



European Road Transport Research Advisory Council

ERTRAC Multi-Annual Implementation Plan for Horizon 2020

March 2013





Letter from the ERTRAC Board

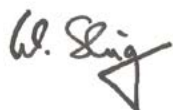
Dear Reader,

Horizon 2020, the next European Framework Programme for Research and Innovation, represents for both the European institutions and for all the research stakeholders one important step towards a more efficient and focused research funding in Europe. By fully revising its Strategic Research Agenda in 2010, ERTRAC has prepared for this new programme, adopting a consistent systems approach, and structuring its research domains according to Grand Societal Challenges. During the last two years, all the road transport research stakeholders involved in ERTRAC have worked hard in order to implement this new Strategic Research Agenda by developing detailed Research and Innovation Roadmaps. Combined, these roadmaps cover the whole road transport system, and allow to achieve the ambitious objectives on societal challenges set by the SRA.

Today, at the moment of establishing Horizon 2020, ERTRAC continues to drive collaboration between all road transport stakeholders, together with the European Commission services and the Member States representatives, in order to deliver a comprehensive implementation plan for the new research programme. The following document has the intention to identify which topics of the roadmaps can contribute to the challenges laid down in the pillars of Horizon 2020. This mapping exercise is critical in order to ensure a coherent coverage of all the necessary research areas all along the multi-annual implementation of the new funding programme.

The strength of ERTRAC lies in its inclusion of experts from all domains of the transport system. The multi-annual plan delivered for Horizon 2020 will therefore truly allow to achieve the objectives set, by addressing across the pillars of the new programme all the research and innovation needs. Thanks to this integrating approach, these goals shared by both the research stakeholders and the EU institutions can be addressed with confidence: strive for excellence in research, innovate for societal challenges, and achieve industrial leaderships.

ERTRAC stakeholders will continue on this basis to work all along Horizon 2020 in order to establish year after year recommendations for its most efficient implementation.



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Reminder:

Overview of the ERTRAC Strategic Research Agenda approach and objectives

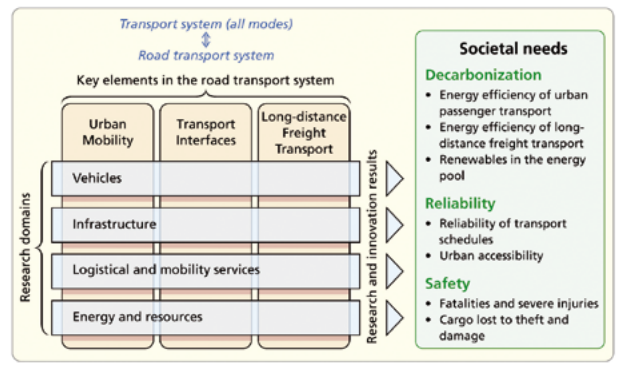
ERTRAC - the European Road Transport Research Advisory Council, has recently revised its Strategic Research Agenda by taking a system approach and addressing Grand Societal Challenges. As described in the table and figure below, objectives have been set, for an **overall efficiency improvement of the transport system by 50% in 2030 compared to 2010**, and with specific targets for each of the societal needs identified: decarbonisation, reliability and safety.

Table 1 Guiding objectives for 2030

| | Indicator | Guiding objective |
|------------------------|--|------------------------------------|
| Decarbonization | Energy efficiency: urban passenger transport | +80% (pkm/kWh) * |
| | Energy efficiency: long-distance freight transport | +40% (tkm/kWh) * |
| | Renewables in the energy pool | Biofuels: 25% Electricity: 5% |
| Reliability | Reliability of transport schedules | +50% * |
| | Urban accessibility | Preserve Improve where possible |
| Safety | Fatalities and severe injuries | -60% * |
| | Cargo lost to theft and damage | -70% * |

* Versus 2010 baseline

Figure 2 A systems approach to achieving a 50% more efficient road transport system



The ERTRAC SRA is being implemented through Roadmaps covering topics for **research, development, and innovation framework**. Together, the ERTRAC roadmaps cover all aspects of the transport system and allow to reach the objectives set in the SRA. The approach focuses on the following three key elements of the transport system: **urban mobility; long-distance freight transport; and interfaces between transport means**. Together, these elements provide an integrated core transport system that serves the road transport demand of more than 80% of the population, so they are of the greatest strategic significance to meet the European societal challenges.

ERTRAC, thanks to its multi-stakeholders membership gathering all the actors of road transport research, is then able to cover the four enabling research and innovation domains, which are: **vehicles, infrastructure, logistical and mobility services, and energy and resources**.

A mix of these domains is usually needed in order to address efficiently one issue and be efficient in delivering benefits towards the societal objectives. It is by addressing these four research domains with coherence that the research planning to 2020 will ensure maximum efficiency. Although the ERTRAC MAP has been structured following the pillars of the Horizon 2020 programme proposal, it will be crucial during the implementation to ensure coherence across the four research domains.

Legend to the ERTRAC roadmaps:

This ERTRAC MAP for Horizon 2020 has been built by a process of comparing the content of the ERTRAC roadmaps with the European Commission Horizon 2020 document COM(2011) 811. Content has been extracted from roadmap chapters and allocated to pillars and sub-pillars of Horizon 2020 that can cover such content. The present document is therefore truly a mapping exercise, allowing to oversee all the research and innovation needs from an ERTRAC perspective all over the Horizon 2020 structure. Details about the objectives, the milestones and the research, development and innovation activities remain within the roadmaps. In order to implement year by year the programme, it will be necessary to go back to the roadmaps in order to use their detailed content and specific R&I activities proposed for each timing. In order to keep this link between the MAP and the roadmaps, references to them are made all along the document, using the following legend:

- CCRT:** Climate Change Resilient Transport
- EBSF:** European Bus System of the Future
- ERT:** Electrification of Road Transport
- GC:** Global Competitiveness
- HDT:** Heavy Duty Truck
- HRT:** Hybridisation of Road Transport
- IGV:** Infrastructure for Green Vehicles
- IUMS:** Integrated Urban Mobility System
- LDPF:** Light Duty Powertrains and Fuels
- LUTI:** Land Use and Transport Interactions
- RUBE:** Road User Behaviour and Expectations
- SRT:** Safe Road Transport
- SFTFE:** Sustainable Freight Transport For Europe

All these roadmaps are available freely for download on the ERTRAC website: www.ertrac.org
The ERTRAC roadmaps are living documents that will be updated regularly.

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This Multi-Annual implementation Plan represents ERTRAC research priorities for Horizon 2020, recognizing that the priorities of other sectors will also contribute to the objectives of the pillars. The document reflects the pillars of Horizon 2020 relevant to ERTRAC, showing numbering and titles of the respective pillars as they are presented in the European Commission document COM(2011) 811.

Readers are invited to refer to this document in order to obtain the perspective of the European Commission on these pillars.

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Pillar 4.1.1:**Making aircraft, vehicles and vessels cleaner and quieter will improve environmental performance and reduce perceived noise and vibration**

ERTRAC research topics for 2014-2020 will focus on achieving better vehicle efficiency through advanced cleaner propulsion technologies, including adaptation to alternative energies. In addition, improvements in energy-efficiency should be obtained through weight reductions, improved aerodynamic and reduced rolling resistance. Moreover, it is necessary to address the infrastructures required to support the deployment of such green vehicles.

Better vehicle efficiency through advanced cleaner propulsion technologies, including adaptation to alternative energies:

There are many technologies pathways that have the potential to reduce vehicles consumption, pollutants and noise emissions. Substantial reductions will need appropriate technology pathways combinations. The research and development activities focus on advanced ICEs and the next generation of hybrids and full electric vehicles, and will address issues such as:

- Continuing improvements in ICEs, extending the useful range of engine operation and improving the performance of auxiliary systems to enable better performance (e.g. turbocharging and engine downsizing); Reducing fuel consumption through optimal thermal management and advanced control technologies; new technologies for highly efficient aftertreatment systems, with the reduction of precious catalytic metals; improvements to the combustion processes to avoid expensive after-treatment systems.
- Advanced dedicated and fuel-flexible engine technologies for new liquid and gaseous fuels.
- Developing highly efficient hybrid powertrains, including vehicle system integration; and non-electrical hybrid concepts.
- ICEs optimization for application in hybrid propulsion concepts; including hybrid concepts for larger vehicles e.g. for special applications; Utilizing modular concepts enabling most suitable powertrain architectures for various applications; development of range extenders.
- Providing breakthrough technologies for electrified vehicles: storage systems, cost, weight, efficiency, power electronics, drive trains components; with the goal of developing the next generation of Full Electric and Hybrid Vehicles affordable for mass market deployment.

Expected impact:

- Bringing significant first steps towards the ERTRAC guiding objectives for energy efficiency (+80% for urban passenger cars, +40% for long distance freight transport, by 2030 compared to 2010)
- Reduction of CO₂ emissions and fossil fuel consumption, as well as pollutant emissions, and noise
- Simplification and modularization
- Reduce dependability on strategic raw materials, such as rare earths
- Enabling the progressive electrification of transport e.g. by bringing effective energy storage and components enabling mass production of hybrid and electric vehicles, as described by the 2020 milestone of the Electrification roadmap: "Batteries providing about doubled life time and energy density compared to 2009 Li-Ion technology status at about 30% of 2009 cost. Highly integrated and inexpensive electrical motors and power electronics, highly efficient and affordable thermal solutions."

Opportunities for programme efficiencies:

- Coordination with pillar 3 Energy challenge for the development of alternative fuels and necessary infrastructures; coordination with Part II 1.3 Materials, with pillar 4.3 global leadership for the European transport industry.

References to ERTRAC roadmaps:

- **LDPF:** Advanced cooling technology (A1.9); Controlled Auto-Ignition combined with... (A1.11); Variable Compression Ratio (A1.12); Extended speed/load range HCCI (A1.13); Fully flexible valvetrains (A1.2); Multivariable model-based control systems (A1.4); Waste heat recovery (A1.8); Fully flexible injection systems, pressure... (A1.1); Compression Ignition (CI) engine... (A1.7); Continuous recharging capabilities (A3.4); Particulate Matter (PM) control with focus... (A1.5); Spark Ignition (SI) engine technology... (A1.6)
- **HDT:** High efficiency scalable powertrain concepts; Advanced NOx aftertreatment/non-precious...; Variable Valve Actuation; Efficient integration in vehicle energy management...
- **ERT/ HRT:** Energy storage systems (V2G compatibility, higher density and lifetime, safety, cost, testing and validation standards, hybrid energy storage systems); Post lithium batteries research; Advanced Battery Management Systems; Drive train technologies, Highly integrated motors and controls, New EV drive electronics to support rare earth-free motor technologies; Vehicle system integration, New solutions for heating, cooling and air conditioning under various environmental conditions, ICT architecture deployment; Hybrid passenger cars charging systems, plug-in, inductive and contact charging for trucks.

Better vehicle efficiency through reductions in weight and in aerodynamic and rolling resistance:

- Downsized, more efficient, and lower-weight engines
- Reducing vehicle mass through materials substitution, smart design, and mass reduction of vehicle components
- Light-weight vehicle designs using more easily recycled materials, without compromising on crash safety standards.

- Light-weighting through hybrid system integration, modular & flexible vehicle architecture
- Advanced WTW/LCA and related assessment tools to speed up the decision-making process for novel materials
- More aerodynamic and modular vehicle designs, including those that are tailored to specific applications
- Improving vehicle aerodynamics solutions (Improved design, reduction in drag, active grill shutters, ...)
- Reducing rolling resistance by optimizing tyre materials, shape, inflation, without compromising performance, and taking into account the tyre-pavement interaction
- Reducing vehicle mass: material substitution with downsized powertrain, smart design and mass reduction of vehicle components

Expected impact:

- CO₂ and fuel consumption reduction through lower weight powertrains and vehicles as well as more energy efficient vehicle and tyre designs
- Vehicles and trucks that are specifically designed for their application
- Vehicles rightsizing to their applications

Opportunities for programme efficiencies:

- Coordination with pillar 3 Energy challenge for the development of alternative fuels and necessary infrastructures; coordination with Part II 1.3 Materials, with pillar 4.3 global leadership for the European transport industry.

References to ERTRAC roadmaps:

- **LDPF**: Engine light weighting (A1.14); Engine downsizing, engine down speeding, and .. (A1.12); Infrastructure redesign for efficient recycling (A4.2); Component technologies (A4.4)
- **HDT**: Tailored trucks & Standardized Load Carriers; Cost effective vehicle combination architectures; Aerodynamics & Light weight solutions; Configurable modules
- **SFTFE**: Vehicle dimensions for optimised load capacity; Vehicles and infrastructure matching each other; Vehicle technically specified for running in corridors
- **HRT/ERT**: System integration, modular & flexible hybrid architecture; lightweight materials for energy storage systems, Cost efficient and light weight highly integrated motors and power electronics, Lightweight materials, Eco-design and recycling, lighter or smart materials for power dissipation, new design concepts and novel materials for EVs, modular EV concepts, packaging & integration combining functionalities

Infrastructures for Cleaner and Quieter vehicles:

The research and development focus on dedicated infrastructures for clean and efficient long distance and urban transport. New cleaner and quieter vehicle concepts and propulsion technologies will improve environmental performance and reduce perceived noise and vibrations from road transport. In order to follow an integrated approach and recognise infrastructure-vehicle interaction (e.g. rolling noise emissions, rolling resistance) the infrastructure needs to be prepared for the new concepts. The environmental performance of infrastructure components will improve. Cost-benefit considerations are required in order to allow for large scale deployment. Due to the need and expected impact, the implementation of innovative technologies to reduce energy consumption in a systems approach will focus on corridors and urban environment first.

