MOBILITY 4 EU

OPPORTUNITY MAP FOR THE FUTURE OF MOBILITY IN EUROPE 2030

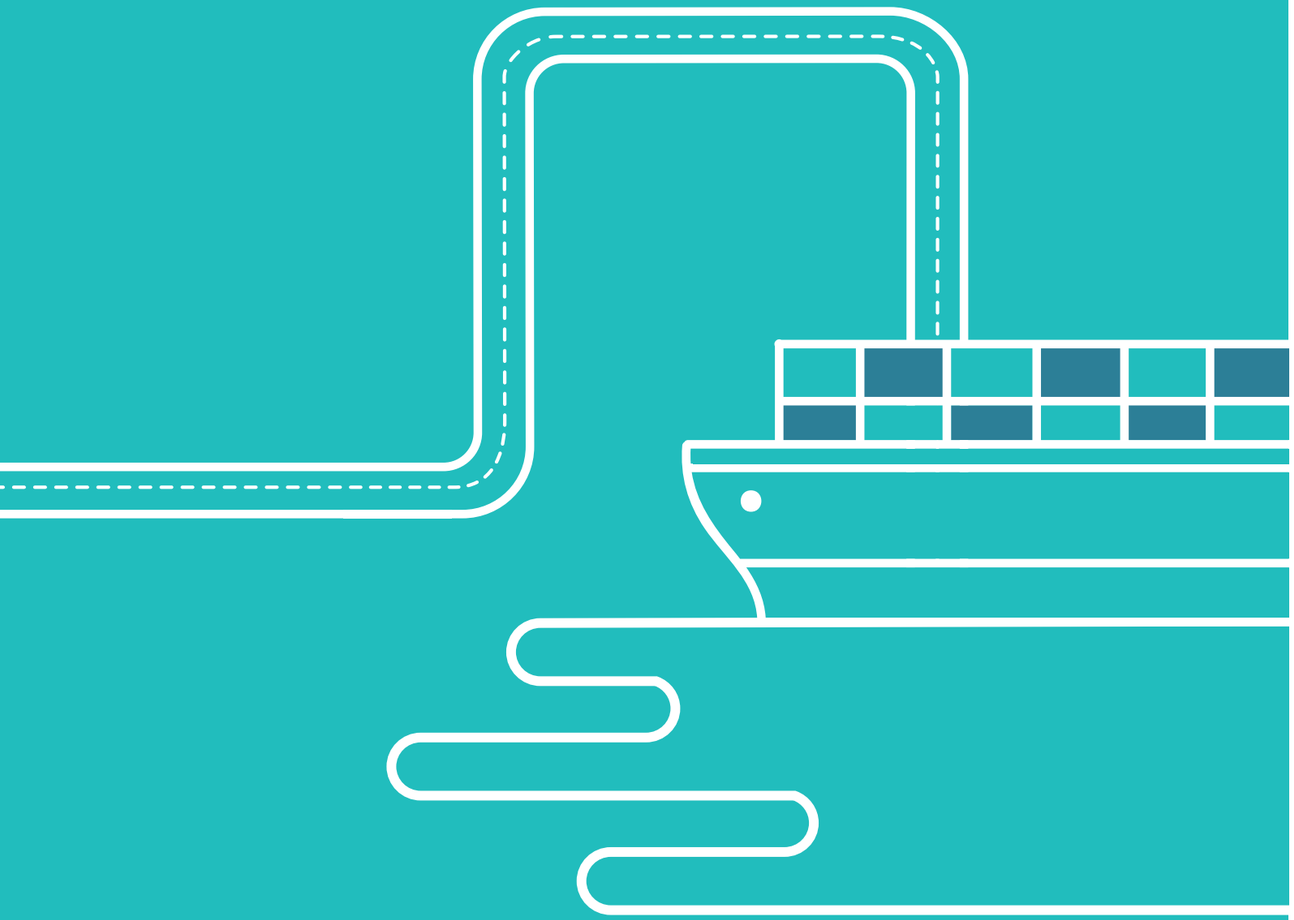
ACTION PLAN FOR THE FUTURE OF MOBILITY IN EUROPE
EU COORDINATION AND SUPPORT ACTION H2020
JANUARY 2016 - DECEMBER 2018

In this brochure:

DEFINITION OF USER NEEDS / INNOVATIVE SOLUTIONS FOR DIFFERENT MODES OF TRANSPORT AND USES / **CROSS-MODAL APPROACHES** / LINKS TO ENRICHED CONTENT

OPPORTUNITY MAP

TABLE OF CONTENTS



PROJECT

INTRODUCTION

MOBILITY4EU IS WORKING ON DELIVERING A VISION FOR THE EUROPEAN TRANSPORT SYSTEM IN 2030 AND AN ACTION PLAN, INCLUDING A ROADMAP, TO IMPLEMENT THAT VISION. THIS WORK IS BEING CARRIED OUT WITHIN A STRUCTURED PARTICIPATIVE APPROACH FOR STAKEHOLDER CONSULTATION AND A SERIES OF INTERACTIVE WORKSHOPS EMPLOYING VISUALIZATION TECHNIQUES.

TRENDS AND AND USER NEEDS

The ongoing work towards that **vision and action plan** is based on the identification and assessment of societal challenges, requirements and needs that will influence future transport demand and supply. This led to the definition of **9 trends** shaping the future European transport system.

These trends have been described in a **comprehensive report** and set into context to the transport system in 2030 within a **context map interactively generated** with stakeholders from all fields in transport and mobility.

The **research on trends** and their impact on mobility, the **structured participative discussions** with **stakeholders on needs** for European transport in 2030 and the investigation of **stakeholder objectives** by using a stepwise and scientifically sound approach (Multi-Actor Multi-Criteria Analysis - **MAMCA**) led to the definition of **15 user needs** setting the requirements on mobility and transport in Europe in 2030.

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for Context Map *for Report on trends* *for MAMCA*

PORTFOLIO OF SOLUTIONS

Together with European experts from all fields in transport of passengers and freight, a portfolio of **93 promising and innovative transport solutions** across all modes answering the identified user needs has been composed. These include solutions in concept or research state but also recently implemented ones that need to be supported for advancing technologies or products and for wider deployment.

OPPORTUNITY MAP

The opportunity map gives a comprehensive view on the portfolio of solutions across all modes. It visualizes the connections between solutions and user needs in 1 matrix for each transport mode (air, waterborne, road, rail) and 2 for the multimodal fields (urban and freight transport). Finally, one matrix on “all modes” shows solutions that relate to all of the four transport modes. The last visualization of the opportunity map analyzes user needs which could be met through collaboration across modes.

FORMULATION OF

USER NEEDS

THE USER NEEDS ARE IMPLICIT OR EXPLICIT AIMS AND NEEDS OF FUTURE PASSENGERS, TRANSPORT OPERATORS, SERVICE PROVIDERS OR GOVERNMENTAL INSTITUTIONS. THEY ARE DIRECTLY RELATED TO THE SOCIETAL, POLITICAL AND ECONOMIC TRENDS SHAPING THE FUTURE TRANSPORT SYSTEM IN 2030. MOBILITY4EU HAS DRAWN A COMPREHENSIVE PICTURE OF USER NEEDS ACROSS ALL MODES OF TRANSPORT.

#1
EFFICIENT AND INTELLIGENTLY MANAGED TRANSPORT FLOWS AND CROSS-BORDER NETWORKS

This need helps to meet private or commercial timetables and to enable efficient freight and logistics and decrease non-productive time in all applications and for all users. This applies within modes but also cross-modal with special emphasis for modal interfaces, within member states and across inner-European borders as well as beyond Europe. Intelligent solutions are needed i.e. for managing complex traffic, logistics planning and efficiently addressing critical situations in real-time.

#2
MEANINGFUL SPENDING OF TRAVEL TIME

This need comprises e.g. the need of being chauffeured or the possibility to carry out activities normally done at home or at the office by using digital connected devices in the transport vehicle. Nevertheless, this demand also relates to enabling new uses of travel time as e.g. physical activity, engaging in games, creating new social spaces during travel. This may ultimately not only apply to passengers but also to truck drivers, train operators etc. especially when roles change due to automation.

#3
REAL-TIME TRAVEL INFORMATION AND TRAVEL PLANNING SERVICES INCLUDING CROSSBORDER & AFFORDABLE DATA CONNECTIVITY

This need serves an accelerated society, enables denser time schedules, shorter connection times etc. These services are in demand for passenger as well as for freight transport. This applies especially to the interfaces between modes and to inter-city or inter-regional travel as well as travel between member states and internationally. Affordable data connectivity during travel is required to stay informed without limitations.

#4
EASY-TO-USE, COMFORTABLE AND FLEXIBLE TRAVEL

This specification is required from all passengers including vulnerable to exclusion citizens and across modes. Services as e.g. renting and ticketing etc., multimodal interfaces and hubs should be easily understandable and useable without comprehensive tutoring/instructions.Comfortable refers to the need of convenient interior within the transport mode used, i.e. accessibility, enough private, flexibly usable space. Flexible travel planning and modal choice is especially important to enable spontaneous travel and serve new trends in travel profiles as e.g sharing vs. owning a car.

#5
INTER-OPERABILITY AND RELIABILITY OF MOBILITY SOLUTIONS & ENHANCED SEAMLESS END-TO-END-JOURNEYS

These specifications will provide individually adaptable intermodal transport with less transfers and good last mile services. Interoperability and reliability of transport vehicles and infrastructure in all modes and between modes is key to provide better transport services for transport of people and goods. Confidence of passengers but also shippers in on-time and efficient transport of people and goods needs to be enabled. Seamless journeys of people and goods require the fine tuning of connections as well as services provided before and during the journey, reliable and well-functioning intermodal hubs. Passengers experience a difference of absolute and relative time depending on factors such as the amount of waiting time between connections, the hurdle to find the connective transport solution or the movement of and storage of luggage.

#6
EFFECTIVE AND SEAMLESS MEASURES TO IDENTIFY AND PREVENT THREATS

This need is a demand of both, end users and governmental stakeholders. While security at hubs should be increased the measures taken should be seamless and non-embarrassing. Seamless refers to the need of non-intrusive security checks, especially for travelers with heavy luggage, larger groups of travelers, people with special needs or disabilities, etc. Also for freight transport this demand needs to be answered increasing security while avoiding delays, bottlenecks and selecting the most cost effective security measures.

