W			15%	15%	20%	39%	75%	78%	86%					
	Th				14%	9%	49%	81%	88%	88%	98%				
	F					35%	40%	82%	86%	92%	80%	86%			
	Sa						100%	69%	71%	77%	81%	74%	83%		
	Su								19%	33%	36%	48%	63%	63%	

Analysis of interurban mobility in Spain

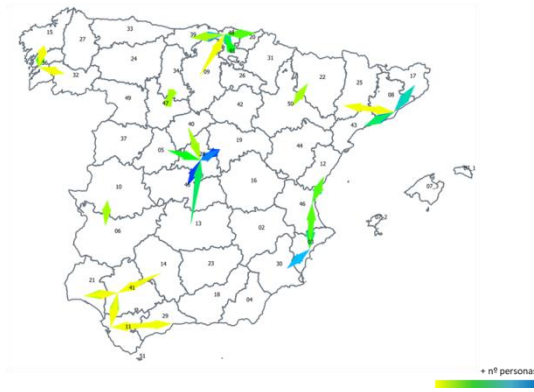
Fri 14th July

Average Thu of October

Sun 15th October



- Home-work relationships



Laborable

Domingo

Julio/agosto



Octubre



Mobility monitoring during the COVID-19 crisis



01/03/2020 23/03/2020



Provincia origen

Madrid

Provincia destino

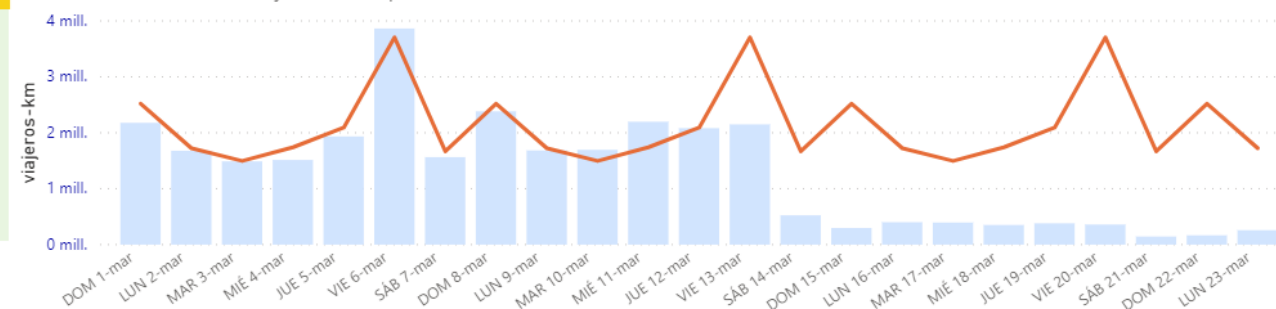
Alicante

Distancia

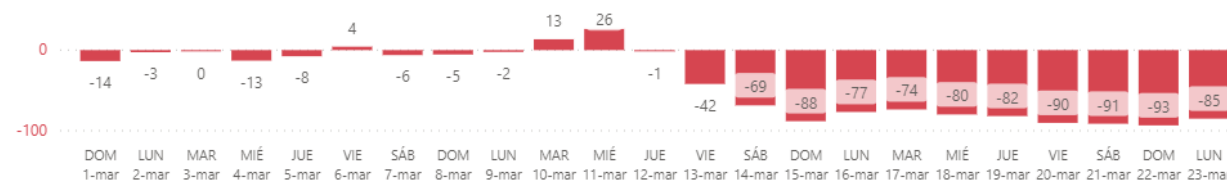
☐ Más de 100 km

Evolución de la movilidad diaria

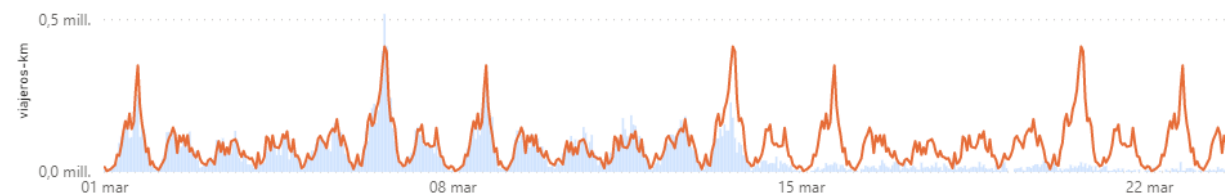
distancia ■ Más de 100 km ● viajeros-km en el periodo de referencia



