Modus Scenarios for the Future of Multimodal Transport: Horizon 2040

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EUROPEAN PARTNERSHIP

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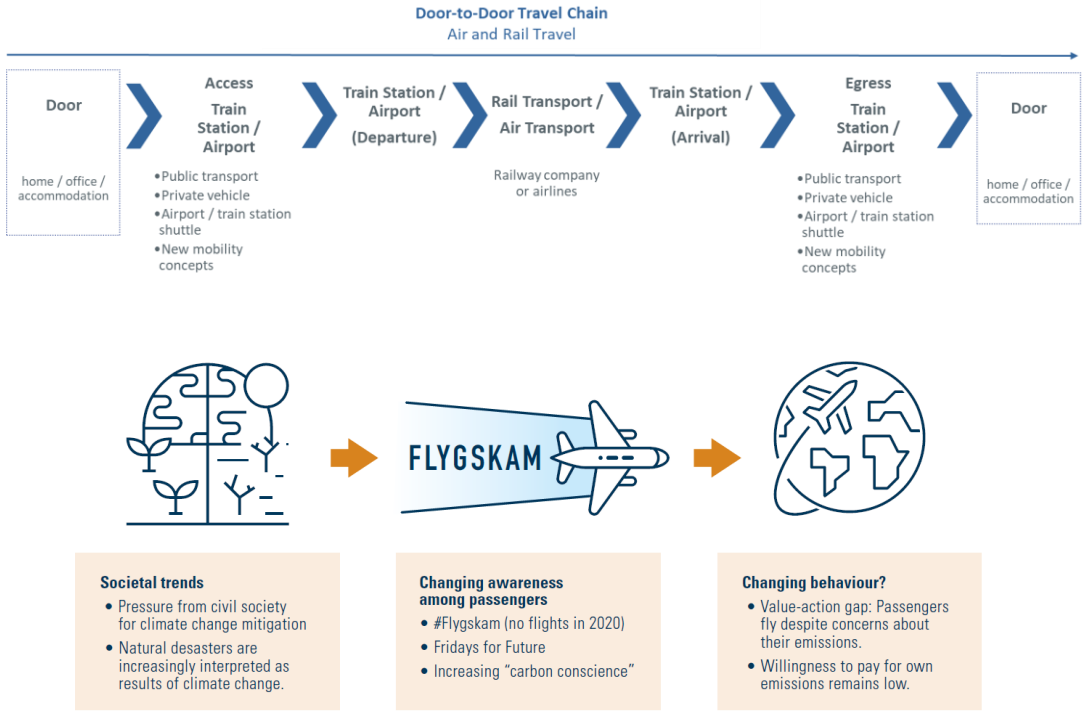
Moving Towards a Multimodal European Transport System

What could future multimodal air- rail mobility look like?

- Multiple challenges ahead!
  - Enabling a **seamless passenger journey**, including multiple providers and information
  - Meeting **environmental goals** and facilitating a sustainable transport system
  - Identifying and developing **new business models** that enable multimodal transport
  - Tackling the long-term **implications resulting from COVID-19**
  - Rethinking the use of current **infrastructure** and future challenges



Source: Adapted from Schmalz et al. (2021)
& Bauhaus Luftfahrt Yearbook (2019)

Modus EU project

An Exploratory Research project in SESAR ER4: 2020-2022, led by Bauhaus Luftfahrt

Modus Objective

The high-level objective of Modus is to analyse how the **performance of the overall transport system** can be improved by considering the entire **door-to-door journey** holistically and considering **air transport within an integrated, intermodal approach.**

Motivation: the overall performance of the (future) European transport system will strongly depend on the alignment and improvement of multimodal transport

Constraints:

Transport's greenhouse gas emissions to reduce by 90% by 2050

- European Smart and Sustainable Mobility Strategy (European Commission, 2020)
- European Green Deal

Modus Approach

Understand
Multimodal door-to-door mobility

Explore and model
Multimodal performance assessment

Identify
Way forward

- Drivers for supply and demand
- European transport objectives and goals

(1) Modal choice analysis
(2) Modus scenarios and use cases
(3) Traveller archetypes