#7
STATUTORY INCLUSIVENESS, ACCESSIBILITY AND AFFORDABILITY OF MOBILITY OFFERS ESPECIALLY TARGETING VULNERABLE AND EXCLUDED GROUPS

This need will enable the usage of transport means and services by all users without the need for adaptation or specialized design. Inclusive design should be prioritised above the creation of specialist services for different groups of the population. Affordability of offers for all citizens is a further important requirement.

#8
DATA SECURITY, PRIVACY AND TRANSPARENCY OF THE USE OF DATA

This is a demand of all types of users although interests may vary regarding the type of data that shall be protected or exploited for service providers, cities, end users and others. This demand applies to existing and novel data based services, to data collected by sensors while traveling (cameras etc), data related to shipped goods, data collected and shared in relation to security measures and more. Besides securing data and guaranteeing privacy, the transparency of which data is used and for what purpose needs to be provided.

#9
REDUCING THE IMPACT OF TRANSPORT ON CLIMATE, ENVIRONMENT AND HEALTH

This need demands to fulfill EU-objectives for GHG emissions, to use all possibilities for higher efficiencies of energy and resources in the transport of goods and passenger system, to reduce noise and noxious emissions, to minimize the impact on animals and environment in general. This demand is shared as well by citizens that are more and more conscious of these issues and also by political stakeholders that intend to follow up these issues through policies and regulations.

#10
SUPPORT FOR LOCAL SOLUTIONS THROUGH TRANSPARENT, DEMOCRATIC, PARTICIPATIVE PLANNING

This requirement is demanded by citizens, political and economic stakeholders in order to find suitable local solutions that serve the specified local needs. Citizens know the issues within their city by experiencing transport problems every day. If transport providers implement new solutions, lack of consulting the end- users can lead to low utilization and unfavorable return of investment. Citizens more and more wish to participate in co-creating solutions. New methods of participation often enabled by technological solutions let citizens be part of a transparent and democratic passenger and goods transport planning process.

#11
RESILIENT URBAN DESIGN SUPPORTING ACTIVE MODES AND REDUCING TRAVEL DEMAND

This need takes into account the travel and transport that will is needed or will be created through urban design into every design process. Urban settlement should be created to save trips needed to do daily errands. Furthermore, urban design considers space for people and aims for public spaces and urban design that not only supports walking and cycling but motivates active modes.

#12
HIGHER SAFETY IN FREIGHT AND PASSENGER TRANSPORT IN ALL MODES

This requirement is continuously asked for by all types of users and can be considered as one of the top priorities. Safety systems have to be affordable for all users of individual and public transport of people and goods ranging from cities to operators and service providers in passenger and freight transport, end-users and so on. Safety systems and measures need to be designed for special accessibility needs.

#13
ECONOMIC EMPOWERMENT OF NEW PLAYERS AND INNOVATION SYSTEMS

This need has to use the potential of the rising start-up and spin-off scene, shaping the more and more digital-based and service-oriented transport system. New players need to be provided with a vibrant innovation system, also helping small firms to break through. This concerns economic support as well as the promotion of solutions that provide space for novel ideas and new players.

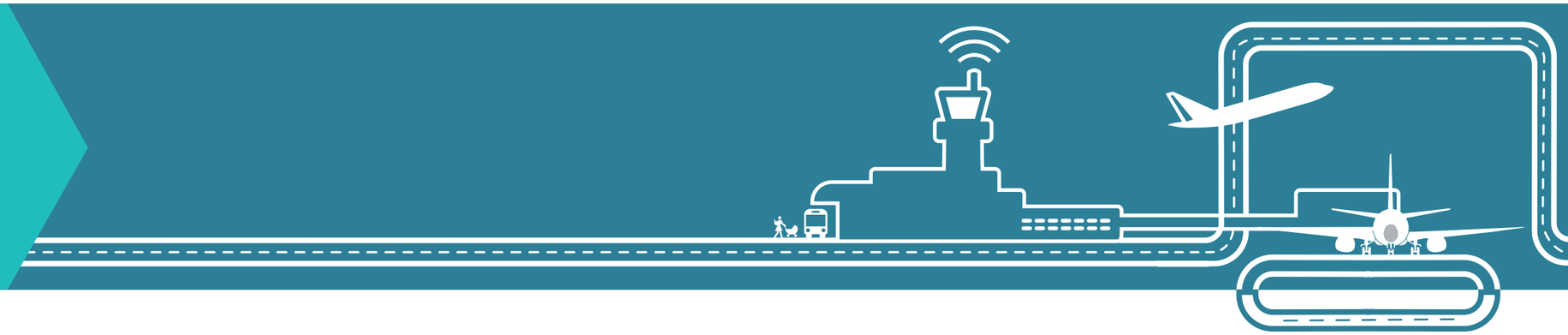
#14
(COST-) EFFICIENT MAINTENANCE AND UPGRADING OF RESILIENT INFRASTRUCTURES

This need is required to gain a positive return on investments. Transport and infrastructure providers require a resilient infrastructure that is long lasting but can be updated to new developments. Efficient maintenance is needed for flawless operation.

#15
PERSONALIZED MOBILITY OFFERS AND (SHARED) OWNERSHIP MODELS

This need is called to answer the demand for new forms of mobility that adapt to the individual needs and preferences of users. This requires business models and concepts for new services as well as technologies that enable personalization. A bigger trend in this domain is the sharing of cars and bikes vs. buying them which may in future develop beyond cars and bikes.

TRANSPORT MODE **AIR**



OVERVIEW

NOVEL AND INNOVATIVE SOLUTIONS FOR

AIR / 19 IDEAS

USER NEEDS

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
Efficient transport flows & networks	Enabling meaningful travel time	Real-time travel info & services	Easy-to-use and comfortable travel	Interoperable seamless journeys	Effective and seamless threat prevention	Inclusive, accessible, affordable	Data security/ privacy & transparency	Protecting climate, environment, and health	Democratic, participative planning	Resilient urban design	Safety	Empower new players & innovations	Efficient infrastructures maintenance	Personalized mobility offers & shared models
ADVANCED LOW-NOISE AIRCRAFT								■						
AIR TRAFFIC CONTROL /AIR TRAFFIC MANAGEMENT VIRTUALISATION	■			■			■							
ALL-ELECTRIC/HYBRID AIRCRAFT								■						
CENTRAL AIRPORT AND INNER-CITY AIR TRANSPORT CONCEPT					■					■				
MONITORING OF ENVIRONMENTAL FOOTPRINT								■						
FLIGHT CABINS AND ZONES ACCORDING TO INDIVIDUAL NEEDS						■								■
FULL AUTOMATION OF PASSENGER BAGGAGE PROCESSES				■		■								
FLYING COMMUNICATION NETWORKS	■	■	■								■			■
GLOBAL EMISSIONS TRADING & OFFSETTING MEASURES								■						
HEALTH MONITORING OF AIRCRAFT											■			
IMPROVED PERFORMANCE AND INTEGRATION WITH OTHER MODES	■		■		■									■
INTEGRATED SECURITY APPROACH	■	■	■		■	■					■			
MODERNIZED AIR TRAFFIC MANAGEMENT	■										■			
PERSONALISED TRANSPORTATION BEFORE, AFTER AND DURING AIR TRAVEL				■		■		■						■
RENEWABLE FUELS								■						
SEAMLESS SECURITY CHECKS AT AIRPORTS	■				■	■					■			
SMALL ON-DEMAND AIRCRAFT				■	■							■		■
VIRTUAL REALITY IN-FLIGHT ENTERTAINMENT		■	■											
IN-FLIGHT COMMUNICATION FOR PASSENGERS		■	■											

MOBILITY SOLUTIONS

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pages 5-6

TRANSPORT MODE **RAIL**

OVERVIEW

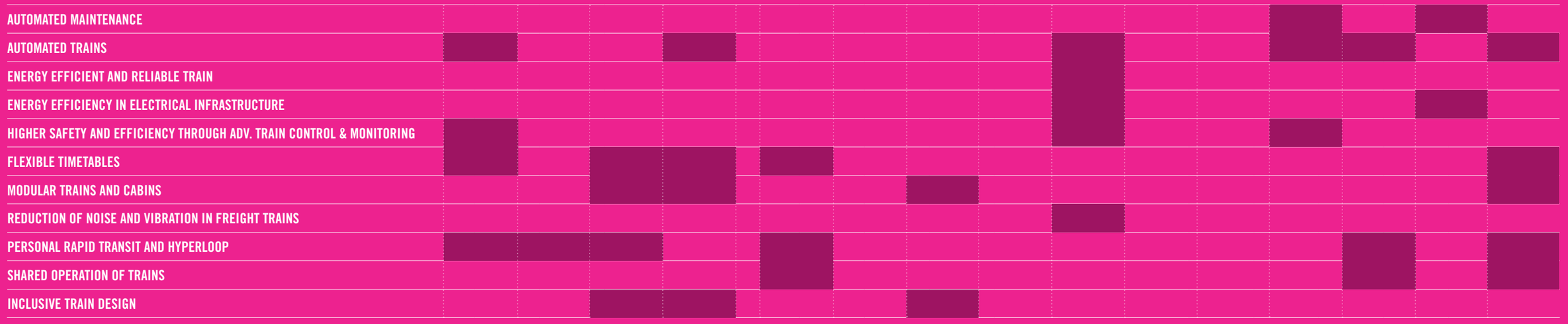
NOVEL AND INNOVATIVE SOLUTIONS FOR

RAIL / 11 IDEAS

USER NEEDS

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
Efficient transport flows & networks	Enabling meaningful travel time	Real-time travel info & services	Easy-to-use and comfortable travel	Interoperable seamless journeys	Effective and seamless threat prevention	Inclusive, accessible, affordable	Data security/ privacy & transparency	Protecting climate, environment, and health	Democratic, participative planning	Resilient urban design	Safety	Empower new players & innovations	Efficient infrastructures maintenance	Personalized mobility offers & shared models