- **Green and quiet corridors** for clean long distance vehicles that enable the use of appropriate vehicle weights and dimensions, support for advanced driver assistance systems, 24/7 operation; support the supply and distribution of alternative fuels/energy in conjunction with conventional fuels, and support efficient driving, including traffic flow enhancement technology.
- **Urban infrastructures** for green vehicles improving both accessibility and convenience and supporting the reduction of noise, vibration and emissions appropriate for the operation hours.
- **Integration of intelligent fuel/energy infrastructures**. This would include testing of inductive charging infrastructures for electric vehicles (passengers/freight) during driving. Particular focus on freight vehicles of 2.5 tons or more. Interoperable dynamic and static charging solutions for Full Electric Vehicles; technologies and strategies for range extension for EVs during inter-city travel to overcome capacity limitations of battery packs
- **Dedicated corridors for autonomous highly efficient vehicles** that could be operated in platoons.
- **Deployment strategies** for infrastructure for green vehicle prioritisation or dedicated lanes/routes during times of peak pollution restrictions.

Expected impact:

- Facilitates market uptake of cleaner and quieter vehicle concepts by providing adequate levels of required operational services and processes.
- Improves environmental quality and liveability of immediate surroundings of the infrastructure; both in the urban setting and alongside transport corridors

Opportunities for programme efficiencies:

- Coordination with Horizon 2020, Part III: pillar 3.1.3 (Smart cities and communities) and pillar 3.4 (single smart European electricity grid)
- Coordination with STTP field 6: Europe-wide alternative fuel distribution infrastructures
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network

References to ERTRAC roadmaps:

- **SFTE roadmap**
- **IGV**: Green corridors for long distance goods transport on dedicated European axis; Production, supply and distribution of advanced biofuels
- **ERT/HRT**: EV and HEV integration into the transport system

Pillar 4.1.2:**Developing smart equipment, infrastructures and services**

Smart equipment and infrastructure services are of great importance for a reliable and efficient transport system of the future. Due to financial limitations and costs savings in the recent years the maintenance backlog is constantly increasing and has in some occasions led to a marked degrading of the competitiveness of countries. In order to fulfil user expectations in an optimal way, the widening gap between funds available for infrastructure maintenance and required activities and measures needs to be bridged.

In order to exploit the potential of smart, green and integrated transport operations to the fullest, a suite of innovations will be developed and tested/demonstrated, that enables the next generation of road infrastructure and transport service operations in particular where it is concerned with advanced systems, materials and techniques for improved durability, advanced management processes, as well as in construction (from a lifecycle perspective).

The suite of solutions will hold 'single technologies and techniques' as well as sub-systems and even full systems level (e.g. for management of transport corridors). Such next generation technology is highly synergetic with the rapid developments in the other components of the road transport system (vehicles, logistical and mobility services, energy and information) and indeed with the other modes, through efficient interchanges (hubs, terminals, gateways).

Advanced systems, materials and techniques for non-intrusive maintenance and reconstruction:

The objective is to enable road operators to minimize intrusion by maintenance and reconstruction to a level that may be considered as 'invisible to the user'. This comprises: the maintenance and construction activity itself; Increased durability of components in order to increase lifecycle; and the overall management process optimising costs reliability, safety and availability of the infrastructure. A suite of advanced solutions in all three fields will be developed and demonstrated 'in situ' on key sections in the European road network together with the respective road authorities and their related key stakeholders.

- Foster the emergence of high-tech industry and service sectors (including operators and related providers) that are competitive on the global market.
- Optimizing durability of the critical structural components (e.g. joints), rapid execution of eventual maintenance and on autonomous inspection & survey and repair and (re) construction.
- Developing, refining and validating predictive models for materials and systems performance.
- Technology capture from other industrial sectors such as offshore, aviation and space exploration (e.g. autonomous inspection, survey and repair).
- Co-objective is to minimize the exposure of road workers/users to dangerous situations
- On-going, rapid integration of intelligent vehicles and intelligent infrastructure will be assessed on its potential for monitoring the infrastructure conditions.
- The delivery of the suite will be accompanied with an implementation strategy including a co-financed testing programme for one or more key European road links.

Expected impact:

- Improved utilisation of available infrastructure and reduced congestion through technologies and processes that result in less intrusive maintenance and reconstruction.
- Less fatalities and severe injuries with road workers and road users
- Reliable accessibility through improved assessment of remaining life span and consequent improved planning and coordination of maintenance interventions.
- Greater harmonisation and standardisation of techniques and processes for benefit of the internal market and understanding of road users.
- New global market opportunities for European road operators, contractors and manufacturers.
- Towards zero congestion from maintenance and reconstruction activities.

Opportunities for programme efficiencies:

- Coordination with Horizon 2020 Part III: pillar 4.2.4 (safe infrastructures; tools for safer roads), and Part II: pillar 1.1.5 (ICT)/1.2 (nano technologies)/1.3 (advanced materials)/1.5 (advanced manufacturing and processing)
- Coordination with STTP field 5: Smart, green, low-maintenance and climate-resilient infrastructure
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network

References to ERTRAC roadmaps:

- **SFTE**: User friendly Design & Construction; durable and integrated Pavements, Bridges, Tunnels & Structures; Advanced Utility, Sensory and Communication Systems

Climate Resilient Road Links across Europe:

The objective is to enable adequate climate resilience in the road infrastructure network throughout Europe through a coherent suite of common solutions that are fit for purpose. For key European road links to be selected within the TEN-T core network in conjunction with the related operators, harmonised strategies for the mainstreaming of cross-border climate adaptation measures into infrastructure development and management implementation strategies will be drafted, building up from the investment baselines of the respective infrastructure authorities and relevant private market players applying a comprehensive and consistent catalogue of adaptation measures including through efficient PPP schemes.

- Implementation of a European risk map for the core TEN-T road network, that will be developed in close cooperation with the network's operators on the basis of a harmonised risk assessment method for the impact of climate phenomena on the management and functioning of the (road) network.
- Identify the vulnerable locations in the network and the impact of eventual disturbance from climate extremes against the backdrop of uniform climate scenarios and harmonised methods. Develop appropriate local and regional application requirements.
- The cost-effectiveness of the adaptation measures will be based on Life Cycle Cost.
- Develop traffic management solutions that can deal with rapid changes in infrastructure that might occur with a major disaster.

Expected impact:

- The direct impact is an ensured availability of road transport on key European road links under extreme weather events.
- Cross-border harmonisation of the implementation strategies implies a timely build-up of long term investment baselines for the adaptation to climate change effects. Large parts of actions under the key research area will be applicable across the modes, driving a climate resilience of the entire transport infrastructure network.
- Indirect impact is the reliability of the network to support its key economic and social functions across Europe, thereby improving competitiveness on the global market.

Opportunities for programme efficiencies:

The societal challenge of climate change drives many major initiatives for adaptation and mitigation throughout Europe, which offer many opportunities for efficiency through coordination and cooperation, for example with the German 'Strassen im 21. Jahrhundert' and French 'Routes 5^e Generation' programmes.

- Coordination with Horizon 2020 Part III: pillar 4.2.2 (seamless information for logistics and drivers)/5.1.1 (reliable climate projections)/5.1.2 (assessment of impacts and vulnerabilities; adaptation measures), and Part IV: pillar 3.5 (f: climate impact analysis)
- Coordination with STTP field 5: Smart, green, low-maintenance and climate-resilient infrastructure
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network

References to ERTRAC roadmaps:

- **CCRT** Roadmap

Advanced infrastructure telematics, fit for purpose:

The objective is to deliver a suite of infrastructure side telematics systems that provides real time support to both the road user (e.g. travel information services, logistics routing) and the road operator (e.g. road condition, traffic management) in the framework of a clearly defined road service value chain, taking due account of the respective roles of the stakeholders concerned on the demand and supply sides.

- The first priority is to define an adequate base information level which will be developed by the public or private road infrastructure operator with respect to the user needs and interoperability along key European road corridors. This includes the requirements such as monitoring and consolidating freight flows, real time and dependable travel schemes and intelligent traffic management to optimize utilization. Current best practices will be inventoried and evaluated for eventual technology gaps that need subsequent research and innovation on telemetric systems.
- This includes the requirements such as monitoring and consolidating freight and passenger flows, real time and dependable travel schemes and intelligent traffic management to optimize utilization.
- The different needs of different user groups will be taken into account to address the heterogeneity between users. By tailoring the information to different users and their specific needs in terms of content, temporal aspects and layout acceptance of information and advice is increased and therefore adhered to. This will increase the accessibility of information and social inclusiveness.
- Current best practices will be inventoried and evaluated for eventual technology gaps that need subsequent research and innovation on telemetric systems.

Expected impact:

- Enables further implementation of user pays, polluter pays” principle through equitable and comparable pricing/charging schemes (e.g. taking into consideration specific use, vehicle type etc.).
- Provides the basis for advanced driving concepts such as assisted/cooperative driving, platooning and autonomous driving, which hold substantial potential for improving utilization of the available road infrastructure capacity.
- Provides the basis for advanced, real time, dependable and interoperable information services to the road user, such as advanced charging schemes, eco-routing and real time early warning services; both in the urban setting as in the setting of long distance road transport. This will enhance social inclusiveness and accessibility.
- Integration of green vehicles in the (multi-modal) transport system .

Opportunities for programme efficiencies:

- Telematics are a topic in many major policies and initiatives throughout Europe, which offer many opportunities for efficiency through coordination and cooperation, for example with the DITCM Dutch Integrated Test Site for Cooperative Mobility (www.ditcm.eu)
- Coordination with Horizon 2020 Part III: pillar 4.2.4 (safe infrastructures; tools for safer roads)/4.3.2 (on-board smart control system), and Part II: pillar 1.1 (ICT)
- Coordination with STTP field 5: Smart, green, low-maintenance and climate-resilient infrastructure
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network

References to ERTRAC roadmaps:

- **SFTFE**: Advanced Utility, Sensory and Communication Systems; Communication infrastructure (X2X); Intelligent Traffic Management Systems ; Integration of urban traffic and travel information; Integration of ticketing and charging services; Co-modality and intermodal seamless interoperability; Intelligent logistics Systems, optimising e-freight , single window
- **EBSF**: EBSF ICT platform integration
- **ERT**: Transport system integration
- **CCRT** and **RUBE** roadmaps
- **IGV**: Electrified vehicle monitoring, service for battery emergencies

Advanced Infrastructure Management Systems:

The objective is to deliver a coherent, trans-national national set/toolbox of tools, methods, models for strategic management of the European transport networks. This will follow a holistic concept allowing optimal risk-based efficiency across the network and the entire road service value chain, while possibly also offering innovative infrastructure management concepts too their modes. Starting from this concept, the tools can be tailored to the specific needs of the respective (public or private) road operators. First action is the development of a common definition of the basic management information. This allows the development of an advanced Building Information Model (BIM) for the core TEN-T network, starting from current best available technology and taking into account market take-up. In conjunction with this BIM, a generic European asset management method will be developed that allows for consistent optimisation between cost, performance and risk in road, rail and waterborne infrastructure operations in reference to clear performance criteria, such as on reliability, availability, maintainability, safety, security, health, environment and economy. Combined, it provides the holistic management concept required by (road) infrastructure authorities and operators in their pursuit of better supervision over their core operational processes, environmental responsibilities and the manufacturing & construction supply chains ('manu-services'). The toolbox will be demonstrated on selected sections of corridors in the core network.

Expected impact:

- Enables consistent and transparent cross-modal and cross-border optimization of TEN-T infrastructure operations (cost-performance-risk)
- Enables integrated supply chain oversight and management for both infrastructure authorities, (private and public) managers and contractors.
- Enables the emergence of new business models and market services from EU-contractors and manufacturers reinforcing the trend to operate networks under DBFM contracts.
- When established for the core TEN-T infrastructure network, provides further roll-out towards the supporting secondary networks.

Opportunities for programme efficiencies:

- Coordination with Horizon 2020 Part III: pillar 4.2.1 (debottlenecking European road links; intelligent TM strategies)/4.2.2 (seamless information services for driver and logistics)/4.2.4 (safe infrastructures; tools for safer roads)/4.4 (economics), and Part IV: pillar 3.4 (items c and d)
- Coordination with STTP field 5: Smart, green, low-maintenance and climate-resilient infrastructure
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network

References to ERTRAC roadmaps:

- **SFTE** roadmap
- **CCRT** roadmap
- **HDT** roadmap

Pillar 4.1.3:

Improving transport and mobility in urban areas

ERTRAC Strategic Research Agenda has set as objectives an improvement of the energy efficiency of the urban mobility system by 80% by 2030 and an improvement of accessibility in urban areas. This will be achieved through both an improvement of the energy efficiency of the vehicles and gains at the system level. This chapter focuses on the later and on the improvement of the accessibility.

Public transport needs continuous and sustained improvement to be more efficient and more attractive as they should play a key role in the future urban mobility system.

Urban logistics is an area where there are significant efficiency gains to be obtained. Research should continue to investigate new solutions for more efficient and reliable urban logistics.

For a more efficient and accessible urban mobility system, there is a need to enable more efficient trips. This requires to provide travel options relying upon a range of tools, all of which require to be supported by innovation. These tools should influence more efficient behaviour. They range from better integrating soft modes with the urban mobility system and infrastructure, to demand management, and innovative transport services. They rely on knowledge to be developed in urban planning and understanding traveller behaviour, which are also addressed in other chapters of this document.