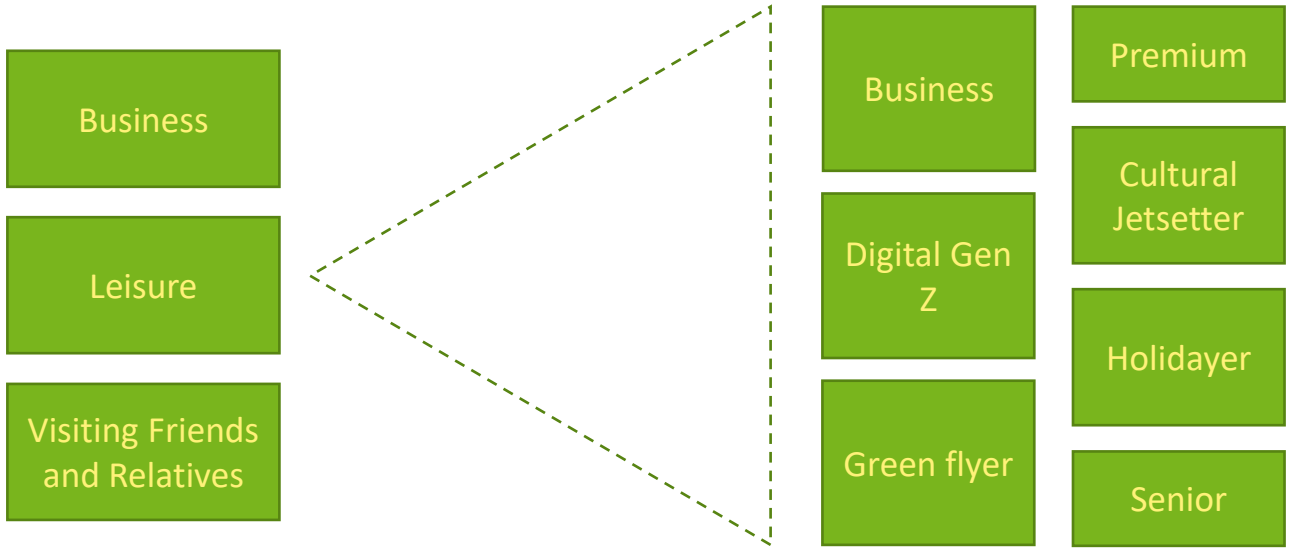
(1) Connectivity and performance indicators
(2) Passenger mobility and flight-centric modelling

(1) Identification of gaps and barriers
(2) Recommendations

Multimodal Door-to-Door Mobility

Drivers for future supply and demand

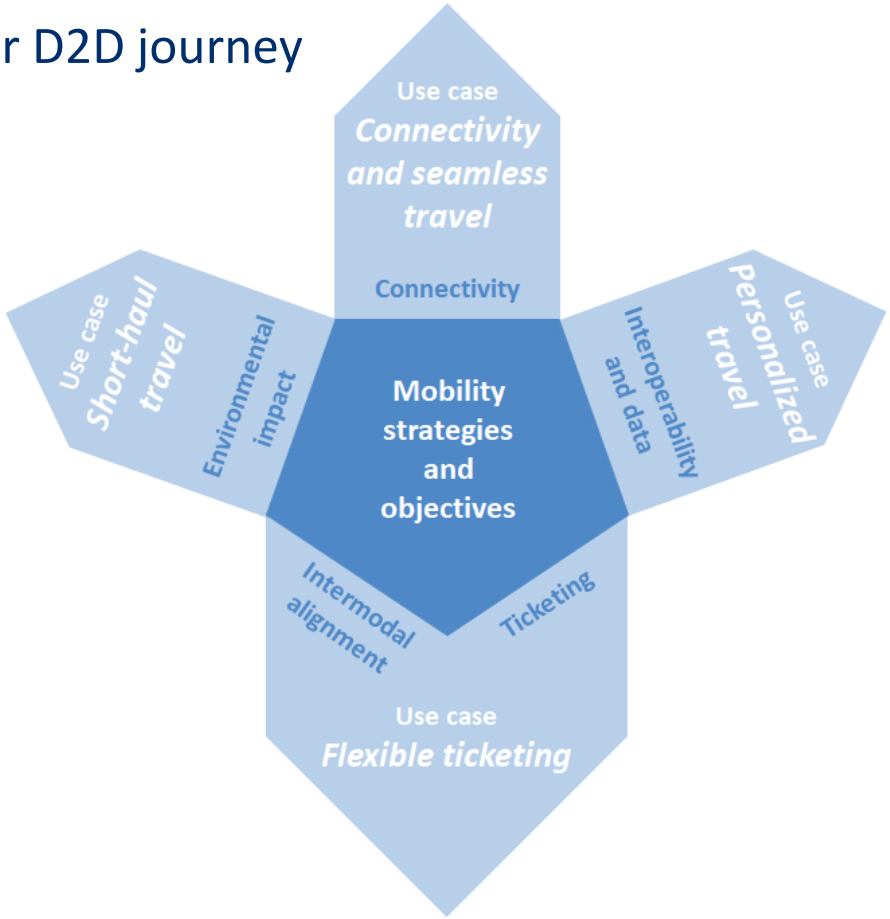
- Diverse traveller perspective: Modus developed seven passenger archetypes with differentiated approach towards trip purpose, price elasticities, value of time or environmental awareness.