% Variación respecto al día de referencia



Viajeros-km por hora y distancia



NOTA: Se ha tomado como referencia el periodo del 14 al 20 de febrero de 2020



Conclusions and future directions

The promise of Big Data

Data streams generated by smart personal devices offer a great potential for analysing passenger behaviour with an unprecedented level of detail

But...

These data also come with a number of challenges:

- Noise and errors
- Biases
- Less explanatory power: behavioural information not always directly observable, it has to be inferred
- Limited sociodemographic information
- Computational challenges
- Additional regulatory, organisational and business challenges (privacy, algorithmic transparency, business models...)

No single data source provides the full picture: need for data fusion

Blend airport-specific data with external data to realise full potential

Algorithms matter: devil's in the details

Rigorous validation is essential

Need for more applied research at the intersection of data science and transportation modelling, in close collaboration with airports

Future research: new SESAR ER projects



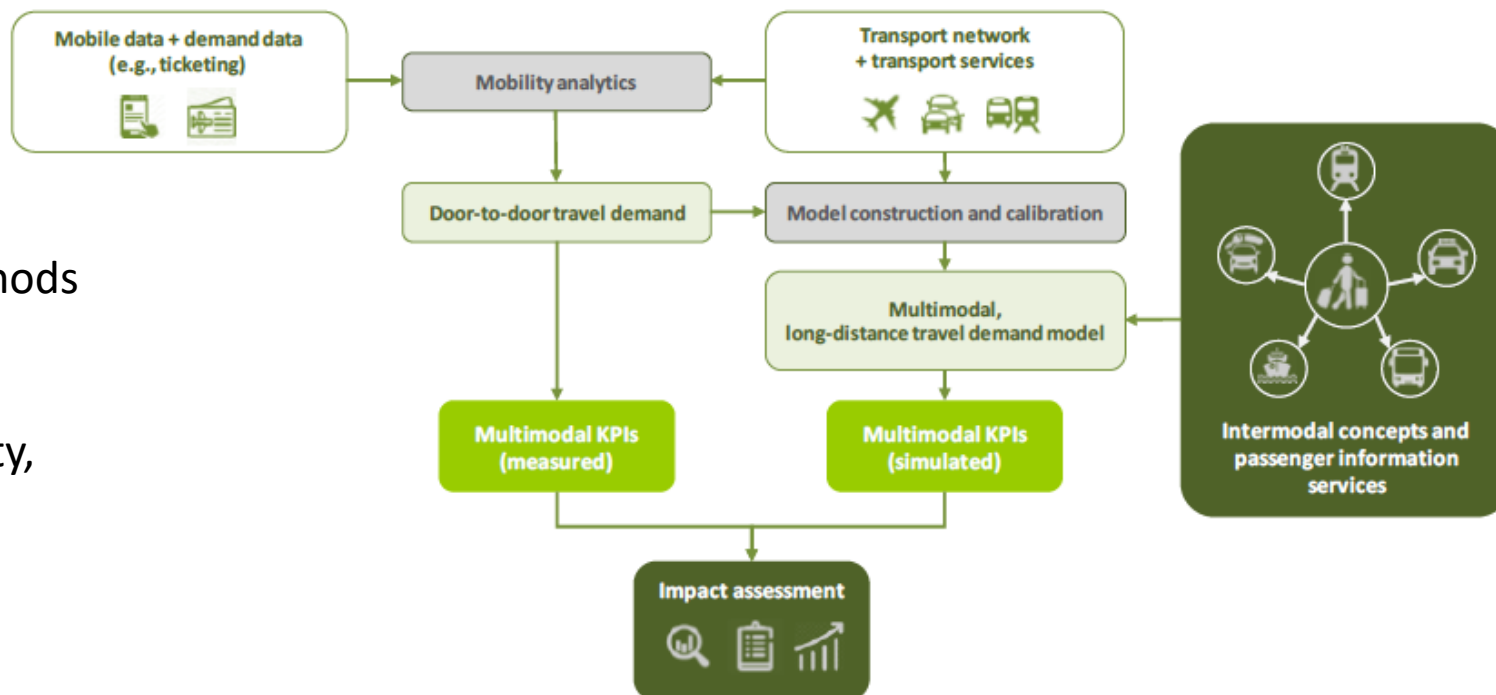
Travel Information Management for
Seamless Intermodal Transport