MOBILITY SOLUTIONS



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pages 7-8

TRANSPORT MODE **WATERBORNE**

OVERVIEW

NOVEL AND INNOVATIVE SOLUTIONS FOR

WATERBORNE / 15 IDEAS

USER NEEDS

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
Efficient transport flows & networks	Enabling meaningful travel time	Real-time travel info & services	Easy-to-use and comfortable travel	Interoperable seamless journeys	Effective and seamless threat prevention	Inclusive, accessible, affordable	Data security/ privacy & transparency	Protecting climate, environment, and health	Democratic, participative planning	Resilient urban design	Safety	Empower new players & innovations	Efficient infrastructures maintenance	Personalized mobility offers & shared models

MOBILITY SOLUTIONS

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
ADAPTABLE MODULAR VESSEL									■				■		
SHIP2SHIP AND SHIP2SHORE	■														
ALTERNATIVE FUELS									■						
AUTONOMOUS VESSELS	■											■	■		
BLUE MODAL SHIFT	■			■					■		■				
RESILIENCE MANAGEMENT						■						■			
DRONES FOR SHIP SUPPLY AND LOADING	■								■						
ENERGY EFFICIENT AND LOW EMISSION SHIP									■						
FLOATING DELIVERY HUBS	■				■										
HYBRID AND ELECTRIFIED FERRIES AND PORT VESSELS									■						
LOW VIBRATION/WAVES VESSELS									■						
MULTI-SKILLING AND COMPETENCE-BASED PORT LABOUR TRAINING SCHEMES	■					■			■			■			
SHORT-SEA-SHIPPING	■				■				■		■				
SMART CONNECTED VESSELS AND AUTOMATED PORTS	■	■	■		■				■			■		■	■
VESSELS EXPLOITING WIND AND SOLAR ENERGY									■						

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pages 9-10

TRANSPORT MODE **ROAD**

OVERVIEW

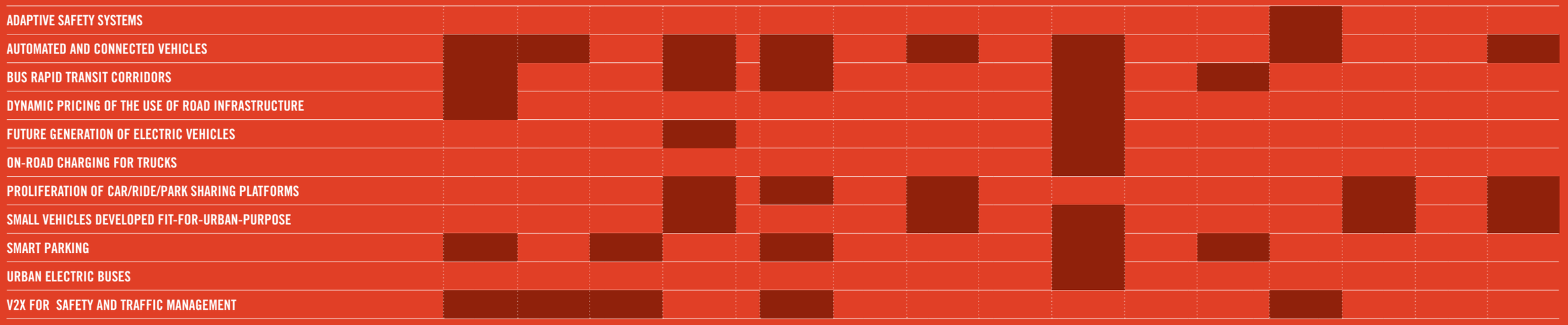
NOVEL AND INNOVATIVE SOLUTIONS FOR

ROAD / 11 IDEAS

USER NEEDS

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
Efficient transport flows & networks	Enabling meaningful travel time	Real-time travel info & services	Easy-to-use and comfortable travel	Interoperable seamless journeys	Effective and seamless threat prevention	Inclusive, accessible, affordable	Data security/ privacy & transparency	Protecting climate, environment, and health	Democratic, participative planning	Resilient urban design	Safety	Empower new players & innovations	Efficient infrastructures maintenance	Personalized mobility offers & shared models

MOBILITY SOLUTIONS



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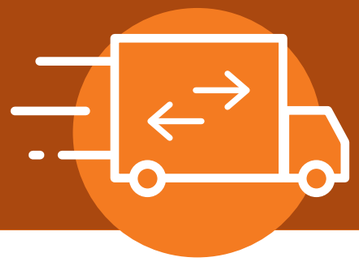
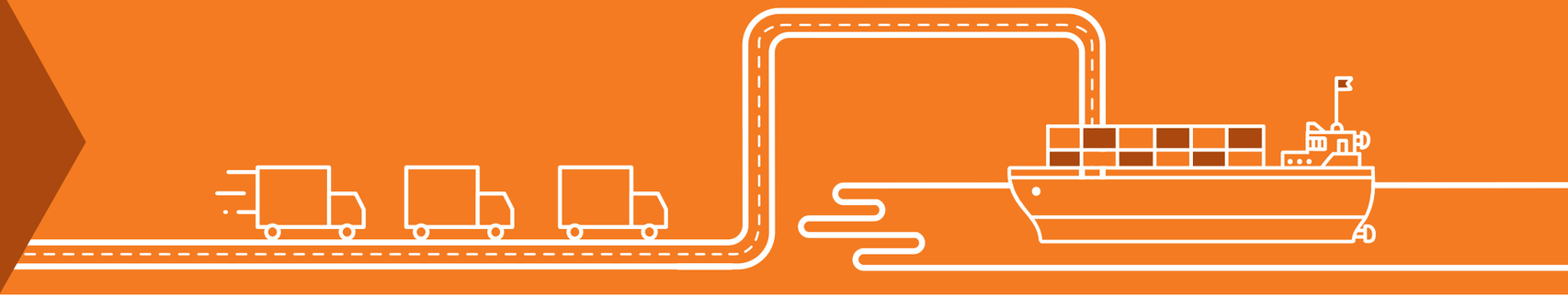
pages 11-12

FREIGHT





OVERVIEW

NOVEL AND INNOVATIVE SOLUTIONS FOR

FREIGHT / 13 IDEAS

USER NEEDS

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
Efficient transport flows & networks	Enabling meaningful travel time	Real-time travel info & services	Easy-to-use and comfortable travel	Interoperable seamless journeys	Effective and seamless threat prevention	Inclusive, accessible, affordable	Data security/ privacy & transparency	Protecting climate, environment, and health	Democratic, participative planning	Resilient urban design	Safety	Empower new players & innovations	Efficient infrastructures maintenance	Personalized mobility offers & shared models

MOBILITY SOLUTIONS

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
CONNECTING TRANSPORT OF PEOPLE AND GOODS	■			■					■				■		■
GHG-EMISSION CALCULATOR									■						
LEGAL HARMONIZATION WITHIN REGIONS	■								■						
LOGISTICS AS A SERVICE	■		■		■								■		■
NOVEL MULTI-MODAL, CLIENT-ORIENTED BUSINESS MODELS FOR RAIL FREIGHT	■												■		■
PLATOONING OF HEAVY DUTY VEHICLES	■								■			■			
URBAN FREIGHT CONSOLIDATION HUBS	■			■					■		■				
PHYSICAL INTERNET	■		■		■			■	■				■		
SHARED COURIER PLATFORMS	■			■									■		■
SUPPLY CHAIN VISIBILITY	■		■					■			■				
URBAN GOODS DELIVERY THROUGH DRONES	■														
URBAN CROSS-MODAL LOGISTICS	■		■	■	■										
URBAN PARKING MANAGEMENT FOR FREIGHT VEHICLES	■			■	■										

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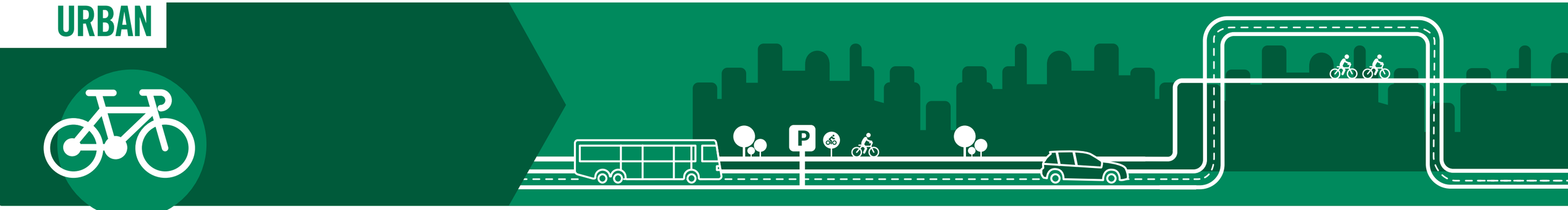
pages 13-14

URBAN



OVERVIEW

NOVEL AND INNOVATIVE SOLUTIONS FOR

URBAN / 12 IDEAS

USER NEEDS

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
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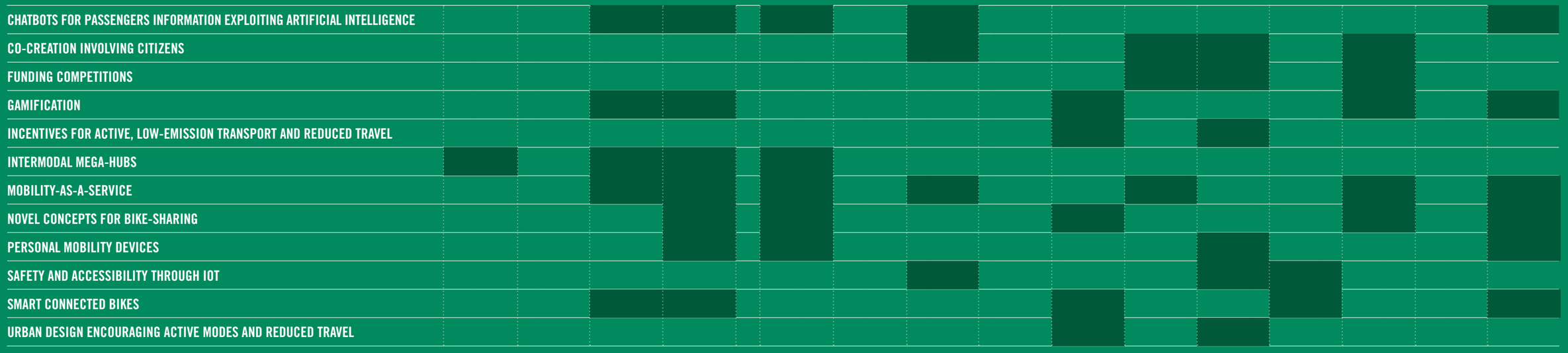
MOBILITY SOLUTIONS