Multimodal Door-to-Door Mobility

Use cases

- Use cases to reflect key different aspects of passenger D2D journey
- What do travellers want?
  - Seamless travel / D2D offers
  - Coordinated mobility
  - Guarantees / protection
  - Perception of comfort and security
  - Informed decision-making
  - End-user-centric systems
  - Affordability (depending on travel purpose)
  - Reliability
  - Sustainability (future driver on travellers)
  - Accessibility (physical and non-physical / inclusion)



Multimodal Door-to-Door Mobility

Future Scenarios

- Development of **future multimodal scenarios for European joint air-rail transport**
- Derived from **European high-level mobility objectives**, existing scenario studies as well as the work conducted within the Modus project
- Focus on particular aspects envisaged for the future, and that have the potential to significantly change the transport system
- Not mutually exclusive: different regions may develop features of several scenarios
- Four multimodal scenarios with a time horizon 2040+

European high-level mobility objectives (extract)

Mobility goals	Definition
Connectivity	Reduction of travel time; Connection of remote regions
Environmental impact	Reduced reliance on fossil fuel; Reduction of CO_2 emissions; Internalisation external costs
Integration and additional demand	Meeting increasing transport demand by adjusting and extending capacities; More efficient resource allocation within transport network
Technological innovation and (widespread) implementation	Develop more fuel-efficient, hydrogen-powered and (hybrid-)electric aircraft and bring these into operation through continued fleet renewal; Ensure that low and zero emission technology options are deployed, including through retrofitting and appropriate renewal schemes in all transport modes

Source: Modus Deliverable D3.2 (2021)

DEVELOPMENT OF THE EUROPEAN AIR AND RAIL TRANSPORT MARKETS

Intra-EU-27 market share 2019 - all distances (**EC 2021**) :

