ERTRAC

EUROPEAN
ROAD
TRANSPORT
RESEARCH
ADVISORY
COUNCIL

European Roadmap

European Bus System of the Future

Version June 16, 2011

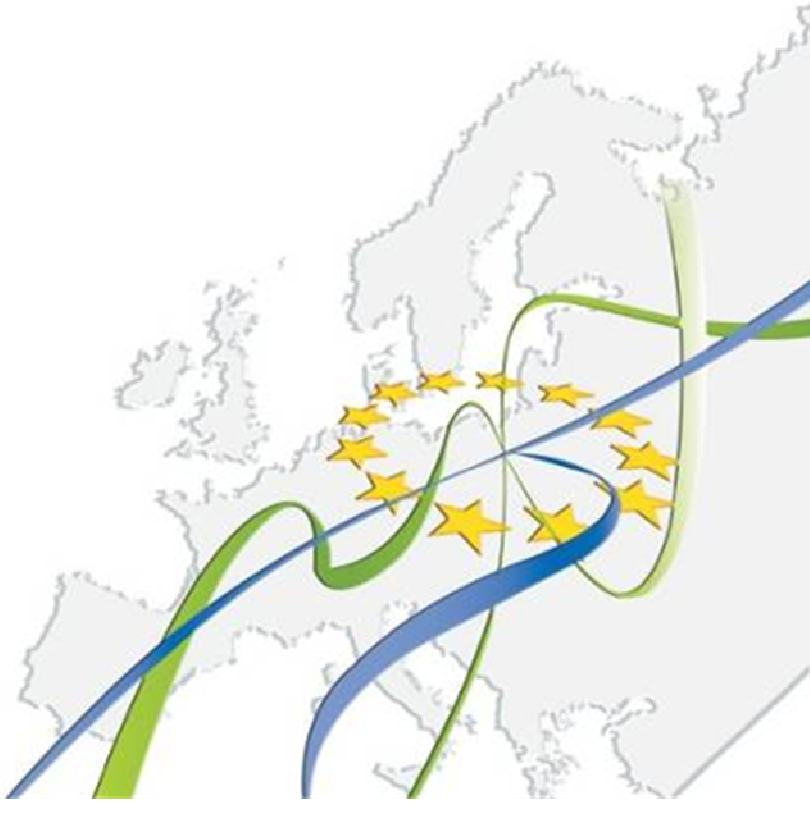


Table of Contents:

1. Executive Summary

The main research objectives for the stakeholders of bus systems such as the industry (manufacturers and suppliers), operators and authorities are identified in line with the UITP global association strategy for the Public Transport sector of doubling PT market share by 2025:

- Reduction of the production costs, increase of the efficiency and the productivity, and increase of competitiveness
- Better effectiveness of investments and operation costs
- More attractiveness of bus systems for existing passengers and for potentially new customers
- Environmental performances and energy alternatives.

2. Introduction

2.1 Background

Today, urban public transport is able to give relevant contribution to some of the EU key issues, such as a more homogeneous European citizens living standards, to achieve a full economic integration, and to reduce the unsustainable sacrifice of human beings that the European society annually pays on its roads to perpetuate its economic model.

On this regard, the bus is a very efficient mode of public transport, as it is cheap, flexible and, in many cases, tailored to the needs of end-customers both in terms of capacity and speed. Buses operate most of the time in mixed traffic. They are therefore in the front line in competing with private motorised transport. In addition, buses have moderate infrastructure costs (mainly depot and workshop but also stops), and are easy to put in service. From an economic, environmental and social point of view, buses still remain the most universal solution for a balanced and sustainable urban development. Today, urban buses have a stake of 60% of the total European public transport in urbanised areas[1].

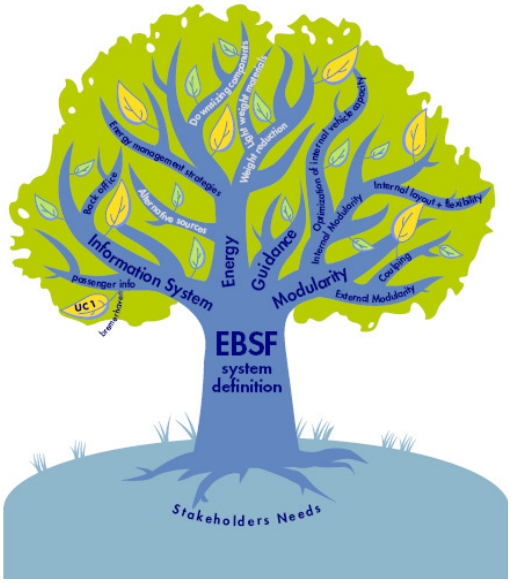
Urban buses offer clear advantages also in terms of less space needed to answer the mobility needs of citizens. Furthermore, if 69 % of road accidents occur in cities (EU White paper on Transport, 2011), public transport is by far recognized as the safest means of passenger travel amongst ground transportation modes. Travelling by bus in particular is ten times safer than by car.

Although bus systems still remain the most universal solution for balanced and sustainable urban development, from an economic, environmental and social point of view, they have often suffered from a poor public image. The bus is still perceived as less attractive than other modes of transport.

In order to break such perception, EBSF (the European Bus System of the Future) is conceived as a driver to increase the attractiveness and raise the image of the bus systems in urban and suburban areas, by means of introducing new technologies on vehicles and infrastructures in combination with operational best practices.

[1] UITP statistical findings

Through the application of a “system approach”, which looks to vehicle, infrastructure and operation as a whole, EBSF aims at setting up innovative high quality bus operating in the new generation of urban bus networks in Europe.



In these years, the EBSF system has been designed in its basic characteristics and functionalities. In addition, some related key new technologies and operational concepts have been developed, simulated and tested in real urban scenarios. Last but not least, EBSF has set-up the initial frame for the harmonisation and standardization of the solutions developed.

In the research scenario, the European Bus System of the Future (EBSF) can be seen as a tree where European research activities on bus systems grow like branches. In coherence with the global system design performed by EBSF and the common specifications defined in EBSF, these new branches:

- develop specific areas or aspects of the whole EBSF system,
- contribute to enrich the global bus system definition

EBSF is based on the identified requirements for bus systems (for the whole system as such and in detail for each system component vehicle, infrastructure and operation) which were validated by a large number of stakeholders (public transport operators, public transport authorities, bus manufacturers). Stakeholders can access to the latest up-to-date EBSF specifications through a specific repository and traceability tool: this would enable the homogeneous and transparent deployment of the EBSF tree through the whole bus sector (i.e., authorities, operators, manufacturers, suppliers).

Furthermore, it must be underlined that the “EBSF tree” with its system requirement and architecture platform, will emerge as the benchmark for testing innovative solutions or analysing the impact of changes on the requirements or behaviour. For example, it could be used to assess the effect of new enabling technologies (like Galileo, Wireless Mesh communication radio system) on IT applications and guidance solutions; or it could be the basis to analyse new requirements coming from new environmental issues.

2.2 Scope

The EBSF Roadmap is built on the basic key functionalities identified for the Bus Systems. With the aim to improve the attractiveness of the bus service as a means to achieving modal shift without adding constraints to people, the different aspects which improve the attractiveness of the bus service are exploited, like comfort, performances, safety and costs.

The Roadmap enables EBSF to identify and assess the most promising future solutions, technologies (IT and engines etc) and upcoming needs (social, economic and environmental) by offering a platform

for their definition, development and test. Then, the EBSF system definition can evolve according to upcoming needs or advantageous new technologies.
On this purpose, the strong use of open technical standards (current and future) and shared operation practices is an important element to reduce costs, improvement operations and enhance product quality for public transport users.