To enable the efficient mobility of persons and goods through efficient transport options, optimum multimodal solutions should be enabled in a seamless urban mobility system. For this purpose, further research and innovation should enable a fully integrated urban mobility system, providing solutions for the integration between modes, services and networks.

To reach the ERTRAC objective, a strong emphasis has to be given to supporting the deployment of innovation. This includes supporting innovative procurement procedures, integrated solutions combining different innovations, and supporting their deployment in a large scale. This will enable to achieve the societal challenges of 2020.

Urban network management for a more efficient urban mobility system:

Innovative tools should be developed by research to enable a more efficient management of the urban network to achieve the objectives of more energy efficient urban mobility systems. This includes technological and non-technological tools aimed at steering behaviours towards more efficient travel solutions. Topics to be addressed include:

- demand management, including parking and pricing, encouraging efficient travel options with economic incentives and the management of space and of the infrastructure. This can also significantly impact the accessibility of the networks.
- the provision of innovative transport services for greater efficiency;
- integrated intermodal network management tools, relying upon advanced planning processes and tools;
- greater safety and security for all type of modes and travellers, including a better knowledge of how to target safer behaviours,
- the provision of better infrastructure and services for soft modes
- policies addressing transport and health, and beyond this encouraging co-benefits;

Expected impact:

- A more efficient urban mobility system through the Integration of innovations on a range of components of the urban mobility system, including all transport modes and the inter-urban linkages
- increased energy efficiency
- better accessibility
- better road safety
- Demonstration of the transferability of innovative measures between cities
- Demonstration of the multiplying effects of the integrated approach

Opportunities for programme efficiencies:

- While CIVITAS can demonstrate the benefits of the integrated approach to improve the efficiency of the urban mobility system, the SmartCities and Communities programme focuses on the integration via ICT of various sectors at the urban level, in particular transport and energy.
- As this focuses on an integrated approach, there are strong links with other pillars of this document, in particular 4.1.1, 4.1.2, 4.2.1, 4.2.2., 4.2.3
- Integrated planning and land use in transport

Reference to ERTRAC roadmaps:

- IUMS roadmap
- EBSF roadmap
- ERT: Transport System Integration

Innovative Bus Systems as key element of future ideal urban mobility scenario:

The objective is to contribute to the development of urban bus systems that answer the needs of all stakeholders and take into account new urban mobility challenges, available technologies and efficiency in operations. It is based on a "system

approach” developed and applied with success in FP7 projects like EBSF and 3iBS. The following areas have been identified for further research on bus systems. Some of them go beyond the pure focus on bus systems and are relevant for the overall urban public transport system:

1. Bus systems integration in urban scenario, including:

- Identification of requirements and suitable solutions for the specific mobility challenges of different categories of passengers taking into account demographic changes (age groups), in particular in terms of accessibility, information, comfort.
- Development of concepts for multimodal urban transport integrating also the bus system and identifying optimal use of each transport means. Design, development and test in different urban scenarios of modular bus-stop and terminal
- Development and test of new technologies for urban infrastructure (pavements, platforms, dedicated lanes, traffic priority systems)
- Development, prototyping and test in real operation of technologies for high capacity buses
- Application of system approach for intercity (short distance) coaches, as part of the whole transport system,

2. Integration of the standard IT platform developed for bus communication into other relative to Public

- Transport and urban mobility, focusing in particular for interoperable and dynamic passenger information.

3. Development and test of an intelligent bus garage

4. Sustainability of bus system, in terms of

- Development and test of new materials for system energy efficiency Development of concepts and demonstrations of the integration of the existing electric and transport networks (electricity provision to trams, etc.) for supporting private and public electromobility (charging, etc.) via the public transport system
- Development and test of a modular electric bus prototype with batteries sited in the trailer to be charged when trailer is unplugged; development of the suitable operative concepts and roll-out plan.
- Development and test of technologies for new generation of trolleybuses with large autonomy and possible use of tram lines.

5. Research on innovative vehicle technologies applied for bus systems:

- Bus Driver assistance systems
- Advanced collision guard systems for bus drivers and pedestrians.
- Adaptation to not guided systems of the solutions to reduce lateral and vertical gap between bus and dock to improve accessibility especially for reduced mobility people.
- Solutions for vibration

Expected impact:

- Improved bus services with cleaner, quieter, more efficient vehicles moving in a more adapted infrastructure
- Reduced CO₂ and fuel consumption of urban mobility
- Increased use of Public Transport Contribute to the smart use of city energy resources
- Efficiency and costs reduction coming from wider use of standardisation in IT

Opportunities for programme efficiencies:

- These recommendations are focused on one key Public Transport component (bus systems) which can be integrated with other Public Transport and mobility solutions
- Smart Cities and Communities, European Green Vehicles Initiative, CIVITAS and possibly other initiatives

References to ERTRAC roadmaps:

- EBSF roadmap
- ERT roadmap
- HRT roadmap
- IGV roadmap
- IUMS roadmap
- RUBE roadmap

Smart urban freight:

The objective is to enable a more efficient integration of urban freight deliveries in the urban transport system and in the logistic chain. This relies on the use of innovative solutions for quieter and more energy efficient vehicles and operations. It also involves the implementation of innovative urban freight delivery solutions. These are enabled by the cooperation between the stakeholders, including the local public authorities, the freight operators and the retailers.

The use of ICT is one of the factors enabling this cooperation with the exchange of data and the provision of information by each of these stakeholders.

New logistical concepts and infrastructures must be developed and tested, and innovative ones must be further research. This includes urban transport consolidation centres, the use of data on goods with consideration for the possible exploitation of eFreight for urban freight delivery, and a better integration of freight operations in network management strategies and operations.

Issues to address:

- Framework for the exchange of data on urban freight, including exploring the potential to link up with eFreight
- Land use and urban freight, including the integration between regional and urban level
- Value added logistics services:
 - > Consolidation schemes and measures related to the urban supply chain.
 - > Data collection and analysis of freight movements
 - > Actions targeting own accounts operators
- Integration of urban freight in urban network management, using ICT
- Design and operation of adequate infrastructures for urban freight deliveries
- Cleaner and quieter urban freight delivery vehicles and equipment and their introduction in the market

Expected impact:

- Better data/information exchange between freight stakeholders
- Reduction of local environmental impact: air quality and noise
- Reduction of CO₂ emissions
- Reduction of congestion and increase of accessibility
- More efficient logistics operations,
- Market-uptake of cleaner and quieter vehicles, equipment and infrastructure

Opportunities for programme efficiencies:

- The integration of urban freight in the logistic chain, and the importance for this activity of the cooperation between transport networks (long distance and urban) requires that this dimension be considered also in the framework of the TEN'Ts.
- There are synergies with several pillars from the document, in particular pillar 4.1 and 4.2

References to ERTRAC roadmaps:

- HDT roadmap
- IUMS roadmap
- LUTI roadmap
- HRT: Freight transport on city corridors; HRT: Semi-/automated and cooperative driving

Seamless urban mobility:

The objective is to research and develop tools to enable a further integration of the urban mobility system increasing the efficiency of the system by providing efficient intermodal travel options. This requires a better integration between all the modes of transport at the urban level, being it the physical integration, or integration of multimodal services (information, payments, network management), enabled by ICT.

In particular, the integration of soft modes is essential to significantly improve the energy efficiency of the whole system. It should allow to move closer towards the optimal modal integration.

Under this topic, research should allow to go further in offering a range of services to enable the traveller to choose the optimal multi-modal solutions to travel, and tools for managing the urban network as a single system.

The goal is also to develop the tools allowing to focus the management on the system on the movement of freight and passengers

- Techniques and standards for the provision of appropriate cycling and pedestrian infrastructure including the interfaces with other modes and means.
- Optimal integration of modes / quality of nodes
- Range of services to enable the traveller to choose the optimal multi-modal solutions to travel
- Tools for managing the urban network as a single system
- Integrated network management tools for managing the movements of persons and goods, and not only of vehicles
- Provision of infrastructure and interchanges for a greater integration of the urban mobility system, including interchanges
- Integration of the urban mobility system with other sectors, in particular the energy network, in the smart city

Expected impact:

- Integrated ticketing and payment systems
- Truly multi-modal personalized real time travel information systems in urban areas across Europe
- Transparent urban network management, based on new tools and strategies
- New concepts for modal integration in the urban environment, with special focus on the soft modes
- Improved public transport systems
- Flexible framework for the integration of new transport concept e.g. electro mobility

Opportunities for programme efficiencies:

- This topic develops the transport component which can be integrated, via the Smart Cities programme, with other networks in the urban environment
- SmartCities, CIVITAS

References to ERTRAC roadmaps:

- EBSF roadmap
- IUMS roadmap
- LUTI roadmap

Integrated Planning of Land Use and Transport:

The objective is to enable transport authorities –from the vision of seamless mobility’- to develop a coherent and consistent framework for Land Use and Transport Planning as well to enable them to execute the consecutive infrastructure renewal and reconstruction works considerably faster and cheaper than in current practice.

An innovative, strategy-driven methodology and approach for a multi-stakeholder coordination and engagement will be developed and demonstrated in selected real practice situations on the urban scale as well as on the European regional scale.

Key in this integrated Land Use and Transport planning approach is the adequate and transparent capture of the economic, societal and environmental values and investments (including accessibility of services and activities and the effects of climate change), to serve as a common reference for expressing the various stakeholder interests in monetary terms. This capture will be done from a functional definition of accessibility.

Following on this initiate frame working phase, a practical toolbox will be developed and demonstrated for the operational planning and execution of the consecutive infrastructure (re) construction works that achieves significant increased efficiency in investment, planning cost and output quality for the relevant key stakeholders included in the respective spatial envelope. Next to local and regional authorities such as municipalities and infrastructure authorities these are concerned with public and industrial stakeholders, such as transport operators, and businesses.

The aim for 2020 is to develop and demonstrate a common framework/toolbox that enables the simultaneous evaluation of requirements from the perspectives of the (multi modal) network and the involved institutions as well as the supporting basis of data, methods and models. The demonstration will focus on selected works that are planned for three key European transport corridors. Next to the framework/toolbox a roll-out strategy will be delivered focusing on the core Ten-T network.

Expected impact:

- Better coordinated mobility planning and land use planning at the urban scale as well as at the EU regional scale, leading towards improved availability, reliability, resilience of the transport system and towards improved accessibility of infrastructure services and activities.
- Better, methodological understanding of the drivers for location choice of businesses and people, such as parking and access to transport modes and services. From this understanding: improved efficiencies in decision making, leading to an effective reduction of travelling distance and time in commuter patterns; of the environmental impact on the immediate surroundings of the infrastructure as well as improved consolidation of urban areas
- Significant cost savings in the operational planning and execution of renewal and (re) construction works: up to 10 % less investment (by finding smarter and more specific solutions), up to 50% less planning costs (by strongly shortening the planning duration), and a leverage on investments up to 1:6

Opportunities for programme efficiencies:

- Smart Cities

References to ERTRAC roadmaps:

- LUTI Roadmap

Pillar 4.2.1:**A substantial reduction of traffic congestion**

ERTRACs research focus under this pillar is on the debottlenecking of transnational road links in combination with the deployment of user-centric traffic management system in conjunction with next generation road transport systems for freight and passengers. Key focus areas are the urban network and the interfaces and interchanges to it. Opportunities for co-modality will be taken into account as well as the causes and sources for transport movement upstream in the supply chain. However, ERTRACs research respects the fact that ultimately it is the user choosing the optimal solution.

Debottlenecking the European key road links:

An implementation strategy will be delivered for resolving the bottlenecks in key European road links from congestion. This concerns urban as well as interurban links. The focus is on the physical pinches in which demand exceeds available capacity.

- For each of these pinches appropriate measures will be proposed, that could include: capacity provision, improved

alignment; advanced traffic management and information, upgrading and improved management of the available capacity ('sweating the assets').

- The availability of high-precision measurements has to be technically realized and secondly new control strategies for suppressing the measurable emergence of traffic congestion at the bottlenecks have to be developed. This includes the full spectrum of mobility (demand) management concepts.
- Also, particular attention will be paid to the opportunities that interchanges to the other modes may bring (rail, inland navigation). Here the focus to 2020 will be on the key locations where the market determines choice of mode for freight such as in ports. All relevant stakeholders from infrastructure as well as logistical and mobility services will be engaged.

Expected impact:

- Optimal match between demand and available network capacity.
- Evolution of new better management and control strategies at that can deal explicitly with congestion bottlenecks
- Focus on reliability of travel times and robustness of road networks
- Less congestion in particular for the urban/economic areas
- Cross-border cooperation on congestion reduction (multi stakeholder approach, including first responders, infrastructure authorities, businesses, transport operators etc.)

Opportunities for programme efficiencies: Smart Cities,...

- Coordination with Horizon 2020 Part III: pillar 4.1.2 (advanced infrastructure management systems)/4.2.4 (safe infrastructures; tools for safer roads)/4.4 (economics)
- Coordination with STTP field 5: Smart, green, low-maintenance and climate-resilient infrastructure; field 7: Efficient modal traffic management systems. Fields 8, 9, 10 important for providing wider context.
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network; in particular where concerned with connecting to ports and airports. Freight and traffic management systems.