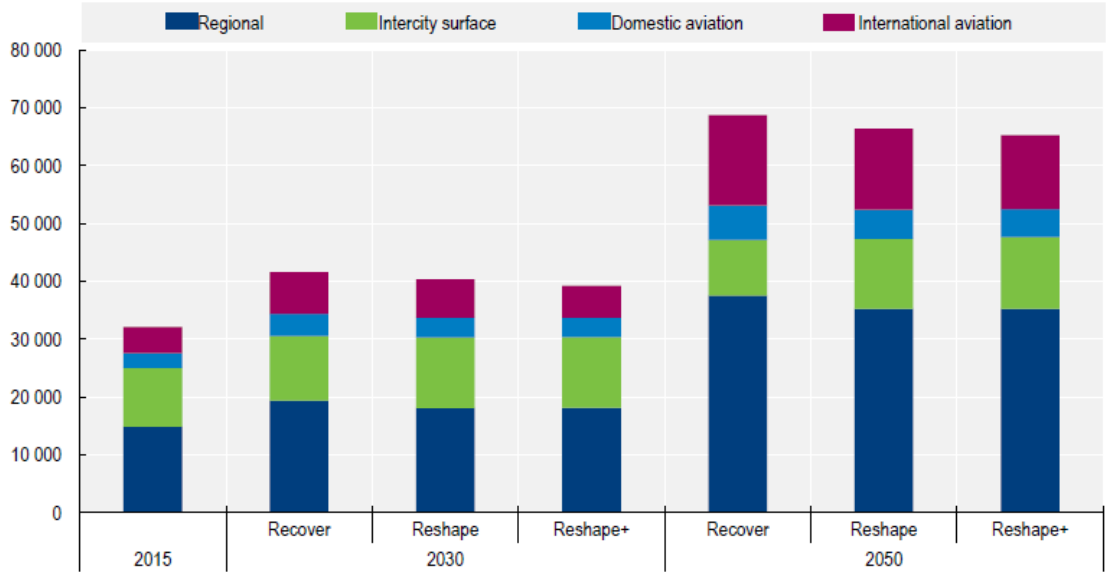
- **Rail : 7%**
- **Air : 9.7%**

Overall traffic increase between 1995 and 2019:

- **Rail : 34.8%,** 421.4 billion passenger km (pkm)
- **Air :145.7%,** 582.9 billion pkm

Figure 4.2. Demand for non-urban passenger transport by sub-sector to 2050

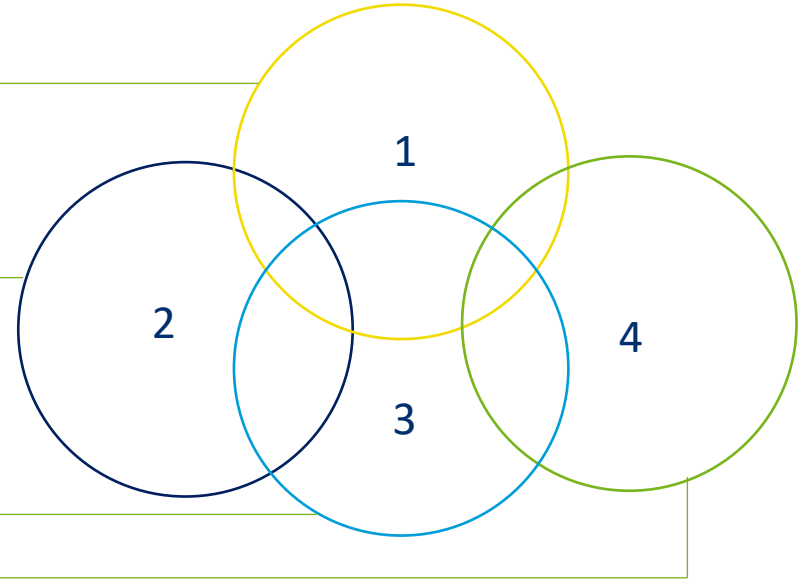
Under three scenarios, billion passenger-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Regional refers to daily local transport activity that happens outside of urban areas (peri-urban, rural); intercity surface refers to transport movements by private road vehicles (two- and three-wheelers, cars), buses, and rail between urban areas.

FUTURE SUPPLY AND DEMAND SCENARIOS

- Derived from **European high-level mobility objectives**, existing scenario studies as well as the work conducted within the Modus project
- Focus on particular aspects envisaged for the future, and that have the potential to significantly change the transport system
- Time horizon: **2040**
- Four scenarios
    1. Pre-pandemic recovery (baseline)
    2. European short-haul shift
    3. Growth with strong technological support
    4. Decentralised, remote and digital



SCENARIO 1: PRE-PANDEMIC RECOVERY (BASELINE)

- The European transport market recovers to pre-crisis levels; air transport and railway network structure remain similar to today's.

- The implementation of innovative technologies, (e.g SAF Sustainable Aviation Fuel), as well as market-based measures facilitate the **reduction of emissions** in each transport sector.

This scenario serves as the **baseline** for the comparison with different future development paths.