An important part of the Roadmap deals with the EBSF integration in the future urban mobility scenarios, in order to achieve an efficient use of urban space and contribute to improving the image of the city. A service which is integrated into the city-environment and that gives to people the possibility to reach their destinations without obstacles enables the city to focus on its living and working-functions.
To achieve integration, is necessary the efficient interaction with other private and public modes of transport; such interaction requires coordination and planning, as well as operational aspects on transport devices, interchanges, information, etc.…

The Roadmap exploits research areas for all the bus system stakeholders:

- to provide all kind of passengers with different needs, goals, experiences and expectations with high quality bus services integrated into their operational environment, and combining a set of complementary services and transport organisation concepts for different sizes of cities.
- to offer different Bus System Solutions to decision makers: for this reason, EBSF has to include tools to assess its quality parameters in order to provide the European decision makers with the most appropriate information to make the right implementation choices, to identify the best solutions, to pursue optimization in investments, etc…
- to allow a reduction of the operational costs: all along its implementation, encourages the development/introduction of technologies and practices for operational cost reduction/control, like maintenance costs, with an impact on the subsidizing government or the customers.

The roadmap addresses the smart use of existing and alternative energy resources for all the elements of the bus systems. The smart use of the resources (maximal performance per energy-use) and research and development of alternative and cleaner energy sources are key points for bus and public transport in general, in order to maintain its characteristic of an environmentally-friendly transport mode.

Then the roadmap addresses the adaptation of the bus system to each specific operational and environmental condition: modularity at all levels can balance the highest level of standardization required by the operator and industry and the individualization of the service provided according to users' preference to have environmental benefits.

The topics included in each area of the roadmap have been initially identified in the last two years by the EBSF Project Consortium. Then, with the objective to produce a roadmap complete, robust and supported by the key actors in the bus service domain, a wide consultation process involving more than 100 stakeholders has been done, involving the EBSF User Group, the UITP Bus Committee, the UITP VEI (Vehicle Equipment Industry) Committee and the UITP ITI Committee (for the aspects relative to the ICT).

As results of the above process, the 6 following research areas have been identified.

1. EBSF integration in the urban scenario, including bus-stop/terminal and urban infrastructure aspects, new system functionalities, the contribution of bus system to the evolution of the concept of urban mobility, and the aspects needed to facilitate the introduction of the EBSF concepts.
2. EBSF ICT platform integration, including standardisation aspects, and the development of key pilot applications, in particular relative to interoperable passenger information and evoluted maintenance processes based on remote diagnostic and predictive maintenance.
3. The sustainability of bus system, in terms of energy efficiency, improvement of the environmental performances, and key aspects relative to the electrification of the bus systems.
4. Research on innovative vehicle technologies, oriented to drive modes, accessibility and comfort
5. Modularity through the application of the system approach, and after the allocation and development of the different functionality aspects to vehicle, infrastructure and operation.
6. The mobility challenges of an ageing society, as majority of European countries are facing an increase of the average population age, and therefore it is important to make public transport more attractive and especially usable by elderly people.

3. Benefits to Grand Societal Challenges

The following figure summarizes the guiding objectives (corresponding to the main areas and indicators) of ERTRAC's "Strategic Research Agenda aiming at a 50% more efficient Road Transport System by 2030".
With reference to it, the grand societal challenges addressed by the ERTRAC Agenda for 2030 and objective of the EBSF Roadmap are:

1) Decarbonization: energy efficiency for urban passengers
2) Reliability: urban accessibility
3) Safety: accidents with fatalities and severe injuries

By considering the system approach on the optimization of interaction of bus vehicles, bus infrastructure and bus operation, the EBSF roadmap will help to increase the performance and efficiency of bus systems (the "green evolution" of the whole bus system) as well as make them more attractive for customers. This will result in an increase of passengers using such bus services and the overall public transport system with a modal shift that is the most efficient strategy towards decarbonisation.

As mentioned in the EU White Paper on Transport (2011), "in addition to lowering greenhouse gas emissions, soft modes of transport (walking, cycling and public transport) bring major benefits in terms of better health, lower air pollution and noise emissions, less need for road space and lower energy use" (point 61). Thus "personal mobility would also be enhanced by greater quality and availability of public transport. This would also reduce accidents, noise and improve air quality" (point 122).

By 2030 Road Transport is 50% more efficient than Today

	Indicator	Guiding objective for 2030
Decarbonisation	Energy Efficiency: Urban Passenger	**+80%**
	Energy Efficiency: Long Distance Freight	**+40%**
	Share of Renewables	Biofuels: **25%** Electricity: **5%**
Reliability	Reliability of transport times	**+50%**
	Urban Accessibility	Preserve Improve where possible
Safety	Accidents with fatalities and severe injuries	**-60%**
	Cargo Lost to Theft and Damage	**-70%**

Table 1. Clear guiding objectives for Decarbonisation, Reliability and Safety in Road Transport. The mission of '50% more efficient Road Transport' is articulated in leading indicators on Decarbonisation (3), Reliability (2) and Safety (2). Each indictor is furnished by a guiding objective for 2030 either indicating the improvement versus a 2010 baseline, indicated with '+' or '-' sign or an absolute level as is the case with 'Share of Renewables'.

Figure 2. Guiding objectives for 2030 (ERTRAC 2010)

As a result, the EBSF Roadmap will significantly contribute to the targets set in ERTRAC SRA to increase the energy efficiency of the urban mobility network by 80%, to improve current levels of accessibility as well as to reduce fatalities and severe injuries in road accidents by 60%.

4. Milestones and Roadmaps

This section details the roadmaps of several topics on innovation and research for bus systems. In general such topics can be developed in the framework of large research and demonstration projects capitalising to a maximum extend the already available knowledge developed for the European Bus System of the Future (EBSF) by the ongoing activities, and more mature results could include or drive harmonisation, standardisation and legislation.
The roadmaps are drafted indicating the main phases to achieve the objective, considering research & development, demonstration as well as the establishment of regulatory frameworks and market introduction. The colours associated explanation of the arrows used in the roadmaps is given below:

a. EBSF integration in the urban scenario

The "Bus System" perspective should be prioritised in order to manage efficiently interfaces with infrastructure, traffic and all users' needs. Combining a "system" approach which links end-users, vehicles, infrastructure and operations together with a high service quality is a daily challenge for operators and manufacturers. The "bus system" integration refers also to the coherence and complementary of its own characteristics with other modes of transports and its ability to adapt to the different typology and transport infrastructures of the cities.

Bus-Stop and Bus Terminal (co-modal and intermodal)

- New generation of bus-stop and bus terminal with: scalable design; architecture to facilitate passenger flow. It includes also the design of bus sections in the interchanges stations and the needed accompanying measures (like regulations and guidelines for Natural Gas buses in underground interchanges).
- Provision of integrated (PT and not-PT) information in bus stops and terminals.
- Integration of stops and terminal in the whole city planning as key for seamless mobility.

  Development of new service and business models (like private sector participation) for infrastructure, bus-stops and terminals funding and exploitation, aiming to economically profitable integration of bus stations/stops into the urban environment (for mixed used of transport and urban functions).

Urban infrastructure for bus systems

- Improvement of average bus commercial speeds via technical solutions (optimisation of traffic light control for enhanced crossroads performance; wear-resistant material for bus lanes - especially if guided-, rutting –orniérage-, etc…), development of a suitable regulatory framework (for example to provide BHLS the same priority that the tram has, by suggesting at CEN level a work item on bus priority for testing and studying the conditions for giving to the bus the priority that the tram have in reference to the Vienna convention on Road Signs and Signals – 1968) and improvement of the interfaces between operators and authorities.
- Improvement of special users' accessibility to urban public transport infrastructure (digitalisation / special adaptation to guide special needs' passenger…).