References to ERTRAC roadmaps:

- **STFTE** roadmap
- **HDT** roadmap
- **CCRT** roadmap

Productive European Freight System:

The objective is to deliver an implementation strategy for substantially improving the productivity of selected key multimodal European freight hubs and corridors. The strategy will aim at the best way of transporting freight over the respective links and will address key issues such as the co-modality, consolidation of consignments across the freight operators, improved spatial planning of distribution/consolidation hubs, information provision, compliance management and effective stakeholder engagement in the supply chain in order to determine further efficiencies in view of the causes and sources of freight movement.

Expected impact:

- Reduced freight transport movements per value delivered over the chain.
- Improved utilization of available road infrastructure
- Development of fair market schemes (e.g. pricing)
- New market services and business models
- Interchanges/interfaces for the integration of the last mile in the logistical chain (urban/economic areas)

Opportunities for programme efficiencies:

- Coordination with Horizon 2020 Part III: pillar 4.1.2 (advanced telematics)/4.1.3 (integrated planning of land use and transport)/4.2.1 (intelligent TM strategies)/4.4 (economical and geographical parameters)
- Coordination with STTP field 9: Seamless logistics
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network

References to ERTRAC roadmaps:

- **HDT** roadmap

Intelligent Traffic Management Strategies:

The objective is to deliver a common implementation strategy that enables the transition to user-centric traffic management on key European road links. The strategy will focus on transitions in a cohesive set of key traffic management entities that form the framework for traffic management systems and cooperation on a strategic, tactical and operational level. Particular research areas to develop are the use of cooperative systems and (forms of) automated transport to improve the performance and utilisation of the infrastructure, increase cost efficiency and to secure free flow of traffic and, clean, safe and reliable travelling; integration of freight logistics and cooperative traffic management; the optimal balance and consistency between collective measures and individualised/personalised services in view of the trend to road user

self-management; quality and availability requirements for a safe, clean, effective and reliable deployment of the new traffic management technologies like cooperative systems, convoying, price variation on road usage and personalised traffic information.

A key issue is an integrated decision support system for consistent and pro-active traffic management with personalized traffic information provision. This enables advanced human-vehicle interaction involving i.a. eco-navigation systems coupled with traffic information data.

The intelligence lies in the exploitation of historical and real-time traffic and traveler's data, case-based control scenarios and automation, and personalized traffic information based on user profile and traffic prediction. A multi-criteria (free-flow, clean and safe) and multi-objective (different organization for whole network) decision support system can help realize the seamless strategic, tactical and operational applications.

In view of the objective of user-centricity, attention will be paid to relevant human factors (needs, capabilities and limitations) in order to enhance optimal acceptance, and use of respective technologies.

Expected impact:

- Enables and exploits advanced driving and service concepts such as cooperative driving, platooning, price variation on road usage and personalized traffic information
- Better use of the new data provided by a co-operative traffic system to improve traffic control and traffic management
- Substantial reduction of congestion/improved accessibility, preserving a clean living environment
- Improved cooperation between the stakeholders
- Improved user appreciation

Opportunities for programme efficiencies:

- Coordination with Horizon 2020 Part III: pillar 4.1.2 (Advanced infrastructure management systems)
- Coordination with STTP field 7: Efficient modal traffic-management systems; field 8: Integrated cross-modal information and management services
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network

References to ERTRAC roadmaps:

- **IGV, HRT:** Integration of electrified vehicles into the transport system
- **IGV, HRT:** Semi-/automated and cooperative driving

Pillar 4.2.2:

Substantial improvements in the mobility of people and freight

The ERTRAC focus for this pillar is the seamless information system for logistics and the driver. Unless this is achieved, all efforts for transport management, trans-European cooperation between logistical and mobility services and market driven supply of advanced end user information applications and services will yield sub-optimal mobility outcome at best. Although its primary focus is to achieve seamlessness across the road transport, ERTRAC acknowledges the importance of interoperability across all the transport modes.

Seamless logistics information services on key European road links

A next generation of logistics-centred information systems will be demonstrated on key European road links, with a particular focus on interoperability in view of co-modality. This will take the form of field operational tests which will build on current and new solutions for information management, data processing, real time planning, data capture technology and monitoring and evaluation, both by businesses and by authorities. Next to improving load factors through 'now time' information provision and assessment, the result will enhance the further development of Single Window Platforms, which are expected to play an increasingly important role in the future efficiency and sustainability of freight, which is a key area in the EU Freight Logistics Action Plan. This requires the development of a new large/open data infrastructure, which will feed applications around hubs concerning freight logistics services for transshipment, customs, parking and added value services. More effective provision of information will not only, for instance, match loads to capacity more efficiently, but information availability will also enable government agencies (customs, police etc.) to improve their performance in supervising business activities, increase their hit-rates and remove administrative burden and bottlenecks. Auxiliary services for road transport (e.g. parking) will be integrated with traffic management services.

Expected impact:

- Improved productivity in freight transport
- Improved reliability and better use of available capacity

- Greener road transport
- Standards for data exchange
- Increased compliance with regulations
- Safer driver environment

Opportunities for programme efficiencies:

- Coordination with Horizon 2020 Part III: pillar 4.1.2 (advanced telematics; advanced infrastructure management systems)/4.1.3 (smart urban freight)/4.2.1 (productive European freight system) /4.4 (socio-economic parameters)
- Coordination with STTP field 9: Seamless logistics
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network; in particular in relation to the theme of freight transport services

References to ERTRAC roadmaps:

- **HDT, IGV:** Driver, truck, load & localization status & instructions data transfer (e.g. E-freight); Protocols/devices/information for V2G communication. Infrastructure communication (X2X)
- **IGV, HRT:** Semi-/automated and cooperative driving

Seamless driver information services:

The ITS Action Plan and Directive set goals for making specifications and prioritize the out roll of traveller information services. The successful European implementation requires cross-border testing. Information should be real-time and should provide advice, possibly integrated with relevant traffic management and personalized information. New sources of information, e.g. crowd sourcing, floating car data, should be fused. Methods for determining the reliability of the data sources and information provided need to be developed. If the number of equipped vehicles increases, wireless ad-hoc networks will have insufficient bandwidth to communicate all information. Ad-hoc wireless networks should be integrated with cellular networks (3G, LTE), or smarter use of the available bandwidth, or increase of bandwidth should be realized to be able to communicate all required information. This could also include priority mechanisms to make sure the most relevant information gets priority.

To get initial deployments, the main focus is on solving (amongst others) the technical challenges on the wireless V2X network. To support viable business cases, it is crucial that also the (fixed) networks backing and interconnecting the V2X networks with each other, with road operators, and with the Internet Cloud support systems from multiple vendors, that services from multiple providers are supported, and that a wide variety of services is supported.

On the information level, information exchange between multiple providers has to be supported to allow for European wide services, to support viable business cases, and to develop an eco-system of mobility services. Due to the regional character of mobility applications (e.g. traffic management), European wide cooperation is required. This has a large business model component. However, business solutions has to be supported by technology, e.g. to allow for fine grained access rights on information, while maintaining the timely information exchange to support the typical mobility applications. Internet technology, including cloud computing and ITS should meet here.

- Ensured link to the web regardless of tunnels etc.
- Continuous connection with information service from market and operator: real-time information, guidance etc.
- Supply of information of same quality
- Context adaptive and dedicated driver support for routing and comfort functions

Expected impact:

- Improved efficiency of (road) journeys through better information and value proposals (e.g. time vs. cost)
- Improved ability for the operator to optimise its management of the system; e.g. on safety, utilisation rate, environment
- Fostering of new emerging businesses/markets for transport and information services
- Enhances the mass market up-take of electrified vehicles.
- Enhances compliance with standards, specifications and guidelines.
- Improved reliability of information to all stakeholders
- Heterogeneous wireless networks for reliable and efficient communication
- Reliable end-to-end networks to support multi-vendor, multi-provider, multi-service solutions
- Real-time, multi-provider cloud based information exchange
- Multi-stakeholder Business Models – In order to realise cooperation of multiple entities based on mutual profit

Opportunities for programme efficiencies:

- Coordination with Horizon 2020 Part III: pillar 4.1.2 (advanced telematics)/4.1.3 (seamless urban mobility)/4.2.1 (intelligent TM strategies)/4.4 (behaviour)
- Coordination with STTP field 10: Integrated and innovative urban mobility and transport
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network

References to ERTRAC roadmaps:

- **IUMS** roadmap
- **STFTE** roadmap
- **HDT** roadmap

- CCRT roadmap
- IGV, HRT, ERT: Integration of electrified vehicles into the transport system

Pillar 4.2.3:

Developing and applying new concepts of freight transport and logistics

ERTRAC will focus its research and development activities on the issues that enable vehicles and infrastructure matching each other much closer as to allow for advanced operations such as cooperative driving, platooning or operating truly green (freight) corridors, integrating green vehicles with smart, green and integrated infrastructure and advanced logistical service concepts such as single window, single payment, e-freight, dynamic routing etc. An additional key research area is focused on the interfaces and interchanges to the other modes as to enable truly seamless transport from origin to destination, including the last mile that is typically carried by road transport.

Vehicles and infrastructure matching each other:

New concepts include systemic smart corridor and hub architectures, solutions for local livability or global sustainability, multimodal network management and e-freight information strategies. Integration between cooperative driving and Logistics ITS technologies to allow communication between passenger and freight vehicles and roadside information systems. Applications include travel information, traffic and transport management (planning/booking/capacity management), auxiliary services (smart parking), guided platoon formation and dedicated infrastructure.

- Dedicated infrastructure: guided vehicle lanes supporting the demand for such vehicles– urban planning and implementation
- Configurable/adaptable truck- truck/vehicle design
- Platooning/green corridors for cleaner and quieter freight transport – operation
- Charging adaptive to both user and grid
- Smart travel information aligned with multimodal TMS

Expected impact:

- Optimal utilisation of available road infrastructure capacity
- Development of ultra-high capacity road transport links
- Advanced infrastructure and logistics management concepts
- Selected urban corridors and international cross border corridors adapted, dedicated infrastructure with high grade of ICT support. Several Driver Villages are established and connecting several modes. Roll-out of modular Green Vehicle Terminals.
- Efficient capacity management concepts
- Multimodal hubs and corridors operations
- Harmonized freight ICT services (roadside and cloud) available

Opportunities for programme efficiencies:

- Coordination with Horizon 2020 Part III: pillar 4.1.1 (all three topics)/4.1.3 (all five topics)/4.2.1 (all three topics)/4.4 (behaviour; societal acceptance)
- Coordination with STTP field 1: Clean, efficient, safe, quiet and smart road vehicles; field 5: Smart, green, low-maintenance and climate-resilient infrastructure; field 9: Seamless logistics
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network

References to ERTRAC roadmaps:

- SFTFE roadmap
- IGV: OEM back-end communication; Driver, truck, load & localisation status & instructions, data transfer (e.g. E-freight) ; IGV: Protocols/devices/information for V2G communication; IGV: Semi-/automated and cooperative driving; IGV: Green corridors for long distance
- IGV, HRT, ERT: Plug-in, inductive and contact charging systems for hybrid trucks and delivery vans integrated in the grid (V2H, V2G); Hybrid distribution & long haul truck concepts and powertrains

Multi-modal Interfaces:

The objective is to enable increased efficiency of passenger and freight transport within the road transport itself (e.g. consolidation of different freight consignments onto a single vehicle) as well as increase the efficiency of passengers and freight transfer to and from the other modes.

- New concepts for improving freight transport within and between the different modes (road, rail, water, air) and mediums (e.g. pipelines), including synchro-modal transport. Synchro-modality is the optimal flexible and sustainable use of different transport modes in a network under the direction of a logistics service provider, so that an integrated

solution for (inland) transport is being offered to the customer (shipper or forwarder). Essential for synchro-modal solution is that a customer is booking mode neutral (a-modal). The decision on the use of modality (s) is left to the logistics provider and not part of the transport demand expression. This is a prerequisite to seamlessly switch between modes, an important mechanism for synchro-modal transport solutions.

- Extending E-freight into the urban environment (truly achieving door-to-door freight transport)
- Develop semantic models with harmonized profiles for delivery instructions in urban areas and corresponding information architectures
- Better network operations
- Improved information services on dangerous loads

Expected impact:

- Enabling a wider range of choice of transport mode through efficient transshipment of freight across the modes.
- More options for network management e.g. in cases of incidents or environmental conditions.
- Discrepancies in the final delivery of goods due to poor information exchange appear frequently. Dutch research (TNO, 2012) identifies the following discrepancies: 94% of Dutch road hauliers, consignors and consignees experience discrepancies in the final delivery process, in 7% this even causes non-delivery (re-delivery or collection by customer required, causing avoidable extra vehicle kilometers) and potential time savings of 13% in case of eventually successful deliveries. IMRG has done a similar study in the UK, identifying the Annual Cost of Failed UK Online Deliveries to be £851m.

Opportunities for programme efficiencies:

- Coordination with Horizon 2020 Part III: pillar 4.1.2 (all four topics)/4.1.3 (integrated planning of land use and transport)/4.2.1 (debottlenecking European road likes) /4.4 (socio-economical/-geographical parameters)
- Coordination with STTP field 5: Smart, green, low-maintenance and climate-resilient infrastructure; Field 10: integrated and innovative urban mobility and transport
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network; in particular where concerned with connections to ports and airports, and freight transport services.