SCENARIO 2: EUROPEAN SHORT-HAUL SHIFT

A high share of short-haul air traffic is replaced by a cooperation between rail and air, which leads to a reduction in overall air traffic on short-haul routes in Europe:

- a high-quality transport network with high-speed rail services on short-haul distances is established, and with clean aviation services improving the coverage of long-haul routes.
- by 2030, **high-speed rail traffic will double** (this mainly concerns major links inter- and extra-EU), and that scheduled collective travel of **under 500 kilometres should be carbon neutral** within the EU. The relevance of rail increases significantly in the segment between 200 to 1500 kilometres.
- increased level of **cooperation** between air and rail to provide both door-to-door solutions as well as efficient connectivity of European regions.

SCENARIO 3:
GROWTH WITH STRONG TECHNOLOGICAL SUPPORT

- Significantly higher **growth** rates of the transport sector until 2040 than in the baseline scenario. (ref Boeing market forecast for 2020-2039)

- uptake of **technological innovations** in the air transport sector to both reduce emissions and alleviate capacity shortages, exceeding levels envisaged by Destination2050, Flightpath2050, EU Smart and Sustainable Mobility Strategy, for example.

SCENARIO 4: DECENTRALISED, REMOTE AND DIGITAL MOBILITY

The trend in **urbanisation** (UN World Urbanization Prospects) is not as anticipated in Europe: the population becomes more dispersed across **rural and remote regions** becoming much more attractive due to increased options for **remote working and virtual meetings**.

In line with the EU Smart and Sustainable Mobility Strategy, remote and rural regions will be better connected to the European transport network:

- significantly increased role of **small and regional airports**,
- **additional railway stations** in the network
- a more decentralised (air) transport network structure.
- widespread implementation of technological innovations for **regional aircraft**.

SOCIO-ECONOMIC SCENARIO PARAMETERS

Scenario parameter	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Socio-economic category				
NUTS2 population	Aging and increasing | UN medium fertility variant			
NUTS2 GDP of departing and arriving airports/stations / NUTS2 average households' income	Current status	Moderate increase (++)	Strong increase (+++)	Moderate increase (++)
Environmental and political development category				
Environmental regulations	Low increase (+)	Strong increase (+++)	Strong increase (+++)	Moderate increase (++)
Mobility network category				
Air traffic demand (passengers per city pairs)	Current status	Decrease in growth in the short-haul market (-)	Strong growth (+++)	Moderate growth (++)
Rail traffic demand (average number of passengers)	Current status	Strong growth (+++)	Strong growth (+++)	Moderate growth (++)
Assumed air space improvement	Current status	Weak improvement (+)	Strong improvement (+++)	Moderate improvement (++)
Assumed rail network improvement	Low level of improvement (+)	High level of improvement (+++)	Moderate level of improvement (++)	High level of improvement (+++)
City archetypes	Continuation of status quo structure (recovered to pre-pandemic)	Stronger focus on existing hubs and large airports (long-haul traffic focus) and feeder rail connections	Uniform growth across air and rail networks, with little or no differentiation between route or node types	Decentralised air transport network
Number of busy airports (airport traffic)	Current status	Current status	Increase	Increase in small and regional airports
Number of HSR lines	Small increase (++)	Strong increase (+++)	Strong increase (+++)	Moderate increase (++)
Airport catchment area effects	Small increase in airport catchment areas (+)	Increase in airport catchment areas (++)	Increased airport catchment areas (++)	Airport catchment areas increase (++)