Contribution of Bus systems to Urban mobility concepts evolution

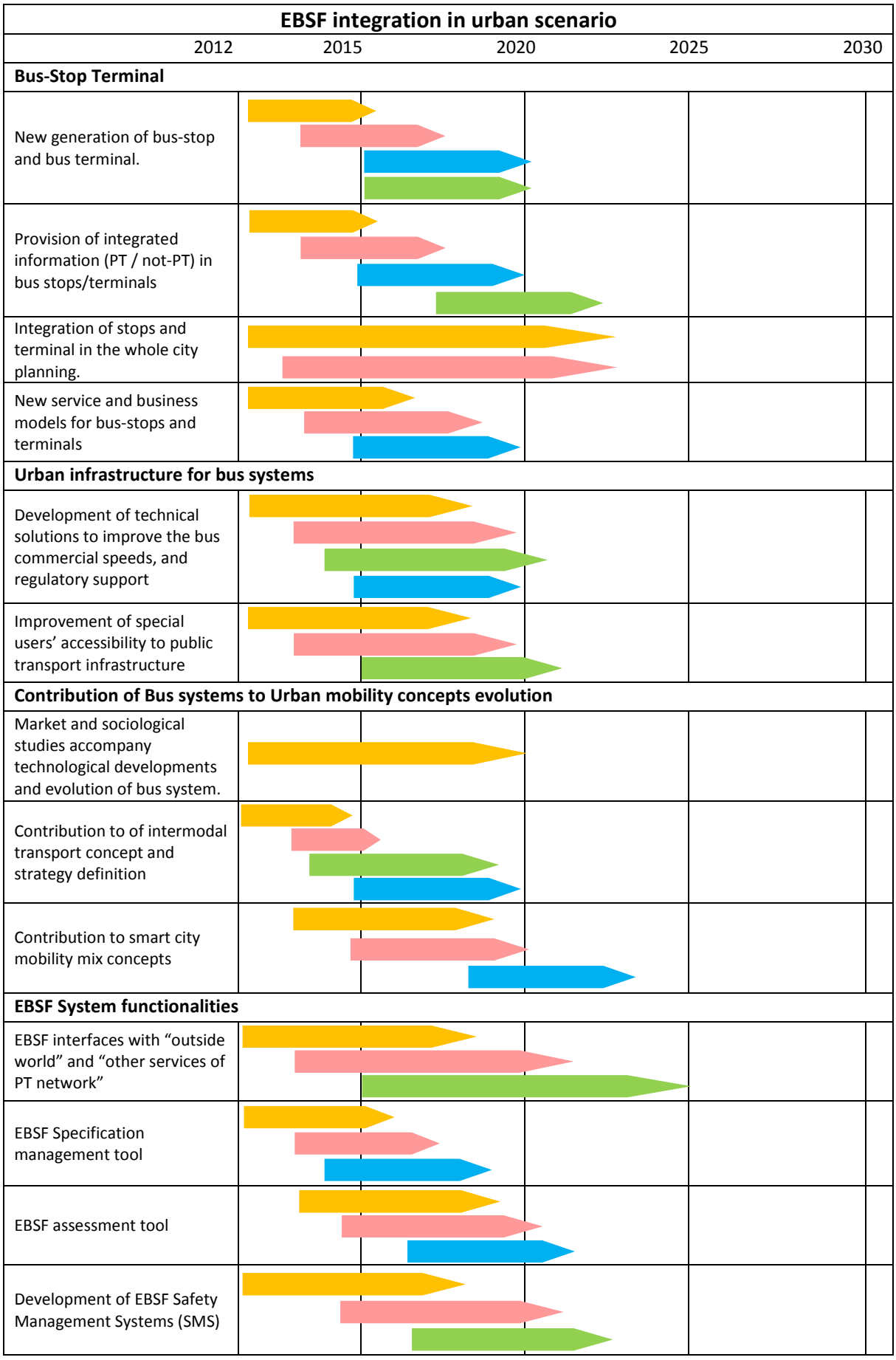
- Market and sociological studies (such as evolution in trends of needs and expectations), to ensure the understanding of mobility needs of citizens, to accompany technological developments and consequently the evolution of the bus system.
- Bus mobility concepts as contribution to smartcity mobility mix, done by individual traffic and public transport
- Development of intermodal transport concept and strategy (which include also bicycles and e-bikes) to maximize the efficiency of the urban transport system using a wide range of measures, including congestion pricing, public transport improvement, promoting non-motorised transport systems and policy tools for mobility management.

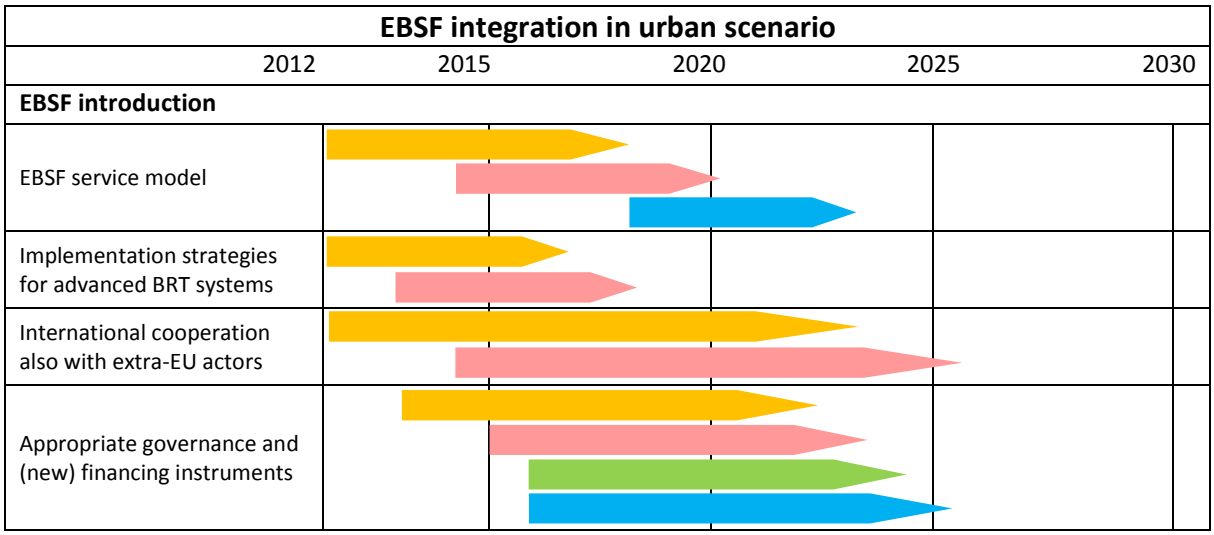
EBSF System functionalities

- Design of EBSF external interfaces (with “outside PT world” and “other services of PT network”) as contribution to mobility management. Outside PT world is considered as the set of entities which interact or can influence the bus service and does not belong to the PT domain. For example: urban utilities, police, meteo information provider.
- EBSF specification management tool, available to PT stakeholders for tendering processes to set the requirements for the suppliers accordingly with the EBSF results and prescriptions, and featuring content updates to accommodate results of further EBSF R&D activities
- EBSF assessment tool available to PT actors for assessing options of changes in specific areas (for example accessibility) by choosing the most suitable KPI from the EBSF KPI Database, evaluating them according to the indicated methodologies, and eventually creating composite quality factors defined on purpose. In particular, creation of test environments where users with special needs (not only physically or mentally-challenged users but also elderly and children) may assess and validate innovative solutions for transit facilities and vehicles, in order to elaborate safety, security, comfort, accessibility specifications and establish common design criteria at EU level. In particular are identified:
  - common indicators for bus safety assessment, in particular for sharing results among BHLS. In fact, even if buses are the safest mode of transport, BHLS are increasing with higher speed and specific lanes, so that there is now a need to be able to measure the effects of these trends, in order to maintain the same quality and safety level.
  - enlarged indicators for quality assessment in contract between operator/authority: for example standard deviation indicators, geographical presentations… This could also require to improve, in case, afterwards the EU standard on service quality (EN 13816).
- Define of EBSF Safety Management Systems (SMS) in line with the EBSF requirements and functionalities. They are composed by processes and tools specifications for assessing “changes” in the system from the point of view of safety of the system itself. The implementation of the most modern practices and tools for safety management allow every evolution related to bus transport to be subject to safety assessments.