References to ERTRAC roadmaps:

- SFTFE roadmap
- HDT roadmap
- IUMS roadmap
- IGV: Distribution terminal, hubs for long distance and regional freight

Pillar 4.2.4:

Reducing accident rates and fatal casualties and improving security

Safety in road transport is a key area in ERTRAC's research and innovation activities. In its SRA 2010, ERTRAC proposed a "vision zero" for fatalities and severely injured in the Road Transport System, using a holistic approach that is composed of 3 elements: the road user, the vehicle, and the infrastructure. Better understanding of the biomechanical and behavioural factors of road users is required in order to improve on testing, modeling and simulation as well as effectively influence the user behavior in traffic; both concerned with the occupants and the Vulnerable Road Users. Also the integration of human factors in road infrastructure engineering is indispensable for enabling optimal safety to the road user from the concept of "self-explaining & forgiving roads". On the vehicle side, key topics are: advanced driver support and automated driving systems; integrated active and passive safety; safety of new vehicles types, and safety of Vulnerable Road Users (VRU). Topics proposed below are presented for the three areas (vehicles, users and infrastructure), but should be always addressed and developed over the innovation chain using an integrated approach. Costs-benefits assessments should be transparent and based on these three aspects.

Safe Vehicles:

- **Advanced driver support and automated driving systems:** driver support for accident avoidance, including inattention and impairment monitoring and support; human-machine interaction; enabling automated driving making use of advanced cooperative/V2X systems. Including simulation, testing and deployment pilots, regulatory (and legal for autonomous systems), standardisation and security matters.
- **Integrated active and passive safety:** right balance between active and passive systems, their integration enabling accident avoidance, or in crash scenarios, collision mitigation with reduction of injury severity, including test methods for active safety; the development of active vehicle structures and fully adaptive restrains systems.
- **Safety of new vehicle types:** improved crashworthiness of light and/or new vehicle concepts and crash compatibility with other vehicles; intelligent vehicle dynamics; integrated safety concepts for electrified vehicles in particular for the

use of new energy storage systems (when driving, charging, at standstill and in misuse/accident/post-crash scenarios); alternative fuels leakage; crashworthiness of vehicles designed with new lightweight materials, as well as for alternative joining techniques; extension of virtual testing for these challenges.

- **Safety of Vulnerable Road Users:** pedestrians and 2-wheelers detection systems for accident avoidance; safety systems for protection of VRUs in case of collision; safety systems for single-vehicle two-wheelers accidents; assessment of the safety situation in European cities of public bikes, e-bikes and other new personal mobility devices. Setting the basis for harmonization or regulatory requirements.
- **Secure road transportation:** advanced alarm and tracking systems for vehicles; tamper-proof identification and access systems.

Expected impact:

- ERTRAC SRA guiding objective: on the path to the Vision Zero, reduction of both fatalities and severe injuries **by 60% by 2030**, versus a 2010 baseline. Including therefore both avoidance of collision and crash mitigation reducing injury severity, with a special focus on improving the safety of Vulnerable Road Users.
- Ensure safety of vehicles running with alternative energies and new lightweight vehicle concepts.
- Supporting competitiveness of EU auto industry by having product leadership in vehicle safety.
- Paving the way towards automated driving.

Opportunities for programme efficiencies:

- Coordination necessary with the Part II 1.1 ICT programming: automotive control systems enabling safety functions rely on multiple ICT components communicating locally or via networks.
- Joint call with Part 2 1.4 Materials: for lightweight design; smart materials for safety applications.

References to ERTRAC roadmaps:

- **SRT:** Advanced driver support systems; Cooperative systems for road safety and security; Safety of new vehicles /
- **ERT:** Integrated safety concepts for novel electric vehicle platforms; Safety of Vulnerable Road Users; Traffic Safety Analysis; Secure road transportation
- **SRT/ HDT:** Automatic protection of Vulnerable Road Users
- **HDT:** Highly automated driving / IGV: Safety measures for automated and cooperative driving
- **IGV:** Safety communication V2V; Safety measures for automated and cooperative driving; Safety communication V2I

Safe road users:

The objective is to eliminate human error as a factor of fatalities and severe injuries in the road transport system. A suite of effective user-centric solutions will be developed and demonstrated in real-life safety situations, including intelligent, cooperative advanced driver assistance and automation systems. A next generation of advanced modelling, testing and assessment tools will be developed that can predict the effectiveness of user-oriented measures more accurately and comprehensively. Including model-based simulations of road user behavior, better bio-fidelity of crash dummies, representing the full range of occupant and VRUs population with higher sensitivity towards lower severity injuries. Further research on human indicators supporting systems for monitoring and subsequently assistance to the driver, in relation to drowsiness, distraction, loss of situation awareness and impairment. Including harmonization and exchange on safety related road user data. Research will also focus on adapting safety and information systems to the driver state and driving conditions and develop standards for assessing new safety systems and their interaction with the drivers to eliminate HMI related errors in the development process. Biomechanics and introduction of advanced human body models into safety system evaluations and virtual testing, including factors such as ageing and gender issues, introduction of computational models and simulation tools e.g. to enable ex-ante evaluation of road user behavior (driver models, models of VRUs) in a systems setting and with the ability to take into account biometrics such as muscle activities. Research on advanced personal safety equipment for two-wheeler riders will also be included.

Expected impact:

- Reduced testing costs by switching from physical to virtual.
- Enabling the development of tailored safety systems for different road users and different conditions
- Greater understanding of vehicle/infrastructure issues and personal responsibilities by road users
- Improvement of the drivers attention

Opportunities for programme efficiencies: Pillar 4.4.

- Coordination with Horizon 2020 Part III: pillar 4.2.4 (safety is an integrated issue over the components user-vehicle-infrastructure)/4.3.2 (on board smart control system), and Part II: pillar 1.1 (ICT)
- Coordination with STTP field 5: Smart, green, low-maintenance and climate-resilient infrastructure
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network

References to ERTRAC roadmaps:

- **SRT** roadmap
- **RUBE** roadmap

Safe Infrastructures:

The objective is to enable the infrastructure to contribute towards the 'vision zero' following the concept of the "self-explaining and forgiving roads"; i.e. a next generation road infrastructure that is capable of intelligent interaction with vehicles, drivers, and in a corresponding context with the road operators. Particular focus is on the urban and secondary road network as well as on the safety issues in the rural environment, taking advantage of relevant experience and best practices acquired on motorways. This includes more emphasis on human factors, including specific needs of VRU. Further, advancements in road engineering as well as infrastructure based pro-active safety systems such as early warning for extreme weather events, and other disturbances in the functioning of the road network. New developments in cooperative systems and V2X communications will be integrated. Quick wins in improving road safety deployment will be pursued through effective knowledge transfer/dissemination of good and best practices in safe infrastructure operations, in particular where it is concerned with the development of the road infrastructure network in the new member states.

Expected impact:

- The direct impact is less fatalities and severely injured, and the associated societal cost. This inherently brings improvements in the utilization rate of existing infrastructures and hence better accessibility for social-economic functions. Improvement of economic attractiveness.
- Standardisation and harmonisation of measures for assessing infrastructure safety characteristics.
- Improved market take-up of better performing road safety solutions and systems
- Mass market deployment of technology via consumer mobile devices
- Reducing secondary effects of accidents (e.g. congestion)

Opportunities for programme efficiencies:

- Coordination with Horizon 2020 Part III: pillar 4.1.2 (all four topics)/4.2.1 (intelligent TM strategies)/4.4 (behaviour); Part II: pillar 1.1 (ICT)
- Coordination with STTP field 5: Smart, green, low-maintenance and climate-resilient infrastructure and field 7: Efficient modal traffic-management systems
- Coordination with TEN-T/CEF-T in view of capturing opportunities for deployment testing on corridors/core network

References to ERTRAC roadmaps:

- SRT roadmap
- CCRT roadmap
- IGV: Improved roadside and tunnel safety

Tools for safer roads:

Based on coordination between all stakeholders directly involved (states/authorities and the private sector; infrastructure owners and operators, drivers, vehicle manufacturers) in the framework of a deployment-oriented EU road safety platform, the definition and the development of a common European repository for relevant road accident statistics (e.g. CARE European Road Accident Database) will be taken further in order to support predictive modelling and simulation. Systems to support security of vehicles occupants and loads, such as telematics, parking and resting areas.

Expected impact:

- Dependable, compatible data/information base to support transport system management, business cases, etc.

Opportunities for programme efficiencies:

- Coordination with Horizon 2020 Part III: pillar 4.4 (social parameters); and Part IV: pillar 3.4 (monitoring)

References to ERTRAC roadmaps:

- SRT, CCRT roadmaps

Pillar 4.3:

Global leadership for the European transport industry

The transport industry is a major contributor to the European economy, with more than 12 Millions of European families depending of the sector. Its competitiveness at the global scale must therefore be an explicit objective, in order to preserve and gain leadership positions in transport technologies and services, which can ensure growth and employment in Europe for the decades to come. Critical matters for the global competitiveness of the transport industry are firstly its ability to become leader in the development of the future transport means, such as electric cars or automated vehicles, and linked to these challenges the capacity for deploying on board smart control systems. The other fundamental matter for industrial competitiveness is the efficiency of advanced production processes: for manufacturing vehicles, for the supply chains management, and for infrastructures. This competitiveness challenge is particularly high, considering that processes have to

be continuously optimized for the production of conventional vehicles while at the same time they have to be adapted and to include additional processes necessary for the manufacturing of the new electrified vehicles.

Pillar 4.3.1. Developing the next generation of transport means as the way to secure market shares in the future:

Innovation towards the next generation of road vehicles implies a double path of electrification and alternative fuels introduction. Electric and hybrid vehicles are today a major focus for the entire industry, with technologies and components of electric drive trains being common challenges for all types of electric vehicles. The European automotive industry is racing against fierce international competitors on these topics, for which gaining global leadership will represent decades of markets expansion, jobs creation, and positive trade balance for the EU. The development of these technologies within Europe should also aim at reducing the dependence towards raw materials and components that have a limited or critical sourcing. Not only passenger cars but also trucks must be covered, with a specific integrated approach, because electrification represents for them a more limited opportunity.

- **a. Electric Vehicles.** Several topics in electrification represent highly critical issues for the global competitiveness of the European industry. The most obvious one is the continuous need to develop highly robust energy storage systems with higher energy and power density as well as lower costs, allowing to reach affordability and to meet costumers' demands, which can therefore enable mass markets for the next generation of EVs. Another key area is research and advanced development on the key components of electric drive trains. In addition, the better system integration of the components and sub-systems – into modules - can represent a real asset against new non-European competitors, less capable of handling the whole system integration and optimization. These challenges are relevant for all types of electric vehicles: full electric vehicles, fuel cell electric vehicles, and hybrids, and require dedicated vehicle integration.
- **b. Hybrid Vehicles.** Many technology challenges of hybrids are common to full electric vehicles on component level and are enablers for progressive road transport electrification. In addition, key topics such as modular hybrid architectures and range extenders as a bridge towards full EVs can help the electrified vehicles to reply and be tailored to customer demands, ensuring their market success, in Europe and worldwide.
- **c. Vehicles running with alternative fuels.** Research and development of drive trains for alternative fuels such as biofuels of the future generations, hydrogen, natural gas (CNG, LNG) and bio/syn-methane and blended fuels and/or dual fuel systems, represent market leadership opportunities for the European automotive industry.
- **d. Next Generation of Trucks.** The hybridization and the use of alternative energies in truck powertrains is a major issue. Particularly the much higher power and energy level at which truck powertrains are operating requires components and subsystems with outstanding performance characteristics, as well as very high demands on durability. But beside the powertrain aspect it is essential to develop the concept of tailored truck, using standardized load carriers, and to enable the green corridor approach, towards self-operating and resilient trucks.

Expected impact:

- The European Roadmap Electrification of Road Transport gives as a milestone for 2020 an objective of 5 million electric vehicles being driven on European roads by 2020 if all research, development and regulatory aspects mentioned in the roadmap are being covered on time.
- By 2020, efficiency gains in system integration will lead hybrid vehicles closer towards a positive costs/benefits ratio to consumers, opening the path to mass market deployment.
- Topics from the Heavy Duty Truck roadmap of ERTRAC give the opportunity to together lead towards the objective set in the ERTRAC SRA of getting a 40% improvement of energy efficiency of long distance freight transport (in tkm/kWh, by 2030 compared to 2010).

Opportunities for programme efficiencies:

- Topics covered by this priority, for example battery technology, call for joint funding between this pillar and other pillars of Horizon 2020 such as 1.3 Advanced Materials under the Part II Industrial Leadership. For vehicle system integration, coordination with Pillar 1.1 ICT of Part II is also very important. Synergies should be done with the Joint Undertaking on Fuel Cells and Hydrogen, especially on components of electric drive trains, which are common to all types of electric vehicles. These technologies and components for all electric vehicles are included within the scope of ERTRAC's Strategic Research Agenda (SRA) and R&I roadmaps. For fuel cell electric vehicles, R&I on the fuel cell stack, fuel cell and hydrogen system is within the scope of the Joint Undertaking on Fuel Cells and Hydrogen.

