

### Motivation

Multimodal solutions that combine air and rail are highly attractive in terms of optimising sustainability and improving connectivity, particularly in dense metropolitan areas where HSR infrastructure is already in place. In this sense, both are complementary ways towards meeting emission reduction goals, making the optimal solution more "plane and train" rather than "plane vs train".

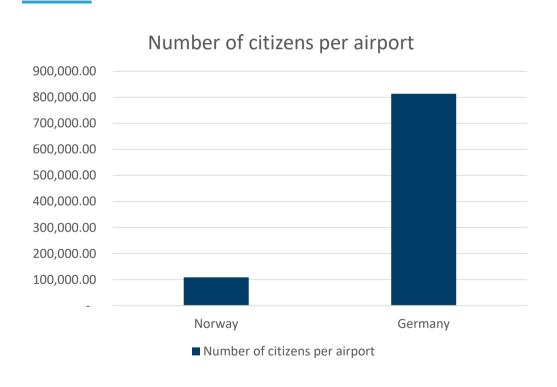
(Eurocontrol Think paper #11 – 3 June 2021)





# How many citizens per airport?

Norway vs. Germany





If you are in a German town with 40.000 inhabitants, you hope to have a train station nearby.

If you are in a Norwegian town of 20.000, you most probably have an airport nearby.



## Europe – A smorgasbord of art, history, and culture

[The difference between Austrians and Germans] "...is like the difference between a battleship and a waltz."





Source: Wikipedia



# Who plays the music?



VS

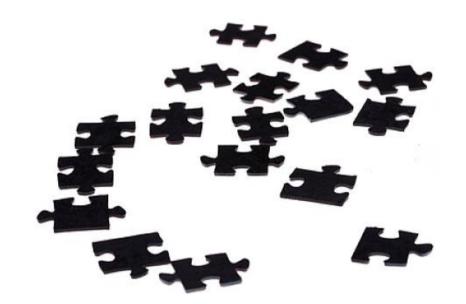


Rockstar Orchestra



## From dissonance ...

Despite the fact that technology and knowledge are mature enough for broader applications, the commission believes that the development has not been as desired, and that established systems and services are often fragmented and without coordination and interoperability.



ITS Directive (2010/40/EU)



## .... to harmony

Tomorrow's transport network will consist of both small and large actors. Together they will offer their service by means of **smart interoperable digital solutions.** This **decentralized** but still **integrated**, **continuous**, **seamless** and **multi-modal** network will allow customers to find and book travels that are **personally adapted** to their own needs and preferences.

#### This is supported by

- The EU ITS Action Plan 2009-2014
- The EU ITS Directive (2010/40/EU)
- The ITS-strategy of the Norwegian Transport Ministry
- The National Transport Plan of Norway (NTP) 2018-2029





# We stand for a European approach to intermodal digital services: A "No Rockstar" architecture

- Distributed travel planning by means of an "orchestrator service" and "soloist services".
- Each soloist can be a specialised travel planner who handles one or more modalities in a possibly confined geographical area.
- The orchestrator utilizes optimization and machine learning algorithms to determine which soloists can be included in the planning of a given travel.







From Bilbao to Oslo, intermodal mobility solutions and interfaces for people and goods, supported by an innovative communication network.