EBSF introduction

- Analysis of Bus Service models in Europe and identification of an optimal theoretical service model for EBSF
  - Pilot case of bus services developed according to EBSF recommendations, in order to demonstrate the understanding of the mobility needs of citizens.
- Implementation strategies for advanced BRT systems
- International cooperation also with extra-EU actors for:
  - raising the awareness of the EBSF (by improving the bus system image, promoting its sustainable character)
  - cross-feeding between experiences in innovative bus-services (with South America, US, Asia)
  - transferring of applicable concepts to developing countries (like Africa)
- Identify appropriate governance and (new) financing instruments, in order to ensure a more rapid deployment of research results (in cooperation with EIB and national bank authorities) and coverage of start-up costs necessary for enlarging offer of public transport, with an effective co-operation between the European funding agencies (EIB), and local, regional and national governments and bank authorities (e.g. similar programs like the trans-national funding program ERA-NET Plus "electromobility").
-


EBSF integration in urban scenario
2012
2015
2020
2025
2030
Bus-Stop Terminal
New generation of bus-stop and bus terminal.
Provision of integrated information (PT / not-PT) in bus stops/terminals
Integration of stops and terminal in the whole city planning.
New service and business models for bus-stops and terminals
Urban infrastructure for bus systems
Development of technical solutions to improve the bus commercial speeds, and regulatory support
Improvement of special users' accessibility to public transport infrastructure
Contribution of Bus systems to Urban mobility concepts evolution
Market and sociological studies accompany technological developments and evolution of bus system.
Contribution to of intermodal transport concept and strategy definition
Contribution to smart city mobility mix concepts
EBSF System functionalities
EBSF interfaces with "outside world" and "other services of PT network"
EBSF Specification management tool
EBSF assessment tool
Development of EBSF Safety Management Systems (SMS)



b. EBSF ICT platform integration

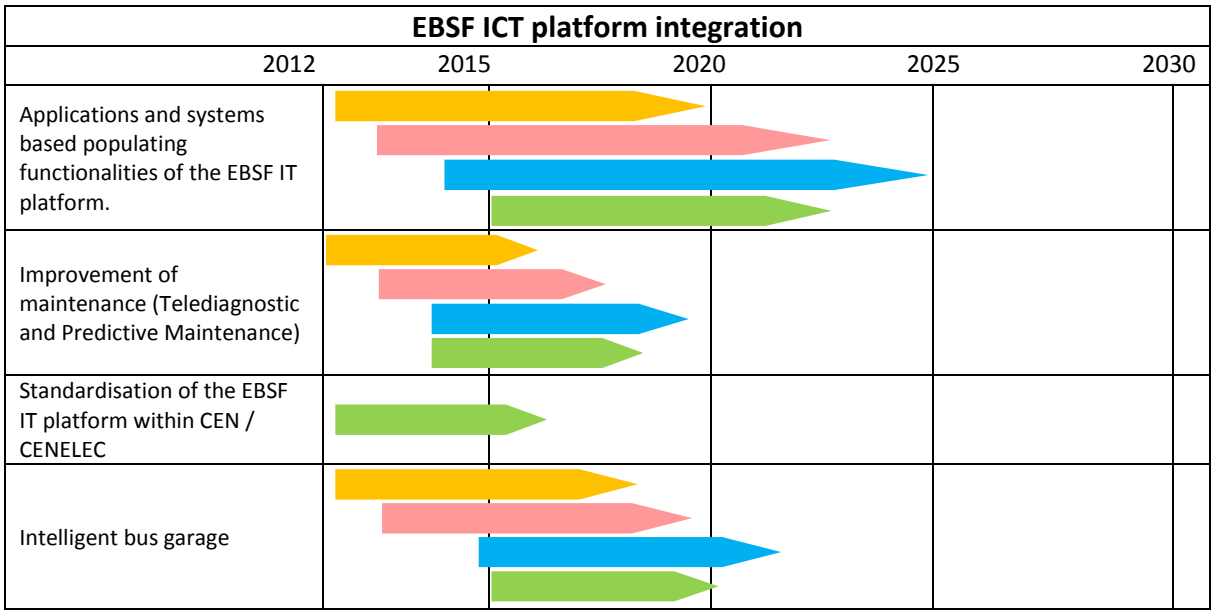
Standardization and harmonization of information system and open architecture are the logical answer to efficient bus system integration.

In general, individual mobility can be achieved only by guaranteeing that clear and complete information are provided to the passenger all along his journey, and independently by the combination of means of transport he use: the PT-user requests complete (i.e. relative to all the means composing the urban mobility scenario), permanent, available and updated information to move from A to B and to remain informed about possible changes all along the trip. For this reason, interoperability between the systems that contribute to the set of information required by the passenger has to be ensured, to provide timely and complete information to the passenger during the entire trip, from the planning stage to efficient door-to-door navigation.

For operators, harmonization of information system through an open architecture is the priority to improve quality of the service provided to the citizens, by enabling efficient maintenance procedures that are based on remote diagnostic to the on-board systems, and prediction of failures by applying sophisticated algorithms.

- Development and test of pilot applications and systems based on the IT platform for communication between vehicle, stations/stops and “back office” developed in EBSF, taking advantage by new enabling technologies (Galileo, Multi-channel gateway using wireless mesh communication network), and targeted to the specific stakeholders needs (i.e. fleet management systems, operations control, integrated ticketing, passenger counting for PT operators, multimodal travel information for passenger/infotainment, traffic data for public authorities, law infringement for police, system performance for industry)
- Improvement of maintenance processes through: the mature implementation of remote diagnostic; and the development of algorithms, implementation of software and systems integration for predictive maintenance of key vehicle equipments.
- Follow-up of the already started standardisation activities for the EBSF IT platform and its IP based communication protocol.

- Development of concepts, requirements and technologies of an “intelligent bus garage”, with programmable multi-function utilities for fleets with large variety of vehicles. This activity is based on the EBSF back-office specification and design and includes pilot.



c. Sustainable bus system

A sustainable Bus System is fundamental to achieve the strategic objectives. Sustainability of bus system can be reached via smart use of the energy all along the Bus System (of which the electrification offer an important contribution), and the improvement of the environmental performances.