References to ERTRAC roadmaps:

- **ERT/HRT:** Energy storage systems; **ERT/HRT:** Drive train technologies; **ERT/HRT:** Vehicle system integration
- **HDT:** Dedicated hybrid powertrains (for trucks); **HRT:** Hybrid distribution & long haul truck concepts and powertrains
- **HDT:** Self-operating and resilient truck; **HDT:** Tailored trucks and standardized load carriers
- **SFTFE:** Vehicle technically specified for running in corridors

Pillar 4.3.2. On board, smart control system:

Communication interfaces between vehicles and with infrastructures are necessary to increase the efficiency of transport and its integration as a system. Several important areas are concerned and represent opportunities for Europe to build competitive advantages: to enable advanced driver support systems, for integrating urban mobility, and to develop

efficient freight systems towards more integrated and autonomous trucks. Highly or full automation will indeed contribute to the enhancement of transport efficiency. Cooperative driving offers high potential benefits if combined with traffic management, which can then intervene at different levels of the driving task, such as navigation or vehicle guidance. Its intervention can range from purely informative systems to direct influence on the vehicle motion, and it could influence the availability and selection of a certain automation level within the vehicle. Here further research is necessary in order to fully exploit the potential in a manner that is safe, understandable and acceptable to the driver and other stakeholders. Human-Machine Interfaces (HMI) are there an important research area. Such solutions enabling connectivity and information collection and management will be useful for both the users and the public services interests.

Expected impact:

- Enabling advanced driver support systems, which bring benefits on several societal challenges: for safety, for energy efficiency and decarbonisation, and for the transport system reliability. As basis for such smart control systems, highly sophisticated real-time capable, model based control techniques have to be made available. Dedicated online-observation capability – utilizing also human-machine-interfaces including new sensor technologies.
- Enabling traffic and travel planning thanks to real time information with sufficiently high quality.
- Enabling autonomous functions for trucks and supporting the green corridor approach.
- Enabling information exchange necessary for various EV charging modes, and their optimization.

Opportunities for programme efficiencies: Obviously coordination is needed with Part II pillar 1.1 ICT. For automation coordination with pillar 4.3.4 exploring new transport concepts.

References to ERTRAC roadmaps:

- **SRT:** advanced driver support systems
- **IUMS:** Traffic and travel information
- **EBSF:** European Bus System of the Future ICT platform integration
- **HDT/SFTFE:** Self-operating and resilient trucks; **HDT/SFTFE:** Automated collaborative driving
- **HDT/SFTFE:** Transport system integrated trucks; **HDT:** Traffic and Infrastructures Integrated Trucks
- **HDT:** Safe & efficient cooperative driving; **HDT/SFTFE:** Truck and driver security
- **ERT/HRT:** vehicle system integration

Pillar 4.3.3. Advanced production processes

For its products to remain competitive on the global markets, the European industry must develop costs efficient design and manufacturing techniques, coping at the same time with multiple requests such as reduced development times, customization, improved recyclability, sustainability of production processes, etc, and with the issue of globalized sourcing (access to critical raw materials and key components), as well as with the needed skills and competences of the workforce. In order to ensure the competitiveness of future electric vehicles produced in Europe, the aspect of market driven reactivity regarding globally balanced economics of scale needs to be addressed, also with regard to costs efficient design and production concepts. Since the market shares of all types of electric vehicles (including HEVs, PHEVs, FEVs and FCEVs) are volatile and very hard to predict, the establishment of a globally effective production and supply is an unparalleled challenge to the European automotive industry. With the diversity of powertrains having high implications on the production, and with this difficulty of predictions, standardization and modularity will be key concepts.

Design and Production processes for advanced ICEs, hybrids and electric vehicles

- **a.** Efficiency of production processes within the European automotive industry is a major asset to ensure the competitiveness of the sector today and on the long term. One opportunity to achieve cost reductions is through increased simulation to design production processes.
- **b.** Europe aims at production processes that are efficient not only in costs but also in environmental terms: targeting less energy consumption at the production, and integrating recyclability requirements.
- **c.** For producing electrified vehicles, specific challenges must be addressed by the EU automotive industry, such as improved production technologies for batteries, as well as for key components of the electric drive trains like electric motors and power electronics, which contain costly rare materials. For hybrids, design and production of modular hybrid architectures is a key matter.

Expected impact:

- Reduction of costs by bringing closer design and production. Extensive use of simulation. Dedicated simulation and development tools for all configurations of future powertrains. Establishment of an interdisciplinary development (and production) environment for cost and time efficient development, standardized testing and production of electrified vehicles.
- Reduction of energy consumption and of waste, and improved recyclability
- Progressive reduction of use of costly materials (rare earths, magnets), enabling a reduction of the total cost of the wanted technologies to enable cost competitive hybrid and electric vehicles.
- Modularity and Flexibility in design and manufacturing: obtaining the best cost for the right technologies, for the wanted components or systems of components, benefiting from economies of scale.

Opportunities for programme efficiencies: links with part II Industrial Leadership 1.3 and 1.5 Materials and Manufacturing, and with the Factories of the Future PPP.

References to ERTRAC roadmaps:

- **LDPF:** Simulation tools for production design
- **LDPF:** Vehicle redesign for efficient materials recycling; **LDPF:** Catalyst production processes
- **LDPF:** Affordable technologies for producing easily recycled batteries, magnets, etc.

Global automotive supply chain management and production for hybrid and electric vehicles

a. Global Production

- The market volatility demands new global production concepts regarding flexibility and efficiency of production processes to be networked within IT structures in order to optimize the use and capacity utilization of plant and machinery and to allow a real-time response to unforeseen events in production. A “smart EV factory” takes the availability of all data via cloud computing and IoT processes into account and complex operating processes are controlled wirelessly and on an ad hoc basis.
- Manufacturing of EVs yields different approaches according to the EV design and its related assembly structure i.e. Conversion Design and Purpose Design. For both EV production requires the integration into current assembly and series production.
- Optimized supply base management is qualitative and quantitative optimization of the suppliers pool by extending the idea of the “Brand + System Suppliers = FEVs 2.0. Since “less” is not always “more”, the examination of the conditions for reducing the supply base and the development of a highly reactive supply grid adaptation concept will provide the optimum number of suppliers needed for EV production.
- Shortening lead-time in global EV production through a radically new “localization” approach addresses the new challenges in terms of geographical localization between all parties in the supply chain, but particularly between 1st tier suppliers and vehicles manufacturers. In consequence new localization of dedicated components development and production sites in parallel to the shift from ICEs to EVs requires new clusters of EVs and hybrids specialized production sites.
- Advanced real-time Manufacturing Execution Systems enable the necessary “defects per million opportunities” and zero incident operation of EVs in the field regarding the global production of competitive EVs and their components and systems. These methods/tools support the rapid feedback loops between product ramping and development. Total Productive Maintenance as well as new Maintenance, Repair and Operations supplies control instruments complement the processes at facility site to guarantee competitiveness through better utilization of maintenance and production resources. Trimming the global productivity of EVs to fluctuating lot sizes calls for innovative rapid and efficient conversion of manufacturing and supply processes from running the current product to handling the next version, particularly when it comes to integrating EV production into assembly lines.
- The interdependence between the highly reactive and complex automotive sector and less flexible industries providing components and materials for EVs, has strong influence on the profitability even at a low production number of EVs in globally distributed sites. Example of being supplied by the chip industry, which has its own agenda and other major industrial customers.

b. Global Supply Chain Management

– Connecting Decentralized Global Production Grids

- Effective quality management across the EV supply chain: Globalization of the markets entails increasing complexity in the automotive supply chain particularly when the production plants of the supply grid are now also located in emerging markets. The lack of real-time information about the remote end of the global supply grid provokes quality risks in the manufacturing processes and needs to be identified on very short notice and remedied as a preventive measure. Focus is placed on the real-time integration and control of the most risky element to the system i.e. the remote part of the global supply grid. This subject would include resilience simulation, quality training and problem solving, involving simulations, scenarios and upgraded methodologies.
- Global production of EVs requires context sensitive access to new and existing knowledge on products/services which enables effective support and re-use of this knowledge and collaborative work on product/process design, manufacturing and usage. Therefore, platform approaches are required as collaborative working environments, following web2.0 principles, comprising intelligent services for the interfacing of involved network partners and the various application systems enabling an efficient and secure information/knowledge exchange. The progressive electrification will reinforce the volume of simulation, therefore it will be necessary to initiate the requisite Network Simulation Studies in the frame of System Networks Beyond Nodes.
- Connecting Decentralized Global EV Production Grids: interacting global production sites according to the concept of best in class regarding cost, quality and delivery needs to address synergies, standards, as well as productivity aspects.

Expected impact:

- Highly reactive and interactive global production concepts for hybrids and the 2nd Generation of EVs, operational regarding productivity, standards and synergy.
- Demonstration of advanced collaboration schemes on global scale, integrating OEMs and suppliers (all level of Tiers) across the worldwide supply chains.
- Implementation of tools to assess the CO₂ footprint of global component supply and logistics.
- Establishment of a near real-time reactive global production system based on an "Internet of Things" and Cloud Computing guided supply grid that is able to deliver at higher quality, reduced costs and just in time and sequence. Enabling optimization of automation of supply chain business (e.g. "bidding on line" with all suppliers integrated) Allowing effectiveness of quality, costs reduction and just on time.

Opportunities for programme efficiencies:

References to ERTRAC roadmaps:

- GC: Global Production
- GC: Global Supply Chain Management

Global Business Processes

- Real-Time Reactivity on Global Business Scenarios: the market for electric vehicles will not develop evenly around the world and create a volatility influenced by areas with stronger growth and others with little or no interest in electromobility. New concepts for the European suppliers need to be developed that involve them flexibly in global business domains. For this purpose, innovative instruments, such as:
 - > Global Monitoring of market demands,
 - > examination of the cost impact on current assets of Automotive Supply Grid Companies,
 - > sustainable innovation payback concept of all actors throughout the whole supply grid must be developed.
- Such concept is expected to take the use of renewable energies and environmentally neutral materials in global EV production & logistics into account. Since EVs require a considerable amount of rare materials, the Global Sourcing of Commodity (components and materials) Management from suppliers and OEMs purchasing operations will be necessary. New extra-financial requirements such as Sustainability Index and Balanced Scorecard Tools in Global EV Supply Chain Processes will round-off this initiative.
- Total cost of ownership in procurement for EV production: global procurement programs give rise to many hidden costs that are not taken (sufficiently) into account when suppliers are selected. In international procurement activities, the concept of "total cost of ownership" helps to ensure that procurement decisions are well structured. Respective business processes will reduce supply chain risks and assess procurement costs realistically, leading to the following key topics:
 - > Definition and application of "total cost of ownership"
 - > Categorization of costs and risks in global procurement
 - > Quantification of operational performance indicators
 - > Dynamics and sensitivity in decision-making
 - > Strategy for effective integration in the organization and processes

Expected impact:

- Better anticipation in crisis, materials and components scarcity situations;
- Optimization of overall logistics flows throughout the supply chains, avoiding market disruptions;
- New fast reaction and intervention IT processes implemented;
- Harmonization of engineering and IT businesses accomplished towards standardization;
- 1st Tools for a comprehensive EV Commodity Management in service.

References to ERTRAC roadmaps:

- GC: Process and Equipment IT
- GC: Global Market Monitor
- GC: Global Commodity Management

Advanced and cost-effective infrastructure

The objective is to enable considerable reduction in the total cost of ownership for infrastructures by introducing advanced production processes, techniques and materials throughout the lifecycle of transport infrastructure (Planning & Design, Construction & manufacturing, Maintenance & operation, Rehabilitation, reconstruction and reuse). For this a suite of solutions will be developed and demonstrated including prefabrication methods, robotized/automated manufacturing and construction, non-destructive testing, new standards, predictive performance models, and BIM steering of the contract/manufacturing chain.

Expected impacts:

- Emergence of high-tech industry sectors in effect improving on the global competitiveness of the European construction and manufacturing sector (product leadership; standardization of dimensions, etc.);
- Minimization of the use of virgin construction materials by optimizing over reuse, recycling and waste and by light weighting construction elements (e.g. bridge decks);
- Introduction of robotized and automated techniques for manufacturing and construction;
- Introduction of new materials with advanced performance.

Opportunities for programme efficiencies:

- Coordination with Horizon 2020 Part III: pillar 4.1.2 (advanced infrastructure management systems)
- Coordination with STTP field 5: Smart, green, low-maintenance and climate-resilient infrastructure

References to ERTRAC roadmaps:

- CCRT

Pillar 4.3.4. Exploring entirely new transport concepts

This sub-pillar requests that innovative transport systems and services shall be researched, including new types of vehicles and automation, in order to ensure competitiveness of the European industry on longer term perspectives. This can be done in particular for electrified vehicles, looking at new concepts, including light vehicle concepts, and at modularity opportunities. This should be done also for trucks and for buses.

a. Automation. Advanced cooperative driving systems are paving the way towards more and more automation. Minimizing human errors, involved today in more than 90% of road accidents, towards highly or full automation, represent a major opportunity to tackle several grand challenges: mitigating and avoiding accidents, offering large major gains in road safety; optimizing driving and therefore improving energy efficiency of vehicle traffic; and congestion reduction thanks to coordination with traffic management systems. Specific speeds of automation are foreseen for freight and passenger vehicles on highways and on urban environments.

b. New vehicle concepts.

- > New light vehicle concepts: two- and three-wheelers as well as quadricycles are opportunities for developing the vehicle range towards new products and new markets, responding to specific needs of mobility, in particular in congested urban areas with restricted parking space. Developing lighter vehicles is also an opportunity for reduction of energy consumption and therefore improved energy efficiency and reduced emissions. New business models e.g. car sharing of these light vehicles could help to improve significantly the efficiency of the transport system in cities.
- > New electrified vehicle concepts: potentially but not exclusively in combination with light vehicle concepts, the electrification of vehicles offer opportunities of new architecture and of modularity e.g. using in-wheel electric motors.