SUPPLY AND TECHNOLOGICAL DEVELOPMENT SCENARIO PARAMETERS

Scenario parameter	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Rail transport frequency	Low increase (+)	Strong increase (+++)	Strong increase (+++)	Moderate increase (++)
Air transport frequency	Low increase (+)	Decrease in short-haul frequencies (-)	Strong increase (+++)	Moderate increase (++)
Rail supplied capacity (maximum number of carried passengers)	Low increase (+)	Strong increase (+++)	Strong increase (+++)	Moderate increase (++)
Air supplied capacity (maximum number of carried passengers)	Low increase (+)	Decrease in short-haul traffic (-)	Strong increase (+++)	Moderate increase (++)
Type of train used	More HSR trains are employed, focus on specific high-demand routes (+)	The use of HSR services and trains increases significantly (+++)	The use of HSR services and trains increases significantly (+++)	More HSR trains are employed (++)
Travel time (air or rail segment)	Current status	Reduced travel times in both the air and rail sector	Current status	Reduced travel time in the air transport sector
Share of train leaving (or arriving) on time	Current status	Strong increase (+++)	Moderate increase (++)	Moderate increase (++)
Share of aircraft leaving (or arriving) on time	Current status	Increase (+)	Decrease (-)	Moderate increase (++)
Monthly price index for rail transport	Current status	Weak increase (+)	Moderate increase (++)	Moderate increase (++)
Monthly price index for air transport	Current status	Strong increase (+++)	Moderate increase (++)	Moderate increase (++)
Level of air-rail integration and cooperation	Low degree	High degree	Medium/low degree	High degree
Implementation degree of new aviation technologies	Current status	Moderate degree (++)	High degree (+++)	Moderate degree (++)
Implementation degree of new rail technologies	Current status	High degree (+++)	Moderate degree (++)	Moderate degree (++)

FUTURE SUPPLY AND DEMAND SCENARIOS - SUMMARY

Scenario 1: Pre-pandemic recovery

- Network structures remain similar to todays
- Implementation of innovative technologies facilitates the reduction of emissions in air transport

Scenario 2: European short-haul shift

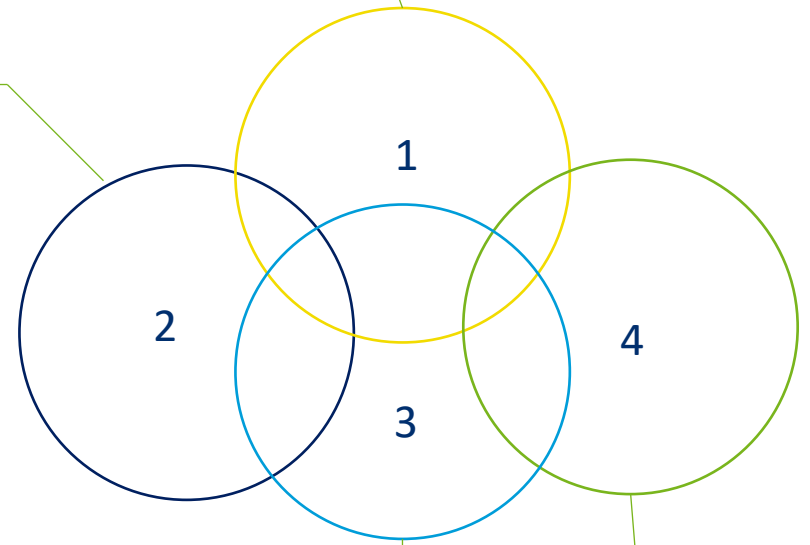
- High share of short-haul air traffic replaced by air-rail cooperation
- High quality of transport network with HSR services on short-haul distances

Scenario 3: Growth with strong technological support

- Higher growth rates of the transport sector until 2040 than the baseline
- uptake of technological innovations to both reduce emissions and alleviate capacity shortages in air transport

Scenario 4: Decentralised, remote and digital mobility

- Population becomes more dispersed across rural and remote regions with increased options for remote working and virtual meetings
- More decentralised air transport network, additional railway stations
- Technological innovations for regional aircraft