C1. Energy Efficiency of Bus Systems

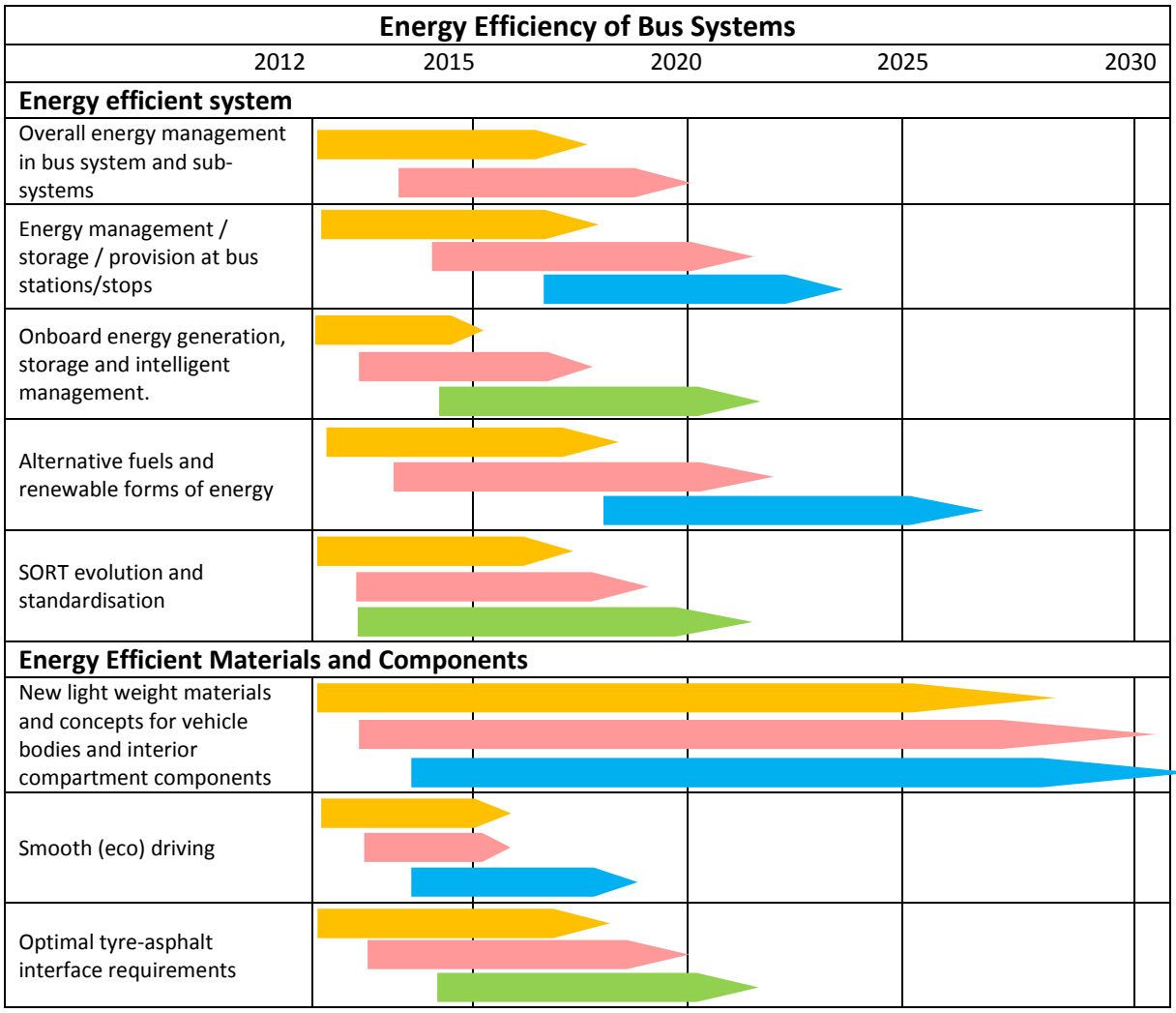
The Bus Systems of the Future shall facilitate and promote the smart use of existing and alternative energy resources: the smart use of the resources (maximal performance per energy use) and research and development of alternative and cleaner energy sources are key points for EBSF and public transport in general, in order to maintain its sustainability and its characteristic of an environmentally-friendly transport mode. To pursue that, it is necessary to focus researches:

Energy efficient system

- Overall energy management solutions for bus systems taking into account vehicle, infrastructure and operation, like efficient bus lanes and traffic control measures.
- Energy management at bus stations/stops (via photovoltaic decentralised energy supply), in combination with “plug-in”/docking solutions to rapidly charge energy into electric buses, energy storage (in batteries)
- Onboard energy generation, storage and intelligent management, including recuperation of maximum breaking energy for hybrid vehicles, new HVAC, auxiliary components and total energy management for electric buses.
- Further developments of alternative fuels and renewable forms of energy with a particular attention to hybrid and electric solutions (see C3)
- SORT evolution and standardisation at European level

Energy Efficient Materials and Components

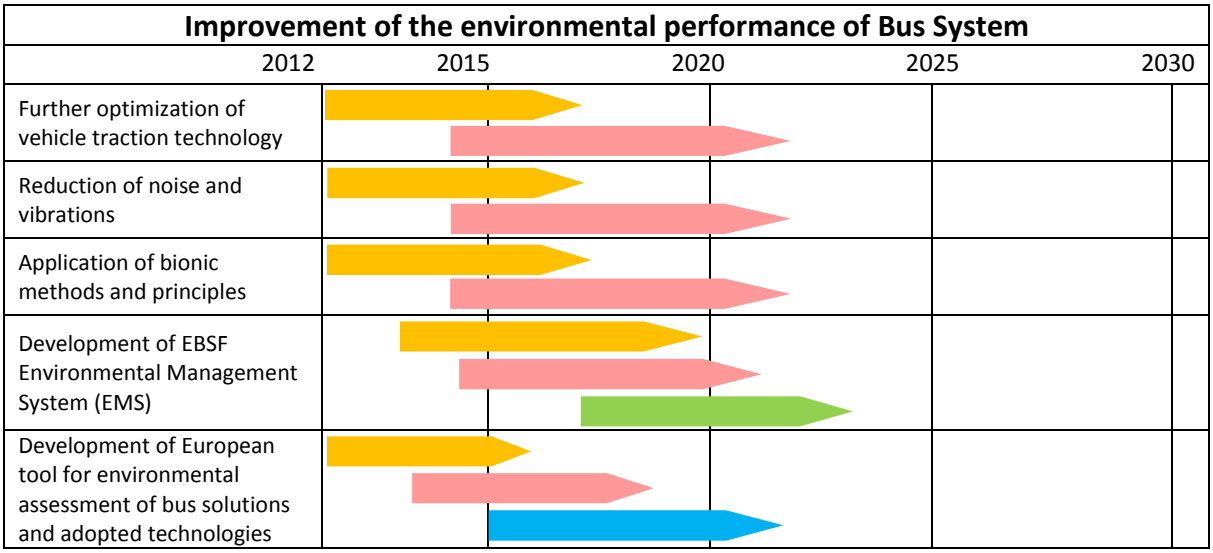
- Development and application of new light weight materials and concepts for the production of vehicle bodies and interior compartment components
- Research in smooth (eco) driving, optimal tyre-asphalt interface requirements



C2. Improvement of the environmental performance of Bus System

In the light of further demands from European legislation (EURO VI), the need to introduce low GHG emission technologies research for further improvements is necessary in the following areas:

- Further optimization of vehicle traction technology including innovative gear control systems
- Reduction (in particular active reduction) of noise and vibrations
- Application of bionic methods and principles like: adoption of specific materials, weight optimisation concepts
- Development of EBSF Environmental Management System (EMS) in line with the EBSF requirements and the functionalities (see also a). They are composed by processes and tools for assessing “changes” in the system from the point of view of environmental impact on the system itself.
- Development of a European tool for the environmental assessment of bus solutions and adopted technologies, and which take into account the complete life-cycle of the vehicle, but also the energy source methods.