Expected impact:

- Safety, energy efficiency and accessibility objectives from the ERTRAC SRA will be supported by automation of road transport. Full automation could become technologically feasible on highways in about 15 years, and in urban environments in about 20 years. The speed of deployment of automation systems will depend on the capacity for system integration, standardization, and on the overcome of legislative and legal barriers, as well as social acceptance.
- New vehicle concepts, lighter, modular, and taking less space on the road, represent long term possibilities for decreased emissions in cities, and improving urban accessibility. They represent however challenges to maintain current safety standards.

Opportunities for programme efficiencies: Link with the Part II 1.1 ICT for cooperative driving and automation. Link with the Part II 1.3 Materials for lightweight vehicle concepts.

References to ERTRAC roadmaps:

- **ERT:** Develop new concepts for vehicle architecture, Implement new design employing new materials
- **ERT:** Realize modular concepts; **HRT:** modular hybrid architecture
- **HDT:** Self-operating and resilient truck, Traffic and infrastructure integrated truck
- **HDT:** Transport system integrated truck; **SFTFE:** Automated driving (X2X), Green, safe and efficient corridors
- **IGV:** Semi-/automated and cooperative driving

Pillar 4.4:**Socio-economic research and forward looking activities for policy making**

When it released its Strategic Research Agenda in 2010, ERTRAC has emphasized the importance of socio-economic factors for realizing the technology vision it held for road transport in 2050 and the clear guiding objectives for 2030 to bolster the

firm course to that vision.

As ultimately the (road) transport system in 2050 will be highly user-centric, it is of eminent importance to understand the causes and sources of freight and passenger movement and the drivers that determine the 'optimal choice' for the various groups of users and environments. Hence the key research area on road user expectations, and acceptance of products, processes and services from ERTRAC's technology research and innovation.

In addition ERTRAC stresses the need for better integration between infrastructure planning and land use planning in view of the many opportunities such multi-stakeholder engagement approach will hold for cost-effectively removing road transport bottlenecks on local and regional scale. Here too, ERTRAC acknowledges the additional benefits from eventual cross-modal settings.

Furthermore ERTRAC stresses the importance of matching the capabilities of the road transport sector's workforce with the new technologies its research and innovation activities will deliver, through building adequate European curricula. This should be supported by the reinforcement of networks of excellence that ensure that state of the art knowledge is transferred immediately across Europe.

Finally ERTRAC stresses the need for a structured, effective stakeholder engagement over the entire timespan of Horizon 2020. This would ensure that the programming of research and innovation activities is on course and on time in reference with up-to-date scenario's and research agenda's and roadmaps.

Road user expectations, acceptance and behaviour:

The objective is to deliver a coherent strategy for the transition towards a user-centric road transport system. The basis will be a comprehensive PEST analysis which systematically considers the key socio-cultural, technological, economic, ecological, and regulatory factors driving user expectations and behaviour. Focus will be on effective implementation and deployment strategies to meet societal expectations invoke behavioural change, for example with respect to road safety, and mobility demand in view of ageing and social stratification.

- Causes and sources of freight and passenger movement
- What drives the 'optimal choice' for different users and environments
- Political dimension (policy will and acceptance)
- Barriers and incentives for user acceptance and driving behavior in relation to ADAS (e.g. through Driver Simulator Studies or real car studies at test site with new assistance concepts).
- Tailored vehicles (passenger cars, trucks, buses) adapted to customers' needs
- User acceptance of new technologies in car driving
- Changes in driving behavior through new technologies
- Identification of further user-needs in terms of driving assistance functions and mobility services

Expected impact:

- Better market uptake of innovations
- Improved safety in road transport
- Better response to user needs and increased customer satisfaction
- To secure mobility for the future

Opportunities for programme efficiencies:

- Cooperation between research and civil society (NGO's etc.)
- Better awareness with policy setting
- Coordination with Horizon 2020: various links to the topics under the pillars described in this MAP document

References to ERTRAC roadmaps:

- **RUBE** roadmap
- **HRT**: Hybrid modular, flexible vehicles, easy to use, efficient and integrated into the transport system

Structured, effective stakeholder engagement:

The objective is to drive - over the entire duration of Horizon 2020 - the coherent and consistent planning of road transport research and innovation involving all key stakeholders in the innovation chain. Particular attention will be paid to eventual updating of research agenda's, roadmaps, implementation plans and programmes in view of the strategic uncertainties and volatilities in market and technology development (e.g. game-changers in the long term global energy markets, unexpected opportunities from break-through and emerging technologies). In addition a structured approach will be designed to build Effective coalitions of parties from policy, industry and research across the road transport sector in order to effectuate the necessary holistic systems approach in the planning and execution research and innovation activities. This allows a planned deployment of research and innovation results across the European road network, such as following the TEN-T corridors or within entire urban regions. The process will be designed to acknowledge the differences in role and position of the actors (e.g. funders/clients of research, suppliers of research, programming bodies) and will foresee an adequate number of quality

seminars, workshops etc. to broker the required cooperation across the sector and the continent.

- Adequate support for staff, IT systems, etc.
- Adequate support for scientific panels, investment panels etc.

Expected impact:

- Higher success rate for the deployment of research results through improved commitment from the key actors in the innovation chain for the R&I strategies of the European Commission and the member states national
- Ensured topicality of the implementation plans from the sector

Leading networks of excellence:

The objective is to build up –along the deployment of the Horizon 2020 programme- multi-disciplinary technology clusters in which experts from industry, policy and research/academia are represented. These networks of excellence primarily focus on the new technologies developed under the Horizon 2020 programme, but would also serve to build capacity –when and where required- for the strategic knowledge of the road transport sector e.g. in the new member states.

- Producing research statements addressing the topicality of research areas and fields based on comprehensive state of the art evaluations in view of eventual technology gaps to be addressed by future R&I programming. This will include adequate impact assessment.
- Evaluation of technology capacity across the technology chain and subsequent advice on capacity building needs
- Providing a knowledge management and transfer environment that protects intellectual capital and competitive advantage.

Expected impact:

- Reinforces Europe's competitiveness
- Faster internalisation of innovative technology
- Capacity building on emerging and key technologies. Consolidation on current strategic technology.

European curricula:

The objective is to enable Europe's future workforce to be educated on curricula that closely match the needs of the road transport and infrastructure sector. This spans to entire educational system i.e. universities as well as secondary vocational, that educates over 80% of the workforce. The aim is to develop comprehensive curricula or courses that evolve with the development in the state of the art as well as to coordinate the development of the European research infrastructure with the capabilities and facilities of industry, including challenging apprenticeships

Expected impact:

- Enlarge collaboration between educational system and industry and research
- Increase the attractiveness of careers in technology
- Foster partnership for innovation in Europe
- Effective access of the workforce to lifelong and continuous education.

Pillar III:

Secure, clean and efficient energy

3.1. Reducing energy consumption and carbon footprint through smart and sustainable usage

The Transport and the Energy challenges are deeply related: as stated in the ERTRAC Strategic Research Agenda, the only way to decarbonise road transport is to combine an improvement of its energy efficiency with the introduction of renewables in the energy pool it uses. To realize this, technologies and services for alternative energy usage must be deployed as mass markets. Two major themes are identified, requesting cooperation between the Energy pillar and the Transport pillar: charging and integration of electrified vehicles into the electricity grid, and availability and compatibility of new liquid and gaseous fuels for road vehicles. In addition, there is a specific challenge of developing smart cities, where the transport, energy and information networks are integrated, in order to enable energy efficiency of urban communities.

3.1.1. Bring to mass market technologies and services for a smart and efficient energy use

Energy efficiency and new energies in road transport imply technologies and services that need to be assessed, optimised

and customised to various environments. This requires research, development, testing and demonstration. Electric and hybrid vehicles represent today one major challenge in this direction: large-scale demonstration projects and pre-commercial deployment activities are necessary. Energy consumption and usage data need to be collected and analysed. The various vehicle architectures and refuelling and recharging possibilities must be investigated.

a. Electrified vehicles charging infrastructures. All types of charging possibilities need to be assessed, including cable less and contactless.

b. Vehicles integration with the energy system. Joint work of the automotive and energy industries is necessary to research, test, demonstrate, standardize and deploy the necessary software and hardware enabling the usage of electrified vehicles as a mass market. Charging EVs with renewable electricity is a technological and a business challenge.

Expected impact:

- Contribution to the Electrification and Hybridisation roadmaps milestones objectives.
- Contribution to significantly reducing CO2 by increasing the usage of renewable energies in mass transport.
- Integration of mobility into the overall energy system

Opportunities for programme efficiencies:

ERTRAC calls for joint funding between the Energy and the Transport Challenges in order to cover these key topics of refuelling and recharging and vehicles integration to the energy system. Synergies with the Joint Undertaking on Fuel Cells and Hydrogen (expected to be included in this Secure Clean and Efficient Energy challenge) are also to be secured.

References to ERTRAC roadmaps:

- ERT/HRT/IGV: Plug-in manual and automated charging
- ERT/HRT/IGV: Stationary inductive charging / Stationary contact charging / Inductive charging while driving / Contact charging while driving
- ERT/HRT/IGV: Service stations for battery charging / for battery change
- ERT/HRT/IGV: Vehicle to Home (V2H)
- ERT/HRT/IGV: Vehicle to Grid (V2G)
- IGV: Power-to-gas, Power-to-liquid

3.7. Market uptake of energy innovation (framework conditions for roll-out of new technologies)

Market uptake of new energy technologies requires not only R&D and demonstration activities but also appropriate framework conditions. One very crucial matter for vehicles powered by electricity is the need for standardisation of the recharging technologies and inter-operability of the energy and communication infrastructures across Europe. For this strategic partnerships are needed between OEMs, system integrators, suppliers and research laboratories. Users' acceptance and markets success depends on these challenges. Together with energy policies, regulatory and administrative matters are there very much involved. For a sustainable EV deployment in Europe, the electromobility has to be built as an imbedded system integrating state of the art technologies, ICTs, smart grids, and new business models.

Expected impact:

- Support to European and worldwide standardisation processes, based on partnerships .
- Standardised and easy to use models for charging and billing.
- Support of regulatory and administrative decisions throughout Europe.

Opportunities for programme efficiencies: integrate in research activities of the Transport and Energy programmes the standardization and regulatory actions done at European level, which can in the other way benefits from assessments done in research and demonstration projects.

References to ERTRAC roadmaps:

- LDPF, IGV, ERT/HRT: Standardisation of recharging technology and infrastructure

3.4. A single smart European electricity grid (including smart grids, electricity storage, ICT)

An increased usage of electricity to power road vehicles will involve important adaptation and new developments to the European electricity grid. Production of electricity from renewable sources will be impacted, and as well will be the distribution and the storage, meaning a possible impact on the grid structure development itself. Because users will request to power their vehicles with low-cost electricity coming from available renewable sources, the management of the grid towards Smart Grids is a necessity. The objective is an integration of the vehicle and the grid, in order to cope with the demands and the limitations of both sides, and be able to plan, manage and trade these new energy flows in a secure and cost-effective manner. ICT will play a key role for this objective.

Expected impact:

- Enabler of road transport electrification as described by the Electrification roadmap.

Opportunities for programme efficiencies: Link with ICT parts, from the Transport challenge pillar 4 and from the Industrial Leadership part II pillar 1.1. Cooperation between the Transport programme and the European Electricity Grid Initiative from the Energy programme.

References to ERTRAC roadmaps:

- IGV and LDPF and ERT/HRT: Smart Grid management and structure for vehicle electrification
- IGV and LDPF and ERT/HRT Vehicle to Home (V2H)
- IGV and LDPF and ERT/HRT Vehicle to Grid (V2G)
- IGV and LDPF and ERT/HRT Protocols/devices for V2G communication
- IGV and LDPF and ERT/HRT Storage infrastructure for renewable electric energies (including Power-to-gas; power-to-liquid)
- IGV and LDPF and ERT/HRT interoperability and standardisation of the charging infrastructure

3.1.3. Smart Cities and Communities

The European Commission has defined the Smart Cities identifying the integration between various sectors in the urban environment, including transport, energy and ICT, as an important challenge for the future.

ERTRAC work on the electrification of road transport, an infrastructure for green vehicles, and urban mobility, is of particular relevance for this topic. Research topics identified in these roadmaps are important references to develop research and innovation on Smart Cities.

Expected impact:

- Improved integration between networks at the urban level;
- improved integration of electric vehicles and electro mobility in the urban environment
- More efficient management of the urban resources
- More efficient transport network
- More efficient energy management

Opportunities for programme efficiencies: Link with Transport challenge pillar 4.

References to ERTRAC roadmaps:

- LUTI roadmap
- EBSF roadmap
- IGV roadmap
- IUMS roadmap
- RUBE roadmap
- ERT/HRT/IGV: Transport system integration (vehicles and infrastructure matching each other, co-modality integration, intermodal seamless interoperability, ICT support, matching vehicles to tasks: customised, modular, flexible & variable design); Inter-/urban terminal, hubs for passenger travel and regional freight; Semi-/automated and cooperative driving, separate/flexible lanes with adapted technology
- HDT: Energy & information infrastructure interface

3.3. Alternative fuels

Meeting the objectives set by the EU for renewable energies increase and CO₂ emissions reduction requires, in addition to energy efficiency measures, the development and deployment of alternative fuels. ERTRAC has very much insisted on this double approach in its Strategic Research Agenda. It means that for both gaseous and liquid fuels there should be research, development and deployment projects looking at supply and production, distribution and refuelling infrastructures, but also into the necessary adaptation of engines, fuel quality, and after-treatment technologies. There is a challenge of reliability of these alternative fuels for the end user, and of durability for all the components used in the system. Both passenger cars and commercial vehicles are concerned.