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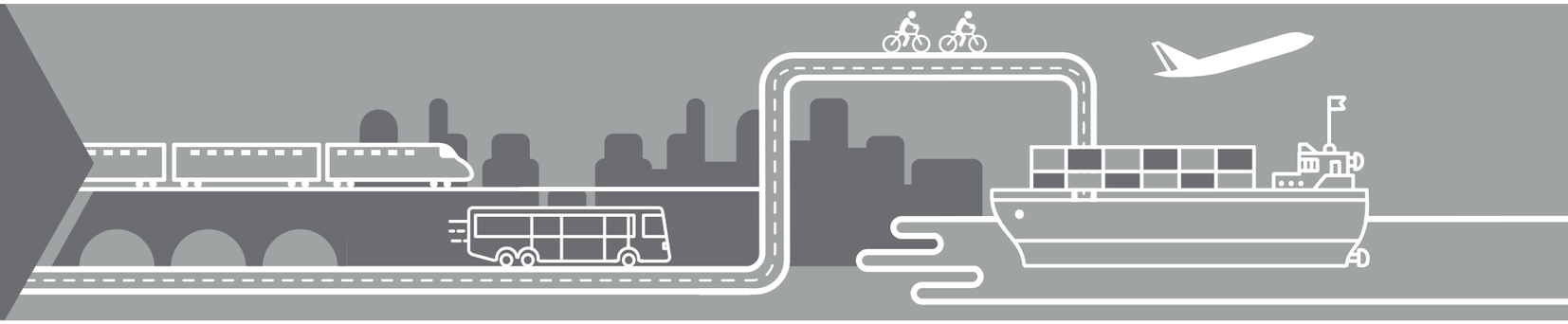
pages 15-16

ALL MODES



OVERVIEW

NOVEL AND INNOVATIVE SOLUTIONS FOR

ALL MODES / 12 IDEAS

USER NEEDS

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
Efficient transport flows & networks	Enabling meaningful travel time	Real-time travel info & services	Easy-to-use and comfortable travel	Interoperable seamless journeys	Effective and seamless threat prevention	Inclusive, accessible, affordable	Data security/ privacy & transparency	Protecting climate, environment, and health	Democratic, participative planning	Resilient urban design	Safety	Empower new players & innovations	Efficient infrastructures maintenance	Personalized mobility offers & shared models

MOBILITY SOLUTIONS

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
ADVANCED CYBER-SECURITY						■		■							
BLOCKCHAIN FOR PASSENGER AND FREIGHT TRANSPORT													■		
GAME CHANGERS IN MATERIALS									■			■			
INCENTIVIZING MODAL SHIFT TO PUBLIC TRANSPORT									■						
ADAS FOR OPERATORS/DRIVERS OF TRANSPORT VEHICLES												■			
SIMPLIFIED TESTING, CERTIFICATION & AUTHORIZATION OF NEW MOBILITY SOLUTIONS							■					■	■		
SMART TECHNOLOGIES FOR THREAT PREVENTION						■									
SMART TRAFFIC MANAGEMENT AND FORECASTING WITH BIG DATA	■		■		■							■			
STANDARDIZATION FOR INTEROPERABLE AND MULTIMODAL TRANSPORT	■		■	■	■	■	■					■	■		
THREAT PREVENTION AND EMERGENCY MEASURES						■						■			
UNIVERSAL DESIGN/DESIGN FOR ALL							■								■

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pages 17-18

ADVANCED LOW-NOISE AIRCRAFT

A low-noise aircraft technology can improve the environmental footprint with regard to noise emissions and, hence, reduce the noise burden especially for residents living in the vicinity of airports. The technology can also be implemented for inner city air transport operations since the city centres usually have high standards and regulations for noise emissions produced by transport vehicles in the city.

AIR TRAFFIC CONTROL/AIR TRAFFIC MANAGEMENT VIRTUALIZATION

ATC/ATM virtualization is dependent on number of elements, including system-wide information management principles of data exchange protocols and open service-oriented architecture. One solution is the remote tower replacing an actual tower with thermal-infrared-camera technologies, video-based monitoring and tracking functionality technologies that transfer the relevant data to a random place.

ALL-ELECTRIC/HYBRID AIRCRAFT

An all-electric aircraft operates with a novel fuel solution based on electricity. This enables a reduction of CO2 emissions up to a zero-CO2-emission operation of an aircraft, in the case of an CO2-emission-free electricity production. In the case of the Ce-Liner, the fuel solution will be loaded as batteries in ULD containers. This has an impact on the payload capacity of an aircraft as well as on the fuel infrastructure at an airport.

CENTRAL AIRPORT AND INNER-CITY AIR TRANSPORT CONCEPT

Airports located in the city center with a layout comparable to an aircraft carrier could have the runway on the upper level. The apron below the runway level could provide the public level that also provides connection points to other transport modes, e.g. trains, buses, cars and easy access to the city. This inner-city airport would accommodate regional aircrafts configured for short take-off and landing and for increased high-lift performance.

DETAILED MONITORING OF THE ENVIRONMENTAL FOOTPRINT OF AVIATION

Methodology for the collection of information on environmental performance that enables realistic consideration of CO2 emissions of a flight or an airline.

DIFFERENTIATION OF FLIGHT CABIN CLASSES AND ZONES ACCORDING TO INDIVIDUAL NEEDS

The idea is to replace economy, business and first class areas by zones meeting the individual needs of passengers, e.g. space for work-related activities like meetings or physical activities for leisure travelers. Disruptive technologies integrated in the cabin concept are: bionic structures, biopolymer membrane, composite materials, integrated neural network (smart materials, morphing materials, self-reliant materials, ecological materials, 3D printing (for production), holographic technology, energy harvesting.

FULL AUTOMATION OF PASSENGER BAGGAGE PROCESSES

Automation and thus higher efficiency may be reached through fully autonomous, self-propelling baggage robots able to conduct check-in, bag tag printing and bag transport capabilities independently. Other options are baggage tracking technologies and re-designing various self-service options at airports.

FLYING COMMUNICATION NETWORKS

Key drivers of airborne communication networks are the air passenger demand for mobile communication as well as new challenges for air traffic related services due to increasing demand for air transport, airline communications and the increase of unmanned aircraft systems. One potential technology solution is the optical connection between aircrafts. Data exchange between aircrafts is realized through high-rate directive links based on photonic technology as well as low interference potential with other radio frequency applications.

GLOBAL EMISSIONS TRADING & OFFSETTING MEASURES

Market-based measures shall support meeting the target of carbon neutral growth from 2020 on. They establish a global market-based measures scheme across all participating aviation nations. Three different types of market-based measures in the context of aviation exist: Emissions trading, Offsetting and Levies (taxes/charges).

HEALTH MONITORING OF CONDITION OF AIRCRAFT

Health monitoring in aviation contains technologies and systems to identify actual damage events in the aircraft system in real-time, whereby fleet operations can be improved and maintenance cost can be reduced. Real-time data is collected and provided to ground operations, at the same time ground staff can process this data and derive decisions based on it.

IMPROVED PERFORMANCE AND INTEGRATION WITH OTHER MODES: 4-HOUR DOOR-TO-DOOR JOURNEYS BY AIRPLANE

Multimodal traffic solutions and the enhancement of efficiency in traveling Multimodal traffic solutions and the enhancement of efficiency in traveling shall enable to provide all intra-European journeys within 4 hours from door to door. This entails especially the management of traffic and travels to, from and within airports, but also the cooperation between long distance modes as e.g. air transport and high speed trains.

INTEGRATED SECURITY APPROACH "NO BORDERS"

An integrated approach of security checks towards travelling without any borders is targeted. The key enablers are sharing of personal information about every traveler, the integration of different national or international databases containing this information, and the processing of this data according to standardized criteria.

MODERNIZED AIR TRAFFIC MANAGEMENT (AUTOMATION, ROBOTICS, BIG DATA ANALYTICS)

SESAR/Single European Sky improves the European Air Traffic Management performance by modernizing and harmonizing the systems through the implementation of innovative technological and operational Air Traffic Management solutions, i.e. automation, robotics and autonomy-related technologies, data science and information management, improved high-performing airport operations, advanced air traffic services.

PERSONALIZED AND INDIVIDUALIZED TRANSPORTATION TO/FROM AND WITHIN AIRPORT AND DURING AIR TRAVEL

Personal electric modes of transport for road, rail or air or a combination of them contribute to minimize travel time to the airport where passengers leave the vehicle close to their departure gate. Furthermore, the security check of passengers and luggage is performed inside the vehicle on the way to the airport gate. The development of mobile devices enables several services and products to personalize services along the journey. A real time update on the flight status, real time baggage arrival update or navigation through an airport terminal are potential applications for mobile devices.

RENEWABLE FUEL ALTERNATIVES FOR AIR TRANSPORT

Sustainable alternative fuels as e.g. batteries, biomass, coal-to-liquid, natural gas, pose challenges to infrastructure and ground handling of the plane. Air transport is likely to be the last to adopt alternative fuels in large-scale because of e.g. limited selection of suitable alternatives and sector's strict safety regulation. The worldwide dimension of acceptance of sustainability certification frameworks is especially important for aviation sector.

SEAMLESS SECURITY CHECKS AT AIRPORTS

Seamless security checks at airports enable seamless passenger processes through the airport that need reduced time. This may be enabled through pre-selection and adapted security check according to passenger security status based on big data analytics.

SMALL ON-DEMAND AIRCRAFT

On-demand mobility solutions in the air transport sector will be supported by small aircraft that are able to replace road vehicles. Sharing of planes is possible for smaller aircraft but hard to realize for business trips.

