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Deliverable D6.6

Exploitation Plan

Updated version

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3	30/10/2018	Final version of D6.6

Consortium - List of partners

Partner No	Short name	Name	Country
1	UIC	International Union of Railways	France
2	VTT	VTT Technical Research Centre of Finland Ltd	Finland
3	NTNU	Norwegian University of Science and Technology	Norway
4	IFSTTAR	French institute of science and technology for transport, development and networks	France
5	FFE	Fundación Ferrocarriles Españoles	Spain
6	CERTH-HIT	Centre for Research and Technology Hellas - Hellenic Institute of Transport	Greece
7	TRAINOSE	Trainose Transport – Passenger and Freight Transportation Services SA	Greece
8	INTADER	Intermodal Transportation and Logistics Research Association	Turkey
9	CEREMA	Centre for Studies and Expertise on Risks, Environment, Mobility, and Urban and Country planning	France
10	GLS	Geoloc Systems	France
11	RWTH	Rheinisch-Westfaelische Technische Hochschule Aachen University	Germany
12	UNIROMA3	University of Roma Tre	Italy
13	COMM	Commsignia Ltd.	Hungary
14	IRU	International Road Transport Union - Projects ASBL	Belgium
15	SNCF	Société Nationale des Chemins de Fer Français (France's National Railway company)	France
16	DLR	German Aerospace Center	Germany
17	UTBM	University of Technology of Belfort-Montbéliard	France

Executive summary

This document is a key deliverable of the SAFER-LC project which summarises the beneficiaries' strategy related to the protection and exploitation of the project results during the project's life and afterwards. It is to serve as an on-going, concise work plan for setting out the main aspects of the exploitation. It also establishes suitable actions to make SAFER-LC a success and ensure sustainability of the results for a long period. It also makes sure that the impact of the project outcomes is maximized; the use of results in further research other than those covered by the SAFER-LC action concerned is ensured, the development, creation and marketing of any further products, services or processes and standardisation activities are aware of and constructively use the project results.

This document also makes the bridge with the deliverable of the WP6 D6.3 "Communication and Dissemination Plan", which sets forth the planned dissemination & communication activities during the project's life and later, i.e., strategies and measures to be followed by the SAFER-LC project consortium in order to raise awareness of the safety challenge of rail-road level crossings, and its suggested solutions and availability of the results within the professional community as well as with the general public.

Another objective is to fill in the existing gaps between (a) research and development, (b) practical implementation and utilization of the results, and (c) end users' decision-making. The document, therefore, attempts to provide a systematic but flexible approach, allowing the end-users to adapt their utilization and deployment decisions to their specific corporate and industrial requirements. Industry adoption of the innovative technologies developed by the project is primary importance which provides important opportunities for new product development and adoption of novel methods in the C-ITS field. SAFER-LC plans its results to be quickly integrated into the industry development roadmap by several means, including standards and industrial recommendations.

SAFER-LC partners are involved in various expert national or international committees that may influence National and European transport policies in topics related to the development of Cooperative Systems, Intelligent Transportation Systems, Railway Systems etc., contribution to policy development is, therefore, an important project activity.

Road and rail transportations are two rather independent modes of transportation operating on distinct and independent technological basis. One main objective of SAFER-LC is to bring the requirement specifications and the enabling multidisciplinary solutions affecting LC safety capable to work in a close symbiosis where interoperability of the safety technologies is a prevailing factor. Liaisons with road and rail transportation sectors, National / market / cultural problems are also taken into consideration.

The final version of this Exploitation Plan will provide a cumulative overview of the undertaken activities at the end of the project (M36). A detailed plan for exploitation or use in further research for each project participant, when the SAFER-LC developments have been completed and the validation results are known is presented.

Table of contents

TERMS AND ABBREVIATIONS

Abbreviation	Definition
3G/4G	Third/Fourth generation cellular phone technology, e.g., UMTS/LTE
5G	Fifth generation cellular communications technology
ADAS	Advanced Driver Assistance Systems
AVIS	Automatic Vehicle Identification System
API	Application Programming Interface
CAM	Cooperative Awareness Message (C-ITS communication protocol)
Car2X	Car to everything communication
CBTC	Communication Based Train Control
CCTV	Closed Circuit Television
CSMA	Carrier Sense Multiple Access
CTA	Cooperative Traveller Assistance application
C-ITS	Cooperative Intelligent Transportation Systems
DATEX	Data Exchange protocol: information exchange between traffic management centres, traffic information centres and service providers
DENM	Distributed Environment Notification Message (C-ITS communication protocol)
DSRC	Dedicated short-range communications
EC	European Commission
EDA	Enhanced Driver Awareness
FOV	Field of View
GeoNetworking	Geographic addressing and routing for vehicular communications
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
IPv6	Internet Protocol Version 6
IPR	Intellectual Property Rights

ITS	Intelligent Transportation Systems
IVIS	In-Vehicle Information System
LC	(Rail-Road) Level Crossing
LDM	Local Dynamic Map
LTE	Long Term Evolution (aka 4th generation cellular communication)
LOS	Line of Sight
MAC	Medium Access Control (layer)
OBU	On Board Unit
OEM	Original Equipment Manufacturer
P2P	Peer to peer
POC	Proof of concept
RSU	Road Side Unit
SDO	Standard Development Organization
SPaT	Signal Phase and Timing intersection control protocol
TCC	Traffic Control Centre
TCDD	Turkish State Railways (Türkiye Cumhuriyeti Devlet Demiryollari)
TMC	Traffic Management Centre
TRL	Technology Readiness Level
V2I	Vehicle to Infrastructure (communication)
V2V	Vehicle to Vehicle (communication)
V2X	Vehicle to Everything (communication)
WAVE	Wireless Access in Vehicular Environments

1. INTRODUCTION

This document is a key deliverable of the SAFER-LC project which summarises the beneficiaries' strategy related to the protection and exploitation of the project results during the project's life and afterwards. It is to serve as an on-going, concise work plan for setting out the main aspects of the exploitation. It also establishes suitable actions to make SAFER-LC a success and ensure sustainability of the results for a long period. It also makes sure that the impact of the project outcomes is maximized; the use of results in further research other than those covered by the SAFER-LC action concerned is ensured, the development, creation and marketing of any further products, services or processes and standardisation activities are aware of and constructively use the project results.