Integrated Multimodal Airport Operations for
Efficient Passenger Flow Management

The goal of TRANSIT is to develop a set of multimodal KPIs, mobility data analysis methods and transport simulation tools allowing the **evaluation of the impact of innovative intermodal transport solutions** on the quality, efficiency and resilience of the door-to-door passenger journey

www.transit-h2020.eu

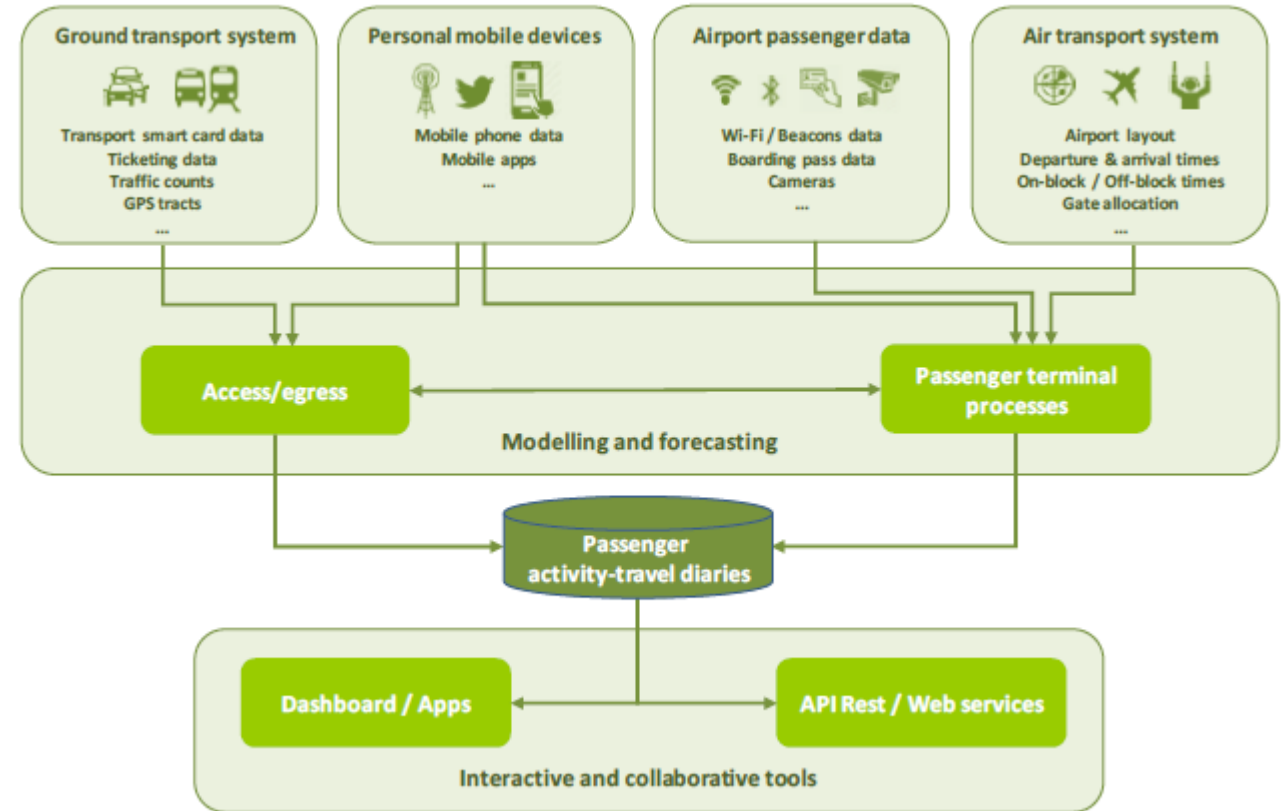




Integrated Multimodal Airport Operations for
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The goal of IMHOTEP is to develop a concept of operations and a set of data analysis methods, predictive models and decision support tools that allow information sharing, common situational awareness and real-time collaborative decision-making between airports and ground transport stakeholders