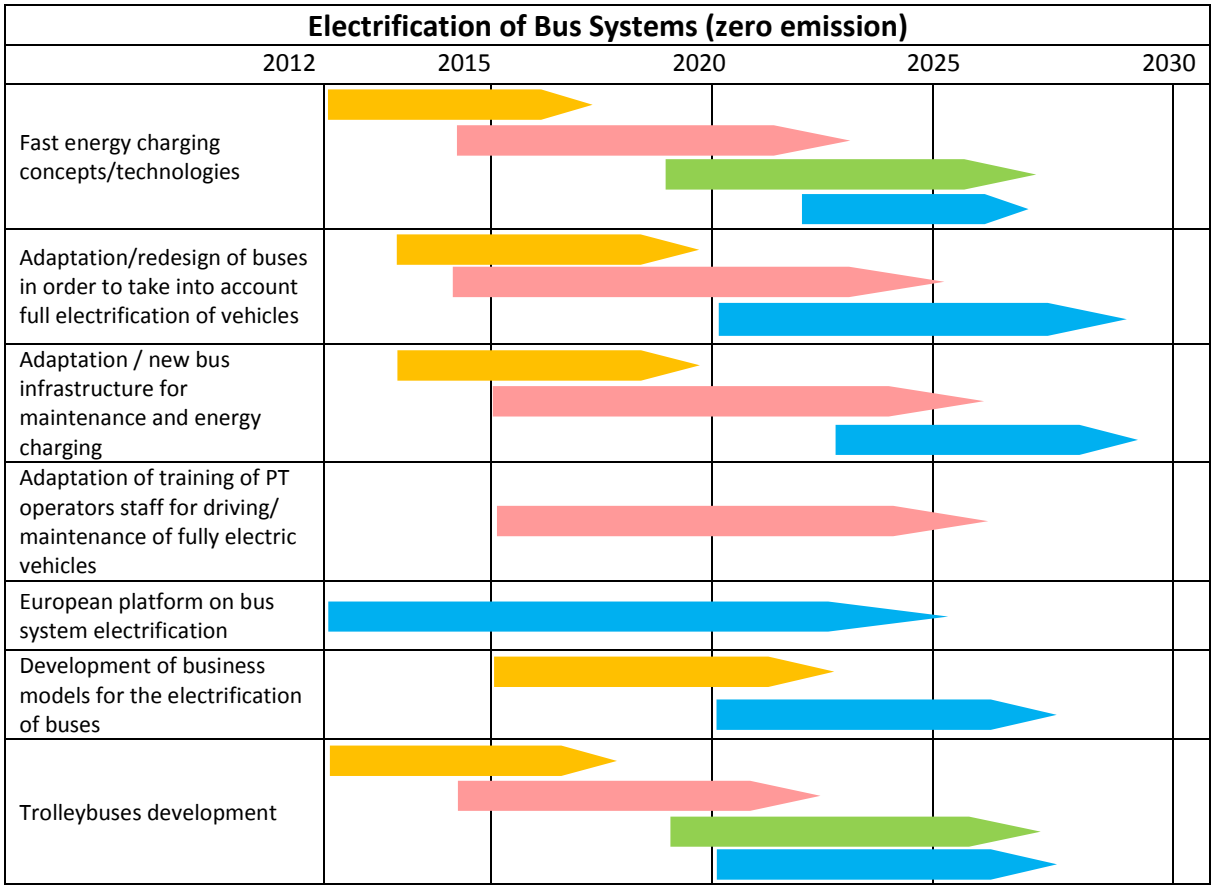
C3. Electrification of Bus System (zero emission)

Electrification of buses contributes to the achievement of the two previous action areas for sustainability; the complexity and potential of the topic requires a specific area of action. Bus fleets are ideal for electrification as buses are normally 10 to 18 h/day in operation and energy charging infrastructure can be installed in a very cost-efficient way in existing bus depots or at dedicated bus stops. Second generation hybrid buses are a first step in the direction of fully electric buses. The trolleybus technology potentialities have to be taken into account in research priorities.

Further research is especially needed in the field of:

- Fast energy charging concepts/technologies ("plug-in"/docking systems/inductive power transfer, high performance batteries/batteries swapping, supercapacitors) during service operation (in contrary to cars which stand still 90% of the day) with high reliability in order to maintain a high availability of buses. For instance, fast recharging available at the terminus (taking just two to three minutes) or at a station (during a normal stop) by recharging the vehicle's on-board supercapacitor storages
- Adaptation/redesign of buses in order to take into account full electrification of vehicles including development of necessary batteries for urban bus operations and optimization of recharging interfaces.
- Adaptation of existing infrastructure for maintenance and design of new infrastructure for energy charging at depots/major bus stops/terminals (including optimization of recharging interfaces)
- Adaptation of staff training of public transport operators for driving/maintenance of fully electric vehicles.
- Common European platform (composed by operators and producers) for exchanges, feedbacks and investigations: by pooling know-how on best practices, this platform could certainly provide a powerful tool for generating economies of scale and also provide the basis for a decision-making tool. Initial activities would be investigations aiming to identify: which type of traffic is suitable for which type of electro mobility; how electro mobility will change the operation from economical and environmental point of view; strategies for development of electrification bus system solutions at European scale.
- Development of business models for the electrification of buses eventually embedded in more comprehensive business models for public transport systems, and exploring funding and incentives schemes.

- Trolleybuses: breaking energy recuperation and feedback in the grid or combination with energy storage systems; relative energy management; contact-less concepts/technologies for down-town and historical city center crossings.



d. Research on innovative vehicle technologies

Oriented to drive modes

- Automatic drive modes and systems
- Design of specific Bus Driver assistance systems like distance control, night view, bird view camera systems, and so on...
- Advanced collision guard systems for bus drivers and pedestrians

Oriented to accessibility

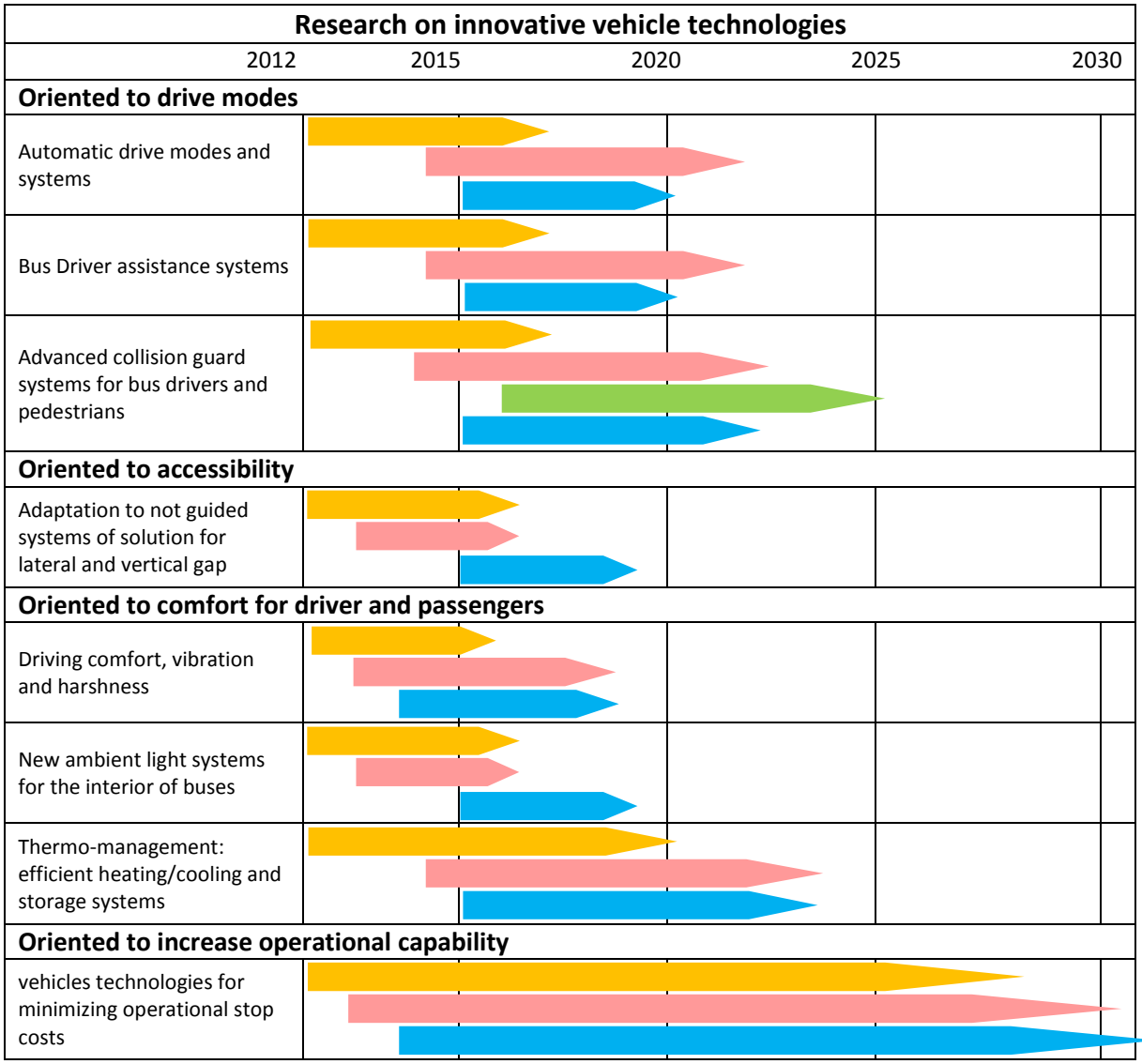
- Adaptation to not guided systems of the solutions to reduce lateral and vertical gap between bus and dock to improve accessibility especially for reduced mobility people