VIRTUAL REALITY IN-FLIGHT ENTERTAINMENT

Virtual reality headsets with 360 degree view are provided to passengers to watch a movie or to get provided with information on the flight status.

WIDE SCALE DEPLOYMENT OF IN-FLIGHT COMMUNICATION FOR PASSENGERS (MOBILE PHONE, WI-FI)

In-flight connection to the mobile phone networks on the ground via satellite connections is possible. The passengers get charged by mobile home provider, what is comparable to roaming charges overseas.

TRANSPORT MODE
RAIL

AUTOMATED MAINTENANCE FOR RAILWAY INFRASTRUCTURE AND TRAINS

Zero-tolerance derailments and fail-safe rolling stock is achieved by automated maintenance that includes advanced construction, certification and maintenance methods. It allows for improved strategies and procedures that are built on predictive, risk-based and condition-based analytics establishing self-inspecting, self-adjusting and self-correcting concepts. Measurement and monitoring tools that provide static and dynamic data capture each infrastructure component's current state.

AUTOMATED TRAINS FOR FREIGHT AND PASSENGER TRANSPORT

Automation includes both train control and navigation. Where complexity is low (e.g. closed subway systems) high levels of automation are already implemented. The goal is to achieve remote control of trains in an automated system of driverless trains in both passenger and freight transportation.

ENERGY-EFFICIENT AND RELIABLE TRAIN

Energy efficiency can be increased through improved traction and braking systems, higher aerodynamics performance, reduced weight of train components and a reduction in thermal losses as well as improved driver awareness of energy-saving driving techniques. Reliability is improved through improvement and simplification of train subsystems that are more prone to operational failure (TCMS, traction, brakes, etc.) and improved resilience towards extreme environmental conditions. Two examples for novel technologies are (1) independently rotating wheels and (2) inductive charging. Both these solutions increase energy efficiency.

ENERGY EFFICIENCY IN ELECTRICAL INFRASTRUCTURE

Increased energy efficiency is gained by improving the productivity of infrastructure assets and by establishing a more holistic and intelligent management based on lean operational practices and smart technologies. These technologies comprise new smart AC power supply, DC integrated power supply concepts, double catenary feeding, controlled reversible substations for traction as well as smart metering for a railway-distributed energy resource management. Along with increasing energy efficiency in infrastructure components, smart grids are to be implemented and smart energy storage systems to be developed.

HIGHER SAFETY AND EFFICIENCY THROUGH ADVANCED TRAIN CONTROL AND MONITORING SYSTEMS (TCMS)

New generation TCMS architectures and components with wireless capabilities, enhanced throughput and safety and security functionalities shall push the development and demonstration of more reliable and safe train control systems. This is achieved by reducing the number of components, optimising the architecture and integrating safety critical functions.

FLEXIBLE TIMETABLES FOLLOWING PASSENGER NEEDS

In order to increase the attractiveness of trains for passengers, flexible timetables could be implemented by developing a software system that gathers the preferred time of travel from each potential passenger in real-time. Based on the collected data, it provides respective connections that meet the needs of as many persons as possible. For freight transportation flexible timetables offer the possibility of increasing the productivity and efficiency of logistical processes by consolidating freight loads of different operators.

MODULAR TRAINS AND CABINS TO FLEXIBLY ADAPT TO PASSENGER NEEDS

Modular design solutions increase the flexibility of vehicle use. A modular design makes it easier to enhance, upgrade, retrofit and (re)authorise trains and enable extended vehicle lifetime. They allow for novel on-board value-added services to be introduced and improve important aspects of passenger comfort by taking different needs of different passengers (families, business travellers, single-travelling active tourists) into consideration. Thus, both, the accessibility and the attractiveness of trains, can be increased.

REDUCTION OF NOISE AND VIBRATION IN FREIGHT TRAINS

To increase the capacity and competitiveness particularly in the freight segment and to limit the disturbance of nearby residents, the reduction of noise and vibration (N&V) can be effectively mitigated through the development of innovative designs and quieter components for infrastructure assets. Such new systems affect both internal (for passenger transport) as well as external N&V exposure.

PERSONAL RAPID TRANSIT (PRT) AND HYPERLOOP

Automated, electric-driven pods (running on batteries or current supply) operate on designated rails or on streets for either scheduled or individual destinations. Hyperloop is being developed as its own system that is based on a pod travelling through a near-vacuum tube.

SHARING OF TRAINS BY SEVERAL MOBILITY OPERATORS

To improve rail utilization and travel experience trains are shared between several operators. Travel agents become the link between operators and passengers by renting out parts of the train depending on passenger needs – this might be single seats, compartments or even whole wagons. In a more long-term future individually propelled wagons (in-wheel engine) might also take individual routes.

INCLUSIVE TRAIN DESIGN

Accessibility of trains can be improved for passengers with reduced mobility through a comprehensive network of guiding displays, signals, lowering thresholds of doors. The cabin concept provides bigger doors for better passenger flows in general, flexible interiors and temperature bridges at doors.

TRANSPORT MODE
WATERBORNE

ADAPTABLE MODULAR VESSEL DESIGN AND CONSTRUCTION

Ships of today are built by assembling steel blocks in the drydock using a piece by piece strategy. But, the more activities are done on land in the workshops, the more time and costs is saved. With modularization, whole building blocks can be pre-manufactured and put together in the drydocks or while the ship is being loaded. Modularity extends the flexibility of vessels for different purposes and allows the integration of incremental innovative technology during the lifetime of ships.

ADVANCED DOCKING SYSTEMS SHIP2SHORE AND SHIP2SHIP

In order to save time and material for complicated tying as well as to reduce forces on the quay, ship2shore solutions allow freight ships to dock tube-like docks that have quays from both sides. Cranes can unload vessels faster. Ship-to-ship automatic docking systems provide a safe and reliable solution for docking between two ships exchanging containers in oceans.

ALTERNATIVE FUELS

The use of alternative fuels such as liquefied natural gas, bio-mass and methanol decreases the emissions of ships. The fuels in use will probably change over the lifetime of a ship. Therefore, there is a need for fuel flexibility of engines and subsystems. Fuel-flexible vessels could adapt to competitive market prices of certain fuels as well as availability, e.g. by hybrid engines utilizing at least two different types of fuel.

AUTONOMOUS VESSELS FOR FREIGHT AND PASSENGERS

Given the rather clear infrastructure compared to road transport, freight (e.g. barges) and passenger ships (e.g. ferries) become an optimal application field for automation. Systems automation, the availability of smart sensors and global networks for data transfer from ship to shore will promote remote controlled and semi or fully autonomous operation of assets. The solutions will be disruptive for the traditional industry and also impact job profiles strongly.

BLUE MODAL SHIFT - BRINGING TRANSPORT TO THE WATERWAYS

Inland waterways have to be developed to provide an attractive transport alternative for passengers and freight shippers. Inland waterways can release road and rail routes effectively in applicable regions. Inter-city waterways at the coastline can take the traffic off coast streets which tend to have higher congestion. Passenger/car/bike transfer on rivers in urban areas can shorten routes compared to bridges. In the context of automation, platooning of vessels or ferries can be an interim step towards autonomous ships, increasing the efficiency of the platoons by using the same water stream of the group leader.

DECISION SUPPORT SYSTEM FOR RESILIENCE MANAGEMENT OF SEAPORT SUPPLY CHAINS

At company level, this system would assist maritime companies in developing, assessing and maintaining a resilience structure tailored to their particular needs and operational requirements. At industrial level, it would allow benchmarking among companies and enable and promote the sharing of best practices to tackle common issues, also taken from other transport domains. This would allow the maritime industry to step up from the typical reactive safety approach to a proactive one.

DRONES SUPPORTING SHIP SUPPLY AND SHIP2SHORE LOADING

The application of drones for delivering ship supply or load smaller items from one to another ship is heralding a big cost and time-saving potential for vessels. All shipping companies face high costs for onboard delivery of small parcels filled with urgent spare parts, mail or medicine. Taken to the next level container transport via drones could enable ship2shore loading.

ENERGY EFFICIENT AND LOW EMISSION SHIP

Energy efficiencies have to be reached through higher efficiency propulsion systems, better hydrodynamic performance, efficiency gains in auxiliary systems, optimizing ship routes and through automation.

FLOATING DELIVERY HUBS

Floating delivery hubs consist of an offshore platform built on concrete floor or on a novel floating platform. These maritime hubs can be used as container storage and /or as transshipment terminals. This way, big vessels do not need to come into ports, so fuel and travelling time can be saved. Goods can be distributed and shared faster between several routes reducing the delivery time.

HYBRID AND ELECTRIFIED FERRIES AND VESSELS IN PORTS

Hybridization and electrification of ferries and of vessels in ports is already ongoing. Advancements are needed to enable longer electrified routes and higher loads. Especially ferries have fixed schedules with only short docking times. Since direct electrical connection also causes challenges related to safety and reliability in harsh environments, inductive charging can overcome these problems.

LOW VIBRATION/WAVES VESSELS

Internal vibration is impacting comfort and external vibrations are relevant for marine noise pollution. Potential technologies for lowering these vary from the use of active material between engine structure and hull or the use of active noise control.

MULTI-SKILLING AND COMPETENCE-BASED PORT LABOUR TRAINING SCHEMES

Changing work processes and digitization at ports requires training in order to use the full potential of the technology and enabling workers to deal with new work environments safely. Further, the training schemes ensure an update of competences in order to keep jobs.

SHORT-SEA-SHIPPING

Short-Sea-Shipping has the potential to contribute to the modal shift. There are rarely traffic jams on waterways and the CO2 per freight unit is lower compared to trucks. Through ship technology for low-water heavy good transport is ready, still logistic partners do not shift to waterborne services. Digital marketplaces in the context of the physical internet can help to calculate costs and can optimize space usage providing a win-win situation for all logistic partners.

SMART CONNECTED VESSELS

Key ICT innovations in systems and software will affect almost all aspects of maritime transport processes. Connected vessels, hubs and third party on-shore logistic companies will enable more efficient loading/unloading, route planning etc. Augmented and virtual reality technologies have potential applications in managing ship's bridge operations, improved port and logistics infrastructure and operations, planning new terminals or assessing existing ones as well as for training the staff. Future applications will connect the virtual world with reality to assist in more efficient decision making, for instance navigation or improving the awareness of threats from pirates.