www.imhotep-h2020.eu



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digital academy

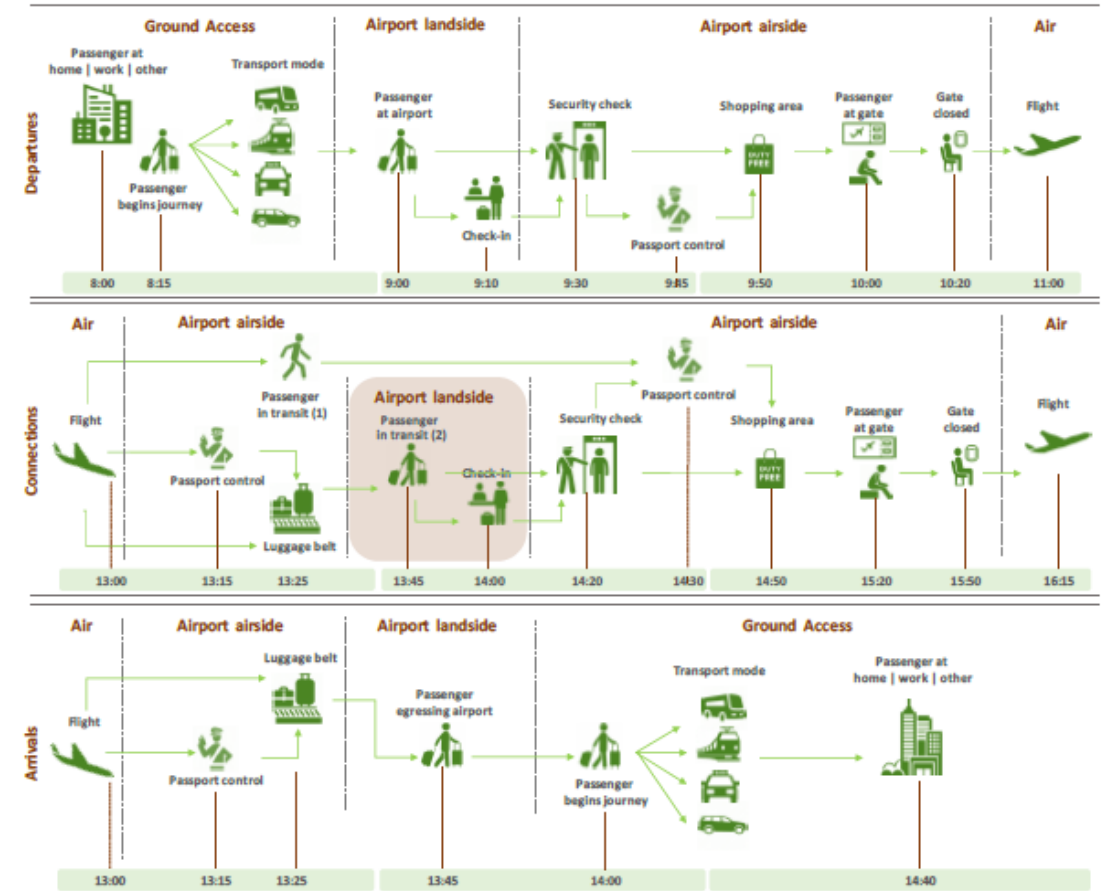




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www.imhotep-h2020.eu



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Resources

- www.bigdata4atm.eu
- www.transit-h2020.eu
- www.imhotep.eu
- <https://observatoriotransporte.mitma.es/estudio-experimental>
- <https://www.mitma.gob.es/ministerio/covid-19/evolucion-movilidad-big-data>