Research should include the development of robust WTW/LCA tools for assessing alternative vehicle/fuel pathways. Such an LCA tool for vehicles should consider the extraction of raw materials, the manufacturing of components, vehicle assembly, and use phase (on a WTW basis) as well as maintenance, end-of-life and recycling. An economic assessment should be done, so that innovative solutions are affordable for the customers and the whole community.

Expected impact:

- Contribution to the SRA objective of energy efficiency improvement of road transport, for both passenger and freight, based on a common approach of LCA assessment.
- Objective of 25% biofuels use from the SRA.
- Increased use of biogas/natural gas: target of reaching similar efficiency to today's diesel engine.
- Storage systems for surplus of renewable energy (electricity) to be used for mobility

Opportunities for programme efficiencies: link with transport part where the vehicles and powertrains technologies are developed, while this part will focus on the fuels. Joint calls could be very beneficial. Concerning hydrogen as a transport fuel, topics are developed by the Fuel Cell and Hydrogen Joint Undertaking.

References to ERTRAC roadmaps:

- IGV: Production, supply and distribution of new advanced liquid & gaseous fuels
- LDPF: A2.2) Advanced biofuel products and adapted engine technology to meet regulated limits

- **LDPF/HDT:** A1.10) Non-precious metal aftertreatment systems for biofuels and alternative fuels
- **LDPF:** A2.1) Process and catalyst technology to improve WTT efficiency of fuel production
- **LDPF:** A2.3) Long-term biofuel storage systems
- **IGV:** Integration of mobility to the overall energy system
- **LDPF:** Fuel quality issues to meet CO₂ and emission legislation
- **IGV/LDPF:** New fuel qualities meeting new demands of advanced powertrain technologies (e.g. fuel stability for plug in hybrids)

Part II:

Industrial Leadership

The automotive industry is historically a leading industry in Europe and has brought to the world markets many innovative technologies: this trend should be continued, both in terms of technological innovation and in terms of highly efficient manufacturing. Several Key Enabling Technologies can help to secure that industrial leadership. One is the Information & Communication Technologies, which are enablers for deploying key technologies like electrified vehicles and automated systems, and for travel information and freight systems. Another one is the adaptation and integration of new materials, which are needed for lighter vehicles and for developing the next generation of energy storage systems and electric drive trains. Finally, manufacturing tools and processing must be improved and adapted to allow a sustainable and cost-effective production of vehicles here in Europe. ERTRAC calls for cooperation for these three Key Enabling Technologies.

1.1. ICT industrial and technological leadership challenges

The ICT pillar, as defined by the EC, targets also industrial leadership in ICT-based solutions: “products and services needed to tackle major societal challenges as well as application-driven ICT research and innovation agendas, which will be supported together with the relevant societal challenge”. ICT topics from the ERTRAC roadmaps include ICT needs for electric and hybrid vehicles, for both vehicle and vehicle-to-grid developments. ICT to enable cooperative systems for road safety remains also a major issue, in particular if taking the view of progressive automation. In the context of urban mobility, ICT solutions are needed in order to develop traffic information, network management, payment systems, etc. For freight transport, ICT products and services are necessary for many aspects, such as e-freight, green corridors, and automated driving. Also for the bus system of the future there is a need for an ICT platform. In all these cases, a shared challenge is the integration of the various vehicle components using common development tools and standardized platforms, which are also able for several functions to exchange information with ICT platforms outside of the vehicle.

- a. ICT for Electrified Vehicles.** ICT and smart systems are important research areas to develop energy storage systems and drive trains of electrified vehicles, as well as to enhance the vehicle system integration, with as objective an improvement of the overall energy efficiency of the vehicles. Some innovative approaches for EVs, such as using in-wheels electric motors, also require advanced integrated ICT solutions to enhance drivability and ensure safety. In addition, charging EVs and their integration to the electricity grid imply many efforts in developing ICT solutions. A major challenge here is to adopt a system approach matching the needs and constraints of various sectors: automotive, smart systems, and electricity grids.
- b. Enabling new safety functions thanks to advanced driver support systems.** Active safety systems, as well as integrated active and passive systems, rely heavily on ICT developments. They are also key enabling technologies to progressively develop automated functions. Connectivity, car-to-car and car-to-infrastructures communications, must be developed to lead to these new functions, with the challenge of working on a system of systems, in which safety and security issues, as well as standardization and regulatory aspects, will have an important influence.
- c. Travel information.** ICT solutions, targeting not only the vehicles but the users, can enable a more efficient use of transport means by the user if he is informed and can seamlessly change and combine transport solutions that best fit his needs. Traffic Management authorities and operators heavily rely also on ICT solutions to be able to perform better their task. ITS solutions can be developed by exploiting the opportunities offered by vehicles connected to each other and to the infrastructure, with specific tasks for reducing congestion or improving the energy efficiency of the vehicles use. Connectivity and data that are open and sharable are important research issues, which will also require extensive testing and piloting.
- d. Freight system.** Many improvements in the efficiency of the European freight transport system lie in the development and deployment of ICT systems integrating the loads, the vehicle fleets and the infrastructures. ICT is also in particular a key element for progressive automation applied as first steps to dedicated logistics areas, or to trucks driven on long distances.

Expected impact:

- Developed jointly with the other components of systems approach, the ICT solutions are enabling technologies for the system integration, which is absolutely necessary to reach the milestones defined in the ERTRAC roadmaps such as the Electrification of road transport, setting milestones for the mass deployment of electric vehicles. In the example of recharging of electric vehicles, inter-operability, connectivity and information services enabled by ICT solutions are necessary to meet consumers demands and allow full market take up potentials. Reaching the objectives of reduction of CO₂ emissions and improvement of energy efficiency therefore relies on these ICT solutions.
- Considering the ERTRAC objective on safety, reduction of both fatalities and severe injuries by 60% by 2030 versus a 2010 baseline, ICT will play a major role as enabling technology helping for both avoidance of collision and crash mitigation reducing injury severity, thanks to advanced driver support systems.
- Progressive introduction of automated functions thanks to ICT will help for the safety objective but also to reverse the weight increase of the vehicles, allowing to reduce fuel consumptions and therefore pollutant emissions. If combined with traffic management, connectivity ability of vehicles will allow to further reduce emissions and work on the improvement of the transport system energy efficiency.

Opportunities for programme efficiencies: as written in the H2020 proposal, this ICT pillar within Part II should cover topics in coordination with societal challenges, such as with the Transport pillar in the case of the topics proposed here by ERTRAC. On several of these topics, synergies should be developed with e.g. Artemis and ENIAC JU.

References to ERTRAC roadmaps:

- **ERT/HRT:** energy storage systems; **ERT/HRT:** drive trains; **ERT/HRT:** vehicle integration; **HRT:** Hybrid truck and bus concepts and powertrains; **ERT/HRT/IGV:** Transport system integration; **ERT/HRT/IGV:** charging systems; **ERT/HRT/IGV:** Grid integration
- **SRT:** Cooperative systems for road safety and security; **IGV:** Semi-/automated and cooperative driving; **HDT:** Safe & efficient cooperative driving (trucks); **SFTFE:** Automated driving in the transport system (X2X)
- **IUMS:** traffic and travel information; **IUMS:** network management; **IUMS:** integrated charging and payment systems; **SFTFE:** Intelligent Traffic Management Systems
- **HDT:** Self-Operating & Resilient Trucks (safe, efficient, autonomous, available); **HDT:** Driver, truck, load & localization status & instructions data transfer (e.g. E-freight); **HDT:** Energy & information infrastructure interface; **HDT:** Trucks in Corridors; **SFTFE:** Communication infrastructure (X2X); **SFTFE:** Advanced Utility, Sensory and Communication Systems
- **EBSF:** EBSF ICT platform integration

1.3. Materials

Key materials issues can be found within several ERTRAC roadmaps with very high expected impacts on industrial competitiveness and leadership opportunities. Challenges on finding and applying new materials are key for both conventional vehicles, to improve their energy efficiency in particular through weight reduction, and for the new electrified vehicles, which need some fundamental breakthroughs in materials for critical components like batteries, which are enabling technologies for mass market deployment. An integrated systemic approach must always been adopted, considering the full value chain of the materials sourcing, processing, designing (including NVH aspects), manufacturing and recycling, this always targeting cost efficiency, which is a fundamental principle for the automotive industry that makes the application of innovative materials to the sector always very challenging.

- a. For Electric and Hybrid Vehicles.** Research and innovation on materials are crucial matters both for the storage systems (studying cell materials: energy density, degradation and lifetime, safety; research on post Lithium cell technology; assessment of availability of raw materials, light weighting of the storage systems) and for drive train components (lower cost and lower weight motors and power electronics; alternative materials e.g. electric engines without permanent magnets; reduced dependency to rare earths). Materials to support thermal management are also an important issue for electrified vehicles.
- b. For Advanced ICES.** Vehicles running with internal combustion engines also raise important topics of innovation in materials, such as engine light weighting and after-treatment systems (in particular towards the use of alternative fuels), or for objectives of cost-reduction and availability of components raw materials.
- c. For vehicles light weighting.** Light weighting of the vehicle body is a major issue for all vehicles, where several challenges compete and call for an integrated approach of the R&D work: the goal is efficiency in weight reduction thanks to new materials and joining techniques, while preserving rigidity and safety functions, with consideration for cost and complexity of manufacturing, and always applying a life-cycle approach e.g. including recyclability. The availability of the materials researched on the international markets is also a key factor, if global competitiveness of European companies is the final aim.
- d. For advanced infrastructures.** E.g. self-repairing, lightweight, thinner and resource-efficient for improved performance and providing new capabilities, and those supporting provision of power and/or energy harvesting.

Expected impact:

- While research on post-Lithium cell technology will still be ongoing, all relevant parameters of existing cells will have been developed towards the requested performance, lifetime and safety, allowing manufacturing of long life, safe and cheap energy storage systems that will support the mass market deployment of EVs. Objectives of the Electrification roadmap for 2020: batteries providing doubled lifetime and energy density compared to 2009 Li-Ion technology status at about 30% of 2009 cost.
- Capacity to evaluate materials options for engine light weighting, and ability to assess the potential for non-precious metal technologies for aftertreatment systems for alternative fuels. Enabling the scale-up of best options to empower commercial potentials, ensuring leadership

positions of European industry.

- Weight reduction of 15 to 20 % thanks to the use of new lightweight materials, and consecutive fuel consumption and emissions reduction over the life-cycle of the vehicle. Objective of reaching cost-attractiveness thanks to the compensation over lifetime. Including end-of-life strategy.
- Quicker and more durable infrastructure construction and maintenance with greater performance over a wider range of conditions (e.g. bridges, tunnels, pavements and road-side equipment, etc).

Opportunities for programme efficiencies: Cooperation with the Transport Challenge, in particular pillars 4.1 and 4.3. Important cooperation as well with the Manufacturing pillar 1.5 of Part II.

References to ERTRAC roadmaps:

- **ERT/HRT:** Energy Storage Systems; **ERT/HRT:** drive train technologies; **LDPF:** Component technologies, such as electric machines, including lower-cost alternatives, availability of raw materials, optimised design, material demands, low-cost options; **LDPF:** LCA for vehicle materials options; **GC:** Global commodity management
- **LDPF:** Engine light weighting; **LDPF:** Catalyst manufacturing and recycling processes; **LDPF:** Non-precious metal aftertreatment systems for biofuels and alternative fuels

1.5.1. Technologies for Factories of the Future

Progressive introduction of electric vehicles will impose to the automotive industry new standards and industrial adaptation, within factories of the automotive manufacturers and of the large suppliers of first rank, as well as for the smaller suppliers. Cooperation with other sectors on technologies for the “Factories of the Future” is necessary, and the automotive industry has several specific interests for the adaptation of its factories. Developing advanced costs-efficient and sustainable manufacturing processes is a constant challenge in the automotive industry. But with the current move towards hybrid and electric vehicles production, new challenges appear and call for innovation in the production systems: it is crucial for future global leadership positions of European companies that technologies such as batteries and electric drive train components can be produced in Europe in an efficient, affordable and sustainable manner. New generation of machinery and tools are needed together with advanced processing for dealing with new expensive materials and components e.g. electronics, magnets. But also new generation of manufacturing processes and logistics requirements will be necessary e.g. clean chambers, dust-proof for equipments/components produced by large and smaller suppliers. They represent extra costs in factory displays and investment plans, and need to be mastered in order to preserve competitiveness. Also the construction industry has manufacturing challenges and calls for advanced design, production and construction technologies, such as prefabrication and standardization.

Expected impact:

- Research topics will look for progress of the automotive industry factories in terms of performance and overall sustainability: financially, in terms of investments; socially, in terms of resilient employment; and environmentally, in terms of respect of new requirements and certifications.

Opportunities for programme efficiencies: between automotive research and Factories of the Future PPP.

Call for cooperation between the automotive industry and the manufacturing industry on issues such as:

- Micro- & nano-electronics (e.g. clean rooms for components production; e.g. copper coating)
- Advanced manufacturing processes, including special machine tools in order to optimize efficiency and reduce the increasing production costs related to vehicles electrification.
- Further progress in automatisisation, digital features, and new equipments: “Digital, Virtual & Resource-efficient” and “Human-centric Manufacturing”, allowing productivity gains, and using highly skilled workforce.
- Manufacturing eco-systems, optimizing the flows of manufacturing equipment and plant materials.

References to ERTRAC roadmaps:

- **GC** Roadmap



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