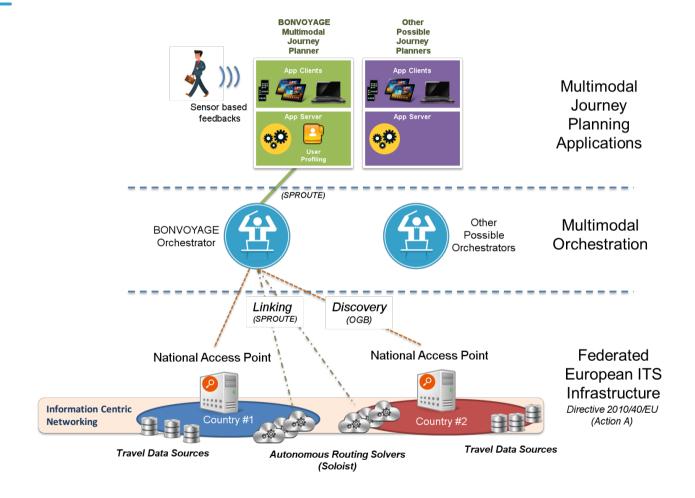
EU-project - HORIZON2020, 2015-2018

Call: Mobility for Growth

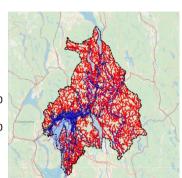
Topic: MG.7.2-2014. Towards seamless mobility addressing fragmentation in ITS deployment in Europe <u>Project participants from Italy, France, Spain, Austria and Norway</u>



## The BONVOYAGE vision







#### Coverage:

Oslo county
Population: 673 000
Akershus county
Population: 614 000

#### **Modalities:**

Car, Walk

Public transport

Bus, Tram, Subway, Ferry, Airport Express train

## Soloist covering selected modes and areas

#### Coverage:

Flights serving selected airports in Europe

Oslo

Bergen

Lyon

Bilbao

Rome

and connecting airports

#### **Modalities:**

Airplane



#### Coverage:

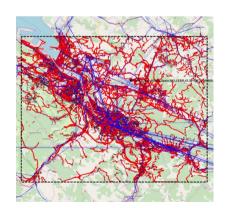
Bilbao city and airport Population: 350 000

#### **Modalities:**

Car, Walk

Public

Bus: Bilbobus, Bizkaibus Train: Euskotren Subway: Metro Bilbao





## **Unfinished Symphony**

- Real-time planning of door-to-door transport
- Real-time support in carrying out the journey
- New modalities from Hyperloop to autonomous vehicles and airtaxis
- (Belly-)Freight



Franz Schubert, composer of the "Unfinished Symphony" (Source: Wikipedia)



## Ode to Joy!

- Aviation as the backbone of a European multimodal system will have positive knock-on effects on other modalities, if well integrated.
- Strengths and weaknesses of modalities need to be better reflected in the digital services. A distributed and federated architecture may better support this.
- A concerted effort of industry and the scientific community is needed.
- Multimodal travel within Europe needs to take into account a heterogeneous environment of culture, infrastructure, geography and topology.



Ludwig van Beethoven (Source: Wikipedia)



# For further reading

- BONVOYAGE project page
  - http://bonvoyage2020.eu/
- Publication in Sustainability (journal)
  - https://www.mdpi.com/2071-1050/11/7/1888





## Federation and Orchestration: A Scalable Solution for FU Multimodal Travel Information Services Andrea Detti 1.\*©, Giuseppe Tropea 1, Nicola Blefari Melazzi 1, Dag Kjenstad 2©, Lukas Bach 2,

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- ivarchristiansen@vegvesen.no CRAT.—Department of Computer, Control and Management Engineering, University of Rome "La Sanienza" (10185 Rome, Italyl lissibilis uniromal) if La Suprenza' , vurtes kome, Haltj: Iss@dis, uniroma1.it Correspondence: andrea.detti@uniroma2.it; Te1: +39-06-7259-7445