VESSELS EXPLOITING WIND AND SOLAR ENERGY

Since the ship is on the water with long exhibit to the sun during the day and wind at all times, energy for ship systems can be charged by alternative energies, such as from high-altitude winds that generate energy through large and fully automated kites, mounted, solid solar sails as well as flexible solar panels on the surface of the ship.

TRANSPORT MODE
ROAD

ADAPTIVE SAFETY SYSTEMS

Safety systems can be of active or passive nature helping to prevent accidents, such as good steering and brakes or helping to reduce the effects of an accident, such as seat belts and airbags, respectively. Adaptive safety systems go one step further, referring to adaption (within a learning process) of the safety feature to the specific conditions and the specific driver.

AUTOMATED AND CONNECTED VEHICLES

Automated and connected vehicles operate without the direct input of the driver (e.g. steering, acceleration, braking, etc.) so that a constant monitoring of the roadway and the driving process of the car is not necessary. Therefore, different communication technologies are used to communicate with the driver, other cars on the road, roadside infrastructure, and the cloud. This technology can be used to improve vehicle and road safety, as well as efficiency and commute/leisure time.

BUS RAPID TRANSIT CORRIDORS

Bus rapid transit aims to combine the capacity and speed of light rail with the flexibility, lower cost and simplicity of a bus system. Bus rapid transit systems run on dedicated lanes, have stations with off-board fare collection, etc.

V2X COMMUNICATION TO SUPPORT SAFETY AND TRAFFIC MANAGEMENT

Vehicle-to-everything (V2X) communication is information exchange from a vehicle to the infrastructure, other vehicles, pedestrians and devices. It enables safety applications such as collision warning, intersection movement assistance and platooning. Furthermore, with novel sensors various parameters of road conditions can be monitored to enable alerting drivers of adverse road conditions in real time and also to plan on-demand repair.

DYNAMIC PRICING OF THE USE OF ROAD INFRASTRUCTURE

New data processing and mobile technologies allow real-time calculation and differentiation of user fees. Thus, it is possible to reflect the true cost of use in the price and vary it by demand to influence the utilization of infrastructure networks.

FUTURE GENERATION OF ELECTRIC VEHICLES

Future generation electric vehicles mainly focus either on driving range improvements for battery electric vehicles for a wider spectrum of potential use scenarios or on the differentiation of electric vehicles for special fields of applications (e.g. light weight urban electric vehicles) and/or special user groups.

ON-ROAD CHARGING FOR TRUCKS

Since conventional battery concepts cannot accomplish long driving distances for heavy duty vehicles, trolley wires or other forms of constant electrical connection are used to power electric trucks. Infrastructure investments remain one of the major hurdles.

PROLIFERATION OF CAR/RIDE/PARK SHARING PLATFORMS

Shared use of resources and moving from ownership to using services is becoming more and more common in the mobility as well as in the transport sector. Ride-hailing and ride-sharing services for people and goods allow connecting those with available resources with those needing transport.

SMALL VEHICLES DEVELOPED FIT-FOR-URBAN-PURPOSE

Small and consequently lighter weight vehicles have a lower energy consumption and therefore safe money for the users. Especially, electric vehicle benefit from small and light weight vehicles for urban purposes, since smaller batteries can be used which in turn result in lower costs, which makes the cars affordable. This is not only valid for passenger vehicles but can also be applied to urban good transportation.

SMART PARKING (REAL-TIME OCCUPANCY AND PRICE INFORMATION & GUIDANCE)

Parking spaces in urban locations are rare. Applying different technologies is improving the ability to monitor and inform about the occupancy or availability of parking spots as well as the parking fees.

URBAN ELECTRIC BUSES

Urban electric buses are a good medium to introduce electric vehicles to the general public and exploit the environmental and energetic benefits (less emissions, high energy efficiency, etc.) that come along with it. Beside environmental aspects, the predictable energy consumption of urban busses and novel charging concepts promote their electrification.

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pages 23-24

TRANSPORT MODE
FREIGHT

CO-MODALITY: CONNECTING TRANSPORT OF PEOPLE AND GOODS

The space of regular services for public transport at non-peak-hours (e.g. at night) or the space of duty vehicles (e.g. clean vehicles) can be used to transport goods in vehicles being on their way in any case. This would help to decrease the CO2-emission of cargo transport.

GHG-EMISSION CALCULATOR FOR FREIGHT TRANSPORT PLANNING

Measuring the carbon footprint of logistics accurately with the help of the standard EN 16258 allows adding environment-related information to the operational supply chain management systems and logistic planning.

HARMONIZATION OF URBAN GOODS DISTRIBUTION LAWS IN MUNICIPALITIES (IN A REGION)

Policy measures in the field of urban freight transport are usually taken by local authorities and not by national or federal authorities. It means that measures can differ significantly between two neighbouring cities which complicates urban deliveries for transport operators. This solution consists of harmonising measures and legislation in a certain region or country and of structured consultation between policy makers and transport operators.

LOGISTICS AS A SERVICE

“Logistics as a service” means that individuals can choose their own logistics service provider instead of being delivered by the logistics service provider of their (online) retailer. Therefore they can select the delivery time and location for multiple purchases from different retailers.

NOVEL MULTI-MODAL, CLIENT-ORIENTED BUSINESS MODELS FOR RAIL FREIGHT

New business models make it easier for private customers and commercial clients to get a suitable service and safer for railroad companies to get payment on time.

ORGANIZED PLATOONING OF HEAVY DUTY VEHICLES (ROAD TRAINS)

A vehicle platooning is a road train with vehicles, where vehicles are autonomously following a manually driven lead vehicle, driven by a professional driver. The road train is arranged via an intelligent online-decision-making service.

(PERI-) URBAN FREIGHT CONSOLIDATION HUBS

The platforms are freight hubs located close to urban agglomerations. They serve as a place for the consolidation of goods between long distance hauls and short-distance inner-city transport, utilizing the most efficient and green mode of transport for each of them.

PHYSICAL INTERNET

To reach interconnectivity of logistics, modular containers of different standardized sizes are equipped with a protocol and an interface to allow efficient stacking on the ship, better handling and transshipment, travelling through an open global logistics system for a more sustainable logistic chain.

SHARED COURIER PLATFORMS

Share-economy courier platforms connect people wishing items to be delivered with couriers going in the desired direction in any case. The platforms are open to individuals as well as to professional service providers (couriers, freight operators, taxi drivers).

SUPPLY CHAIN VISIBILITY ENABLING SUSTAINABLE AND TRUSTED SUPPLY CHAINS

Awareness of and control over end-to-end supply chain information enabling lean, agile, resilient, sustainable as well as compliant and trusted supply chains. Therefore, technologies such as scanning technology, container security devices (RFID tags, for example) and other tracking and tracing technologies are applied.

URBAN AIRSPACE UTILIZATION FOR GOODS DELIVERY (DRONES)

A potential technology solution within inner-city logistics are UAVs (unmanned aerial vehicles), which offer new transport and warehousing options within a city as well as in remote areas with rather bad logistics infrastructure, enhancing performance efficiency and providing infrastructure alternatives. Another solution is the dynamic delivery routing and crowd-shipping of deliveries, driven by the attempts to provide same-day or even shorter delivery times

TRANSPORT MODE
URBAN

CHATBOTS FOR PASSENGER INFORMATION EXPLOITING ARTIFICIAL INTELLIGENCE

Chatbots are computer programs that interact with users through natural languages simulating a human conversation. By developing chatbots which have access to and can intelligently combine real-time data of public transportation, traffic information and weather forecast, sustainability and flexibility of transport can be furthered. The exploitation of novel possibilities of artificial intelligence can greatly enhance the usefulness for passengers.

CO-CREATION OF URBAN MOBILITY SOLUTIONS BASED ON CITIZEN INVOLVEMENT

Co-creation processes combine interactive collaboration of citizens and stakeholders of urban mobility, in sharing opinions, identifying risks and chances and finding novel solutions in a participative and transparent manner to increase the potential of implementing mobility solutions successfully.

FUNDING COMPETITIONS INCREASING PUBLIC FUNDING EFFICIENCY

New funding forms are expected to yield higher efficiencies in public funding. One such form are competitions that increase participation because of the funding design. Additionally, so called leverage effects might lead to implementation of projects even when no funding is received.

GAMIFICATION OF URBAN MOBILITY SYSTEMS

Gamification denotes the use of game design elements in non-game contexts. In the context of smart and sustainable urban mobility, gamification mechanisms help to incentivize voluntary behavioral changes of citizens towards using sustainable mobility solutions, on top of mobility policies and solutions introduced by cities.

INCENTIVIZING ACTIVE MODES, REDUCED TRAVEL AND LOW-EMISSION VEHICLES THROUGH POLICIES

To increase a city’s livability, protect climate and reduce pollution (GHG, NOx, noise etc.) the share of low-emission and clean energy vehicles as well as active transport modes such as cycling and walking shall be increased. Measures to achieve this are among others: (1) banning conventional vehicles, and (2) improving the infrastructure for cyclists and pedestrians. To coordinate measures on a wider scale, Sustainable Urban Mobility Plans (SUMP) can be further established as a helpful tool. SUMPs are a planning practice where strategic priorities are defined in the domain of mobility at urban agglomeration scale. They are credited with providing the framework conditions and the impetus for setting up major public transport transit projects in many European cities.

INTERMODAL MEGA-HUBS INTEGRATING NEW MOBILITY SERVICES

Mega-hubs will contribute to the development of a city-wide multimodal service offer where mobility services seamlessly integrate to minimize transfer time and maximize the utility of passengers. The integration of long-distance, regional and local (with an emphasis on active modes) transport will extend this system at the regional and international scale.

MOBILITY-AS-A-SERVICE

Rather than personally owning the means for certain travel modes, MaaS entails that transport and mobility is consumed as a service. The service is provided through a unified connected gateway (interoperable information interfaces) integrating all options of transport modes, including car and ride sharing as well as bike sharing. Additionally, its goal is to seamlessly integrate with public transport.