Oriented to comfort for driver and passengers

- Driving comfort, vibration (coming from vehicle and/or infrastructure) and harshness
- New ambient light systems for the interior of buses
- Thermo-management: efficient heating/cooling and storage systems

Oriented to increase operational capability

- Innovative vehicles technologies for minimizing operational stop costs (for example constructive solution of glued bus glasses) due to vandalism effects and collisions


Research on innovative vehicle technologies
2012
2015
2020
2025
2030
Oriented to drive modes
Automatic drive modes and systems
Bus Driver assistance systems
Advanced collision guard systems for bus drivers and pedestrians
Oriented to accessibility
Adaptation to not guided systems of solution for lateral and vertical gap
Oriented to comfort for driver and passengers
Driving comfort, vibration and harshness
New ambient light systems for the interior of buses
Thermo-management: efficient heating/cooling and storage systems
Oriented to increase operational capability
vehicles technologies for minimizing operational stop costs

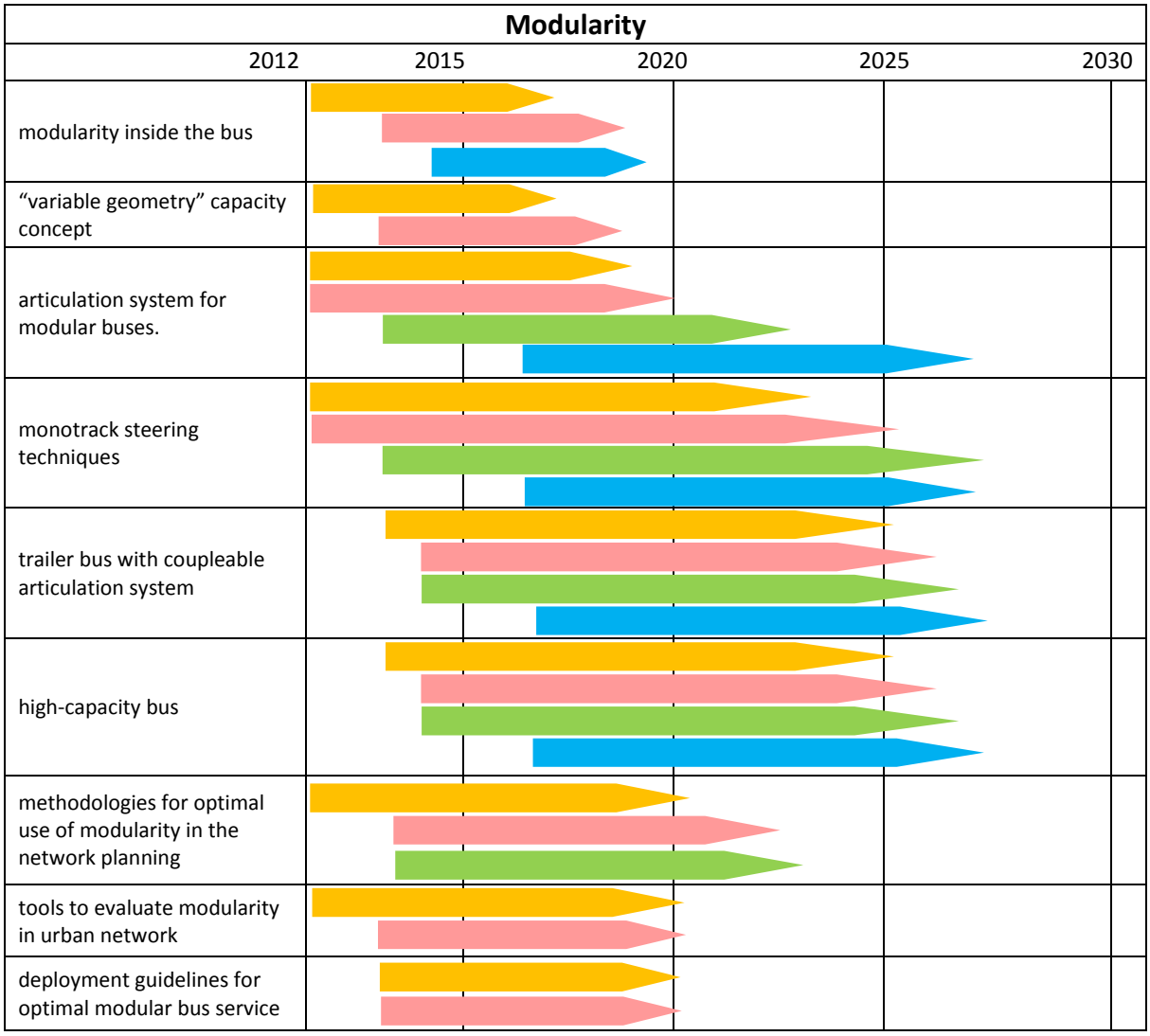
e. Modularity

Modularity can bring an important contribution to the attractiveness of the bus system, through the optimization of the capacity, consumption (and emissions), frequency during different hours according to the demand. It also provides benefits to operators' economy thanks to the increase of the capacity and the dilution of driving costs during peak hours.

For this reason, it is today considered a priority for research for both operators and industries: the first have started identifying the potential benefits, the latter is reaching maturity in the research and development.

The concept of modularity is achieved by applying the system approach, then allocating and developing the different functionality aspects at vehicle, infrastructure and operation level:

- Flexibility of the bus interior layout, for a rapid conversion from maxi capacity to maxi seating
- Develop "variable geometry" bus capacity concept for addressing "peak/off-peak" compatibility.
- Advanced development of articulation system for modular buses aiming to fast and safe plug / un-plug of bus modules.
- Advanced development of monotrack steering techniques and relative prototype. Review of impacted regulations about bus length, and regulatory framework about steering-by-wire
- Development of a bus with trailer by using a coupleable articulation system
- Development of high-capacity bus with a length of 30m+ (to fill the capacity cap between buses and trams)
- Definition of methodologies for making the optimal use of modularity in the network planning, contributing to make easy the identifications of potential benefits,
- Design of tools to identify and evaluate the introduction of modularity in the urban network through Key Performance Indicators specifically identified
- Definition of an optimal deployment plan for the operators, based on the two points above, which will include modularity in the city in the most profitable way.