Received: 12 February 2019; Accepted: 20 March 2019; Published: 29 March 2019 Abstract Multimodal travel planning services allow travelers to plan their journey by combining a multi-transport modes: air rail waterhome exact multi-transport domaind recovering transport Abstract Multimodal travel planning services allow travelers to plan their journey by combining different transport modes: air, rail, waterborne, coach, public transport, demand responsive t different transport modes: air, rail, waterborne, coach, public transport, demand responsive transport walking, cycling, etc. The European Union is fostering the development of cross-border multimodal planning services by establishing a moulation framework for their coordinated and coherent walking cycling etc. The European Union is fostering the development of cross-border multimodal planning services by establishing a negulation framework for their coordinated and coherent development across Member States (under the Directive 2010/40/EU). This EU regulation efves planning services by establishing a regulation framework for their coordinated and coherent depolyment across Member States (under the Directive 2010/40/EU). This EU regulation gives the contract of travel data formate (DATEV II SIRI No TEV 2010) and on fundamental deployment across Member States (under the Directive 2010/40/EU). This EU regulation gives precise requirements on travel data formats (DATEX IL SRI, NeTEx, etc.) and on fundamental control of contr Precise requirements on travel data formats (DATEX II, SIRI, NeTEx, etc.) and on fundamental and recommended system-level services, such as discovery and linking services. However, it does not format the format of the properties of the state of the sta and recommended system-level services, such as discovery and linking services. However, it does not (yet) pose constraints on how to implement them. In this paper, we devise and test a system and recommendation to the proposes an innovative solution implementing such services. not (yet) pose constraints on how to implement them. In this paper, we devise and test a system architecture, named Bonvoyage, which proposes an innovative solution implementing such services. According to the contain travel information of the contain travel information. architecture, named Bonvoyage, which proposes an innovative solution implementing such services. For discovery purposes, it federates nation-wide NoSQL databases that contain travel information contains travel information. Information Control, Materials As most federates are contained in the control of th For discovery purposes, it federates nation-wide NoSQL databases that contain travel information by exploiting a novel telecommunication paradigm, information Centric Networking. As regards a conductation of automatical properties of automatical properties of automatical properties. by exploiting a novel telecommunication paradigm, information Centric Networking. As regards linking purposes, it orchestrates the use of autonomous monomodal or multimodal routing sargical to empity-his etak-sholders by compress the boat Association burners. linking purposes, it orchestrates the use of autonomous monomodal or mutumo provided by small/big stakeholders to compose the best door-to-door journey.

Keywords: intelligent transport systems; federated spatial databases; EU regulation; door-to-door

The ever growing mobility of citizens and goods is making intelligent Transport Systems (ITSs) at the provious citizens and countries. The allow citizens to be bother informed about a broad The ever growing mobility of citizens and goods is making intelligent transport Systems (118s) a muschave for modern cities and countries. ITs allow citizens to be better informed about a broad more of transport systems (118s) a safer more coordinated and more efficient tree of the overall must-have for modern cities and countries. ITs allow citizens to be better informed about a broad range of transport options, leading to a safer, more coordinated and more efficient use of the overall range of the country of the transport contains the transport contains the country of a country part of the country of a country part of the country of range of transport options, leading to a safer, more coordinated and more efficient use of the overall transport system. It has become clear that improving the transport system of a country not only transport system of a country not only infrastructures and means, but also but also transport system. It has become clear that improving the transport system of a country not only requires efforts in preserving and enhancing the transport infrastructures and means, but also in indemnine ITS technologies. Indeed, name covernments and national initiatives, such as ITS

requires efforts in preserving and enhancing the transport infrastructures and means, but also in implementing ITS technologies. Indeed, many governments and national initiatives, such as US implementing ITs technologies. Indeed, many governments and national initiatives, such particles are interesting and initiatives and initiatives are interesting that the transportation communication and communication and communication and communication and communication. JT [1], the European Commission [2], and ITS Japan [3], are promoting ITS deployments.

This have a complex architecture that ties transportation, communication and computing worlds applications are mostly focused on making ITs have a complex architecture that ties transportation, communication and computing worlds together into specific applications. Initially, these applications were mostly focused on making the ties of roads, reducing for instance traffic concession and accidents [4]. together into specific applications. Initially, these applications were mostly focused on making more efficient and safe the use of roads, reducing for instance traffic congestion and accidents [4].

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This objective is still central for ITSs, as evidenced by much research and many developments that have brought connected and automated vehicles closer than ever to being part of our everyday life. Sustainability 2019, 11, 1888; doi:10.3390/su11071888





Technology for a better society