NOVEL CONCEPTS FOR BIKE-SHARING

To increase the share of cycling in cities novel concepts have to take users’ needs (e.g. safety, flexibility etc.) into consideration. These include free floating bike sharing to increase flexibility, (movable) docks and charging stations, better and flexible positioning and repositioning of bikes adapting to demand, usage of smart bikes, protection of bikes against theft and damage, intelligent feedback for damage and needed repairs to provide better services.

PERSONAL MOBILITY DEVICES (E.G. SEGWAY)

Personal mobility devices have grown to an easy and fast transport mode that can complement walking and cycling (e.g.

URBAN CROSS-MODAL LOGISTICS UTILIZING ALL TRANSPORT MODES

Intelligent services plan urban delivery with the most efficient mode possible depending on the route and cargo profile, where usually bikes or tricycles are used.

URBAN PARKING MANAGEMENT APP FOR FREIGHT TRANSPORT

Traditional parking disks are being replaced by the use of an app or SMSs to record loading/unloading operations and inform parking place searchers on available parking options.

Segway, electric skateboard) and help reduce the usage of traditional forms of mobility for short distances.

SAFE AND ACCESSIBLE MOBILITY THROUGH INTERNET OF THINGS

With increasing amount of data collected from different sources within the internet of things, the overall status, conditions and activity in cities is becoming more and more known. Smart solutions not only motivate the use of active modes, but also support the accessibility for vulnerable and excluded persons.

SMART CONNECTED BIKES

The smart bike combines a number of features, making cycling safer and connecting the cyclist to the internet to provide additional online services. Bikes are equipped with motion sensors as well as an on-board unit with GPS tracking and WiFi to provide connection to a smartphone. Smart interface as e.g. haptic feedback can provide input without taking the eyes off the road.

URBAN DESIGN ENCOURAGING ACTIVE MODES AND REDUCED TRAVEL NEEDS

Intelligent urban design shall take into account the existing infrastructure and repurpose it to concentrate on the needs of active modes. This includes transit-oriented development where different activities (work, leisure, entertainment, shopping, city services, etc.) are integrated with each other to increase efficiency and enable a shift towards active transport modes such as cycling and walking.

TRANSPORT MODE
ALL MODES

ADVANCED CYBER-SECURITY FOR IN-VEHICLE SYSTEMS, INTELLIGENT INFRASTRUCTURE & DATA PRIVACY

Along with advances in communication technology the vulnerability of transport systems towards cyber-threats increases. For the customer issues of data privacy become more important. Current technology trends in all modes, such as automation, connectivity, personalization as well as the increasing complexity of electrical and/or electronic systems additionally open weak spots for cybercrimes. Cyber-security has to be implemented holistically on a systemic (rather than component) level including hardware, software, communication (channels), interfaces, infrastructure and span across the entire supply chain.

BLOCKCHAIN FOR DATA SECURITY AND PRIVACY IN PASSENGER AND FREIGHT TRANSPORT

A blockchain database is a decentralized system enabling users to carry-out digital transaction such as authentication in a secure-by-design and trusted system. Due to its decentralized setup, the system can hardly be manipulated, privacy is ensured through cryptography. This is especially valuable in complex processes that need trust from different parties, such as monitoring containers in waterborne logistics on their way to the addressee, the payment on the go for charging electric vehicles or for mobility-as-a-service or public transport as well as to ensure the authentication of transactions in otherwise hard-to-monitor systems, such as real-time ride-sharing of private vehicles.

GAME CHANGERS IN MATERIALS FOR TRANSPORT

Future materials will be designed to reduce emissions and life cycle impact of vehicles and infrastructure on the environment as well as to improve the safety, performance, functionality, comfort and perceived quality. Lightweight materials, graphene and nano-coatings will replace traditional materials in automotive, aviation and marine industries in the future. It is expected that paints & coatings & construction markets to be highly impacted in the next five years by self-heeling materials, as e.g. fiber reinforced composites with liquid self-healing materials for aviation industry, self-healing coatings and paints for surfaces of cars and marine assets such as ships, docks to protect metal beneath the sea from corrosion etc. With respect to environmental impact it is important to consider the entire life cycle, including production, usage and end of live.

INCENTIVIZING MODAL SHIFT TO PUBLIC TRANSPORT – PERSONAL CARBON BUDGET

In order to reach EU-objectives for sustainability and environmental protection, the usage of public transport and active modes has to be incentivized. Incentives addressing the customer may include tax incentives for having no car and by the installment of a personal carbon budget could benefit the modal shift. In a personal carbon budget scheme all individuals receive a carbon budget of carbon emissions covering household energy use, personal transport including land transport and aviation. Public authorities can contribute by providing push/pull measures for advancing and faster installment of convenient and safe routes for active modes, standardization and establishing of interoperable mobility-as-a-service solutions etc.

INTELLIGENT AND ADAPTIVE ADVISORY AND ASSISTANCE SYSTEMS FOR OPERATORS/DRIVERS OF TRANSPORT VEHICLES

Intelligent and adaptive advisory and assistance systems are increasingly being deployed in all transportation modes. In some modes (e.g. airborne and rail transport), they are already routinely in use for specific applications. In other modes, as road transport they just recently being exploited to a higher degree. Intelligent and adaptive advisory and assistance system support the driver or vehicle operator in overseeing the increasingly complex traffic environment. Based on different monitoring components the system gives warning of potential collisions. Depending on the level of autonomy the system either informs the driver/operator or acts independently. On a systemic level it allows for predictive and dynamic traffic management.

SIMPLIFIED TESTING, CERTIFICATION & AUTHORIZATION OF NEW MOBILITY SOLUTIONS

In order to decrease development, production and system costs of transportation, testing, certification and authorization processes need to be simplified. Therefore, virtual certification is introduced to replace more costly on-track tests. Methods include simulation tools and x-in the loop approaches as well as collaborative test environments.

SMART TECHNOLOGIES FOR THREAT PREVENTION

In crowded transport hubs, stations or airports as well as within certain vehicles, new cameras and (facial, mimic, gestural) detection software as well as biometrical methods can support identifying threats by assessing abnormal behavior, detecting luggage etc. The balance between need for security and data privacy and civil rights is a growing issue.

SMART TRAFFIC MANAGEMENT AND FORECASTING WITH BIG DATA

The smart-traffic decision support system is based on big data analytics. It integrates big data from multiple sources (infrastructure and vehicle sensors, cameras, public transport smartcard data and crowdsourced data from users). Through the real-time analysis of the data and forecasting of demand and incidents, it enables real-time traffic monitoring and control. Proactive traffic management covers methods for creating an accurate overall understanding of the current status of the transport system and predicting changes in traffic conditions (transport flow, congestion).

STANDARDIZATION AND HARMONIZATION ENABLING EU-WIDE INTEROPERABLE TRANSPORT WITHIN AND ACROSS ALL MODES

Standardization is key to establish intermodal, cross-border transport. New solutions like electric mobility, alternative fuels, automated vehicles or high-speed trains and others require standardized infrastructure and quality control that works across borders of member states. The same applies for data services that need appropriate interoperable infrastructure and data sharing protocols. Further, legal and policy frameworks have to be harmonized to ease cross-border transport and services.

THREAT PREVENTION AND EMERGENCY MEASURES

In order to preventing emergencies and threats in all means of transport, a number of structured measures have to be newly developed, enhanced and implemented. For instance, hijack-safe protocols, emergency response plans, models and evacuation support systems etc. need to be developed and trained across the modes. Here, the good practices of the aviation domain should be transferred to the rail and the maritime transport. The introduction of nominative ticketing or similar measures to rail and water is a further possibility that can be explored.

UNIVERSAL DESIGN/DESIGN FOR ALL

Universal design refers to designing and developing any transport and mobility provision so that it can be accessed, understood and used to the greatest extent possible by all people without the need for adaptation or specialized design for a specific group depending on their age, size, ability or disability etc. Universal design shall not exclude assistive devices where they are needed for particular groups of persons.

FORMULATION OF

CROSS MODAL APPROACHES

IN A GENERAL VIEW, CROSS-MODAL APPROACHES CAN ADVANCE ALL SOLUTIONS LISTED IN THE MATRICES TO CONTRIBUTE TO A USER CENTERED MULTIMODAL TRANSPORT SYSTEM. NEVERTHELESS, FOR THE DEVELOPMENT AND IMPLEMENTATION OF SOLUTIONS THAT ADDRESS CERTAIN USER NEEDS, CROSS-MODAL APPROACHES ARE A STRONG ENABLER OR THEY OPEN OPPORTUNITIES FOR HIGH ADDITIONAL BENEFIT. HENCE, THESE USER NEEDS MAY ALSO BE THE MOST INTENSIVELY ADDRESSED BY THE ACTION PLAN TO BE DEVELOPED.

Solutions related to these user needs are prone to either be enabled or greatly benefit from interoperability, standardization or technology transfer across modes. This fact is indicated in the matrices 1-7 by a higher number of solutions for these user needs and especially within the urban, freight or all modes matrices. In the visualization on the opposite page, this translates into higher fillings of batteries.