Modularity
2012
2015
2020
2025
2030
modularity inside the bus
“variable geometry” capacity concept
articulation system for modular buses.
monotrack steering techniques
trailer bus with coupleable articulation system
high-capacity bus
methodologies for optimal use of modularity in the network planning
tools to evaluate modularity in urban network
deployment guidelines for optimal modular bus service

f. Meeting the mobility challenges of an ageing society

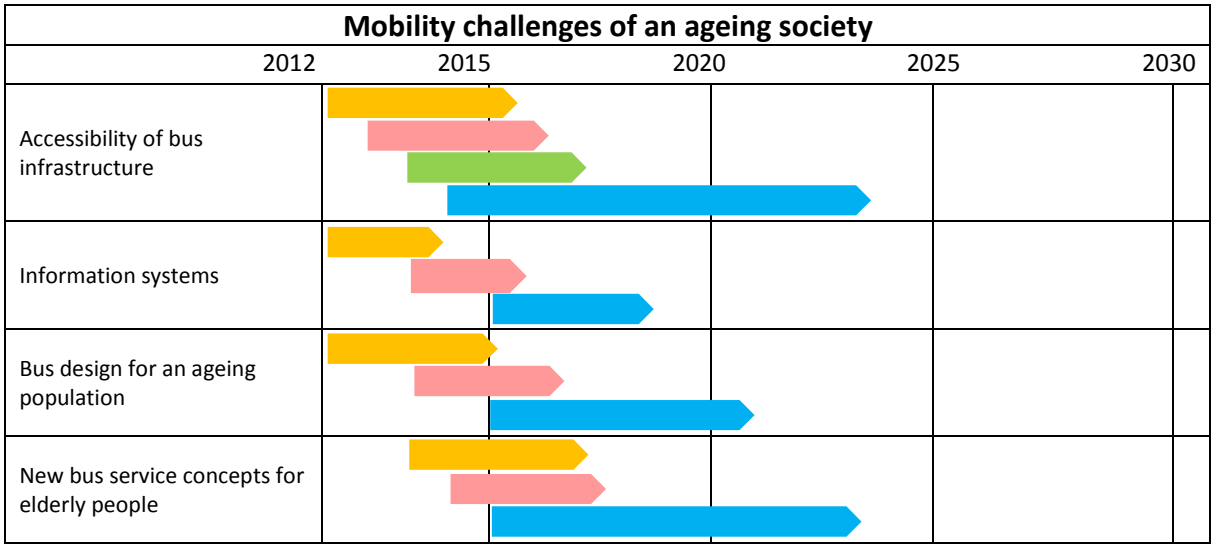
The majority of European countries face average population age increase and the challenges of a shrinking population. It is wrong to assume that elderly people will automatically be “naturally born” customers of public transport. Investigations into mobility behaviour in the US showed that people who grew up using a car will also tend to drive a car as pensioners. Apart from providing service to the public bus operators will be more and more forced to attract elderly people as necessary costumers.

Therefore it is important to make public transport more attractive and especially usable for elderly people. Some features of state-of-the-art buses and bus stops, including information systems, do not meet the requirements of elderly people, e.g. accessibility of bus stops, visibility and audibility of information, arrangement of seats, areas for wheel chairs and walking aids or bus entrance areas.

Most if not all elderly people’s requirements do also facilitate the mobility of people with other mobility handicaps. However, some of the elderly people’s requirements directly interfere with other people’s comfort demands, e.g. sound volume of information, number and arrangement of seats. It is therefore indispensible to find an optimal compromise between the requirements of the different user categories.

Four major research and development areas can be identified

- Accessibility of bus infrastructure including information and guiding systems (distance to bus stops, barrier-free access, visibility of information and guiding signs)
- Information systems at bus stops and inside the bus (e.g. visibility, varying sound volumes of information in different areas within the bus, comprehensibility of information)
- Design of the bus interior incl. entrance areas (e.g. arrangement of seat, areas for walking aids, hand rails, passenger department illumination, colouring and colour contrasts etc.)
- New bus service concepts for elderly people (e.g. flexible bus routes on demand during off-peak traffic)



6. Recommendations

A large consultation of the EBSF Roadmap has been performed within several committees and groups. Such consultation has produced, in addition to specific contributions, the main priorities within the presented topics of the EBSF Roadmap . Here below the main priorities are indicated.

EBSF ICT platform integration. The need for a standardised platform for data communication between vehicle and infrastructure elements is the main priority, due to its positive impact on all the bus service stakeholders, allowing the interoperability of solutions and systems, the development of innovative applications for passengers and fostering the introduction of improved maintenance processes. It is recommended that relevant institutional actors support such standardisation process.

Decarbonisation, electrification, energy efficiency and environmental-friendly bus-system. Such research topics require to be developed with a strong system approach, facing all the aspects that contribute to the objective, not only specifically to vehicle developments or infrastructure. In addition, they require the strong involvement of all the actors of the bus service value chain. For such a reason, it is recommended a long-term perspective with a single dedicated funding programme at European level with a relevant budget to develop European bus system research and incentive and/or co-finance the renovation of fleets. Then, **modularity** (with its impact on operational costs), **innovative vehicle technologies** (in particular oriented to the comfort of passengers and drivers) are identified as priotity, together with operational and technical solutions for increasing **bus average commercial speed**.

Then, priority have been identified for all the aspects relative to the **bus stops, interchange hubs, bus infrastructure components** and **urban infrastructure.**

Finally, it is worth to highlight that in order to improve the attractiveness of the bus-system, promotion of bus services and demonstration of the associated benefits plays an important role, through specific awareness campaign or large pilots.

As stated in section 2, the EBSF “tree” enable the capitalisation and inter-link of all EU R&D related efforts and fields in relation to the bus systems.

7. References

Documentation

- EBSF Project material
- Transport White Paper from DG Move setting the "new" EU transport policy: COM(2011) 144, White Paper 2011 'Roadmap to a Single Transport Area - Towards a competitive and resource efficient transport system'
- UITP PTx2 Strategy

Main contributors:

- Umberto Guida, UITP (EBSF Project Director and EBSF Roadmap responsible)
- Arno Kerkhof, UITP
- Maeva Zebrowski, UITP
- Elios Pascual, strategic advisor for EBSF Project
- Ulrich Weber and Ralph Puetz, VDV
- Helmut Berends, BERENDS
- Jose Campos, MAN
- Daniela Carbone, ASSTRA
- Valery Cervantes, IRISBUS-IVECO
- Carlos Cristobal-Pinto and Laura Delgado, CRTM
- Jean-Laurent Francineau and others, VERI
- Ulf Gustafsson and others, VOLVO
- Thoralf Knote, FRAUNHOFER
- Marino Lizza, ATAC
- Antonio Musso, DICEA
- Valerio Recagno, D'APPOLONIA
- Helmut Warth and others, EVOBUS

Additional contributors or reviewers:

- Stefanie Boege, HUBNER
- Johan Bullynck, DE LIJN
- Amerigo Del Buono, ATM
- Daniela Carvalho, TIS
- Cécile Clement-Werny, CERTU
- Jean-Paul Etienne, TEC
- Brendan Finn, ETTS
- Freire Fonseca, CARRIS
- Luis Garro, RTM
- Rolf Hedberg, SCANIA
- Jesper Kaas, MOVIATRAFIK
- Iain Knight, TRL
- Brian Masson, University of Aberdeen
- Anne Meyer, UTP
- Robert Pribila, WIENER LINER
- Thierry Wagenknecht, TPG
- Keith Watson, ALEXANDER DENNIS

Consulted groups:

- EBSF Project Partners (all the Consortium partners)
- EBSF User Group (all the members)
- UITP Bus Committee (all the Committee members)
- UITP VEI Committee (all the Committee members)

- UITP EU Committee (some members for some topics)
- UITP ITI Committee (chairman and some members for some topics)
- COST action TU603 “Buses with a high level of service” (all members)
- ERTRAC working group, boards and committees