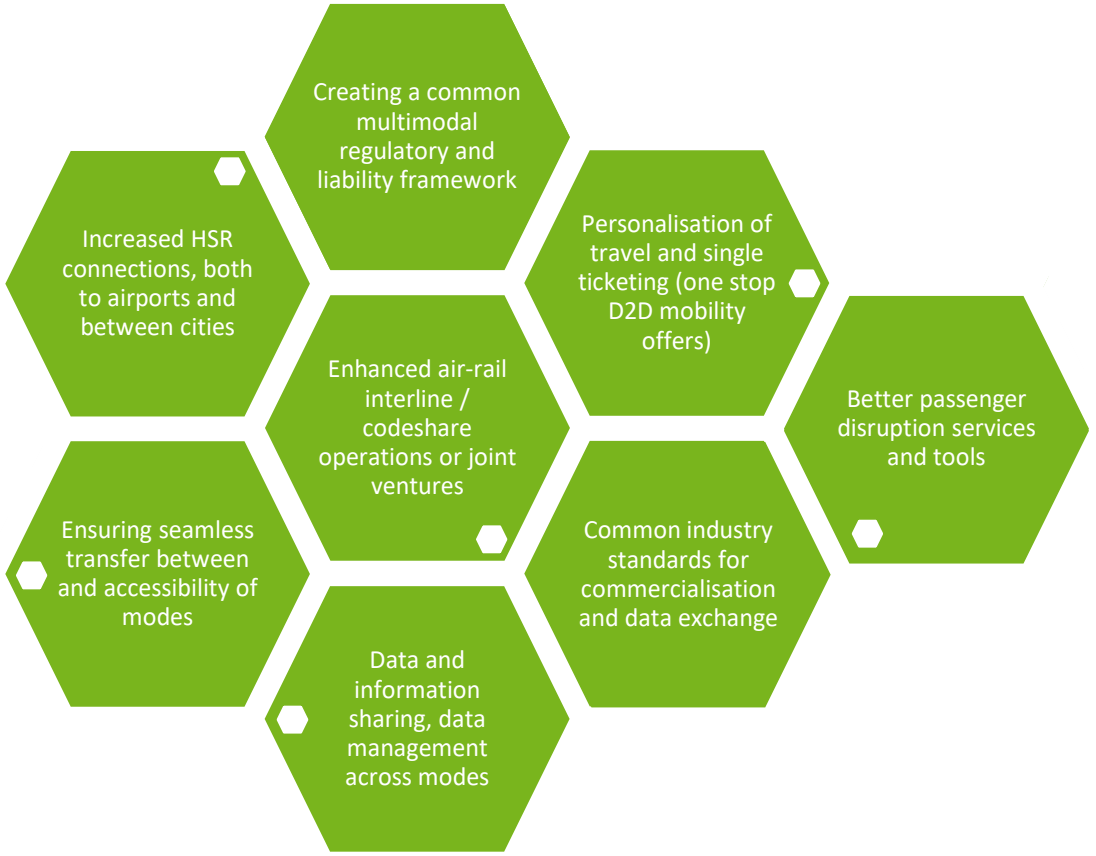


- Development scenarios are not mutually exclusive: different regions may develop features of several scenarios
- Many urgent challenges when improving multimodal cooperation or substitution in the European transport system:
  - **Emissions reduction potential**, in light of a full lifecycle cost and environmental impact assessment:
    - 1 to 2% of total EU aviation CO_2 emissions for banning all flights up to 500 kilometers
    - eligible routes on which rail is a feasible alternative
    - network effects regarding airline feeder flights to hub airports
    - flights via hub airports outside of Europe may benefit, leading to carbon leakage
    - impact on door-to-door travel times
  - **Technological advancement**s in both the rail and the aviation sectors will arise, although not all reflected in the Modus model:
    - electric, hybrid and zero-emissions aircraft, in particular with regional aviation likely quicker to become neutral (Scenario 4)
    - reduction in energy consumption, efficiency improvements in rail sector, with additional electrification or low-carbon propulsion
    - Harmonized train ticket sales (**OSDM2**), Europe-wide integrated rail timetables (**MERITS3**)

Multimodal Performance Assessment

Gaps and barriers

- Modus qualitative assessment highlights that beyond infrastructure and energy developments, strengthening multimodality in Europe means:
  - Ensuring connectivity of regions,
  - A holistic assessment of investment in modal alternatives,
  - Enabling cross-border and cross-mode tickets,
  - Implementing a common regulatory framework that addresses passenger rights, data sharing, or the concept of single ticketing.



- Modus quantitative results will be published in fall 2022.

Developing and assessing scenarios for potential development paths is a valuable tool for strategic decision- and policymaking.

THANK YOU FOR YOUR ATTENTION

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