Cross modal approaches are, for example, needed to address the issues of enabling and intelligently managing flows of passengers, freight and data across modes or across borders. This is immediately apparent for user needs **#1 Efficient transport flows and networks, #3 Real time information and services, #5 interoperable seamless journeys.**

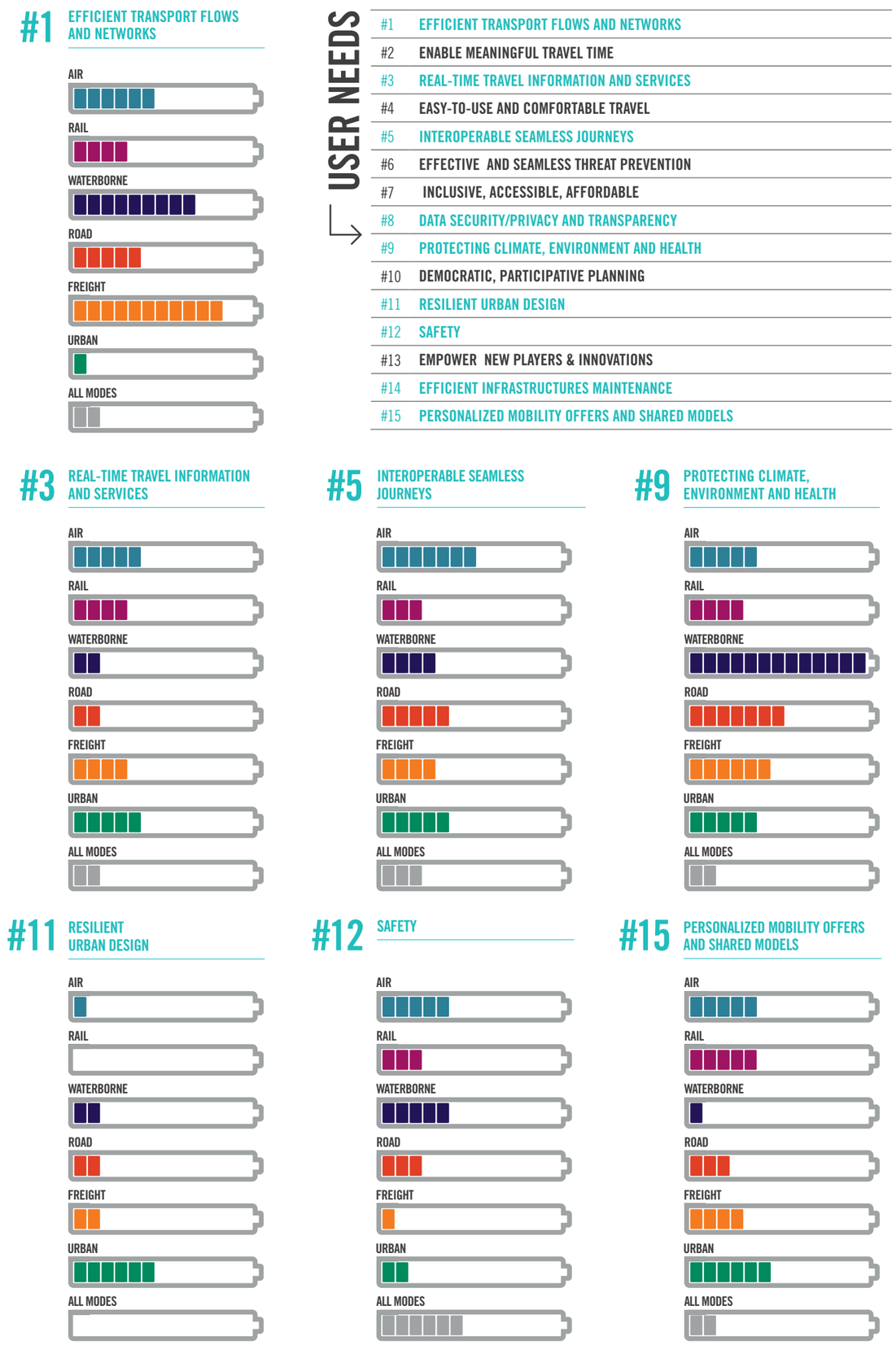
The solutions concerning **#12 Safety**, security, but also **#15 Personalized mobility offers and shared models** strongly rely on similar technologies and concepts that potentially can be accelerated in their development and implementation through technology and knowledge transfer between modes. Technology transfer is further especially relevant for technologies advancing efficiency and lowering emissions and noise and thus contributing to **#9 Protecting climate, environment and health.**

Moreover, many of the technologies in the solutions serving user needs mentioned above are also dependent on players from outside the traditional transport sector, as e.g. IoT, automation, big data, which calls for a broader cooperation strategy.

The need for outreach to policy makers or a strong urban focus calls for collaboration across modes, beyond the transport sector and also to local, regional planners and policy makers. This concerns many of the user needs mentioned above and also **#11 Resilient urban design**. Since data flows across and beyond transport sectors, **#8 Data security, privacy and transparency** can only be implemented in cooperation between transport industry sectors and even beyond.

THE AGGREGATION OF SOLUTIONS ACROSS ALL MODES FOR SELECTED USER NEEDS IS SHOWN IN THE VISUALIZATION

This selection contains user needs with a high number of solutions across all the matrices, a strong urban or freight focus or a higher weight on solutions that apply to more than one or to all modes. Thereby a high potential for cross-modal approaches, collaborations and technology transfer is indicated.



USER NEEDS

#1	EFFICIENT TRANSPORT FLOWS AND NETWORKS
#2	ENABLE MEANINGFUL TRAVEL TIME
#3	REAL-TIME TRAVEL INFORMATION AND SERVICES
#4	EASY-TO-USE AND COMFORTABLE TRAVEL
#5	INTEROPERABLE SEAMLESS JOURNEYS
#6	EFFECTIVE AND SEAMLESS THREAT PREVENTION
#7	INCLUSIVE, ACCESSIBLE, AFFORDABLE
#8	DATA SECURITY/PRIVACY AND TRANSPARENCY
#9	PROTECTING CLIMATE, ENVIRONMENT AND HEALTH
#10	DEMOCRATIC, PARTICIPATIVE PLANNING
#11	RESILIENT URBAN DESIGN
#12	SAFETY
#13	EMPOWER NEW PLAYERS & INNOVATIONS
#14	EFFICIENT INFRASTRUCTURES MAINTENANCE
#15	PERSONALIZED MOBILITY OFFERS AND SHARED MODELS

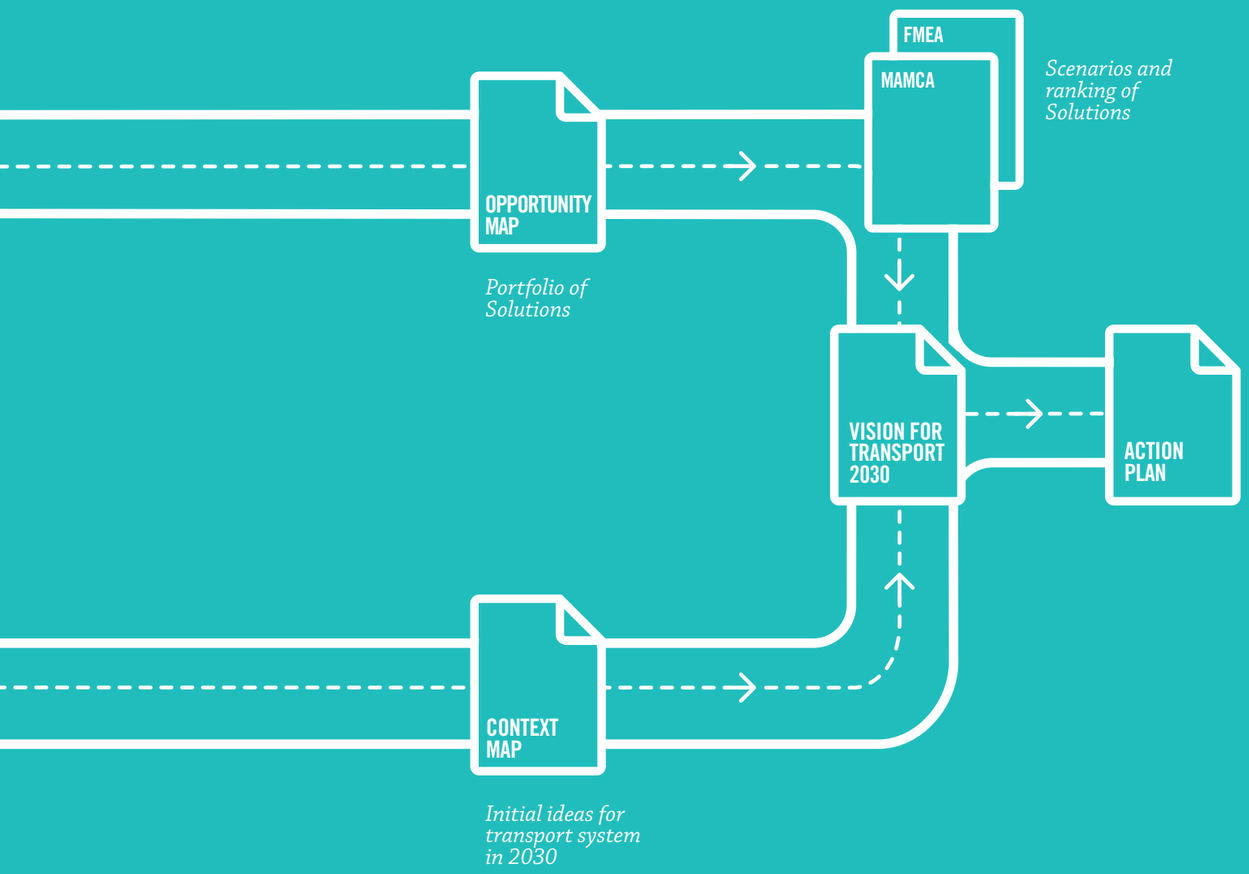
NEXT STEPS

TOWARDS ACTION PLAN

ONE OF THE MAJOR OBJECTIVES OF MOBILITY4EU IS THE DRAFTING OF AN ACTION PLAN FOR TRANSPORT IN EUROPE IN 2030. THE ACTION PLAN WILL DETAIL MEASURES REGARDING POLICY, REGULATION, STANDARDISATION, FORMS OF GOVERNANCE, USER ACCEPTANCE, TECHNOLOGY DEVELOPMENT AND OTHER IMPLEMENTATION RELATED ISSUES.

The portfolio of solutions in the opportunity map, have been the foundation for building the scenarios for the development of future transport in Europe, within the **Multi-Actor Multi-Criteria Analysis (MAMCA)**. Within a structured stakeholder consultation process, these scenarios, and the included solutions, are being ranked by a broad stakeholder community coming from all fields of transport. A further prioritization of solutions will be done through an adapted **Failure Modes and Effects Analysis (FMEA)**. The solutions coming out of these rankings will be taken into a creative process of vision building that will be undertaken together with stakeholders from all fields of transport. This will lead to the **Vision for Transport in Europe in 2030** which will concentrate on interactions, combinations and interfaces between prioritized solutions. Finally, an **Action plan** to implement that vision will be drafted and put into a broad stakeholder consultation.

The image below visualizes this process and indicates next steps.



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