The document is an incrementally advancing (evolutionary) deliverable for the SAFER-LC project which proceeds with the project lifetime. This describes the way how the consortium as a whole but also each individual participant envisions the exploitation of its own involvement and the results what is expected to achieve. As the consortium puts together a balanced team of execution, involving industrial, SME and academic partners, there are – in each case – distinct ways to exploit the project's outcome.

What is reported in the following sections draws-on the initial SAFER-LC exploitation plan sketched by the consortium members.

In Section 3 and 4 we will first explain the general strategy and approaches that the project consortium has agreed upon.

In Section 5 the updated exploitation strategy is reported on a per partner basis in order to highlight the opportunities and technology and knowledge transfer action envisaged by each partner. Clearly, the exploitation plan for each partner (but also for the consortium as a whole) will become more detailed and relevant as the technical work proceeds and the first SAFER-LC results are derived. In this sense, a more detailed description of the considered plans will be available during the second and the third year of the project. The final version of this Exploitation Plan at the end of the project (M36) will provide a cumulative overview of the undertaken activities and a detailed plan for exploitation or use in further research for each project participant, when the SAFER-LC developments have been completed and the validation results are known.

This document also makes the bridge with the deliverable of the WP6 D6.3 "Communication and Dissemination Plan", which sets forth the planned dissemination & communication activities during the project's life and later, i.e., strategies and measures to be followed by the SAFER-LC project consortium in order to raise awareness of the safety challenge of rail-road level crossings, and its suggested solutions and availability of the results within the professional community as well as with the general public.

Another objective is to fill in the existing gaps between (a) research and development, (b) practical implementation and utilization of the results, and (c) end users' decision-making. The document, therefore, attempts to provide a systematic but flexible approach, allowing the end-users to adapt their utilization and deployment decisions to their specific corporate and industrial requirements. Industry adoption of the innovative technologies developed is primary importance which provides

important opportunities for new product development and adoption of novel methods in the C-ITS field. SAFER-LC plans its results to be quickly integrated into the industry development roadmap by several means, including standards and industrial recommendations.

SAFER-LC partners are involved in various expert national or international committees that may influence National and European transport policies in topics related to the development of Cooperative Systems, Intelligent Transportation Systems, Railway Systems etc., contribution to policy development is therefore an important activity of the project.

Road and rail transportations are two rather independent modes of transportation operating on distinct and independent technological basis. One main objective of SAFER-LC is to bring the requirement specifications and the enabling multidisciplinary solutions affecting LC safety capable to work in a close symbiosis where interoperability of the safety technologies is a prevailing factor. Liaisons with road and rail transportation sectors, National / market / cultural problems are also taken into consideration.

2. PROJECT SUMMARY

According to Eurostat 2015, more than six hundred persons are killed in EU-28 at railway level crossing incidents yearly. This represents 35% of all accidental casualties.

Reducing hazards and increasing traffic safety at railway crossings involving the traffic of trains, road and rail vehicles is, therefore, a key focus area for the creation of safe and sustainable transportation strategy in Europe.

2.1. The consortium

SAFER-LC partnership incorporates 17 partners from 8 different EU countries including one associated country from Western, Northern, South, Central and Eastern Europe. The decidedly trans-European character of the project presents a particular added value since it deals with issues of a common concern at pan-European level, which, in conjunction with the partners' multidisciplinary expertise creates an efficient form of collaboration where sharing of practices, technology transfer and joint collaboration in the process, methodologies and deliverables results to more effective cooperation and leads to the beginning of a sustainable networking across European research and educational area.

The consortium consists of a complementary mix of parties and uses and exploits the benefits of an established partnership between enterprises and stakeholders from the railway industry, academic, educational and training institutions, universities and research and development organisations, as well as with civil society authorities who can valorise the results directly, and/or indirectly, through subsequent cooperation with industrial partners and rail and road service providers. The various participations of rail-road stakeholders and of the local LC managing authorities or private road owners in pilot projects further enrich the consortium's related knowledge portfolio.

2.2. Scope of the SAFER-LC project

SAFER-LC is a Research and Innovation Action (RIA) Project within the EU's H2020 Framework Programme running from 1st of May 2017 to 30 of April 2020 whose main objective is to answer the call of the number of fatalities and develop methods for LC safety enhancement as discussed in the objectives section in more details.

The project will focus both on technical solutions, such as smart detection and warning services and advanced infrastructure-to-vehicle communication systems and on human processes to adapt infrastructure design to end-users and to enhance coordination and cooperation between different stakeholders from different transportation modes. The project takes an exemplary approach in this respect when it stresses the need for the rail and road systems to share information and data so that each party can manage disruptions caused by the other in an optimal way: this balance is emphasised.

In the coming self-driving cars populated traffic railway crossings poses an additional safety challenge that cannot be overlooked. The problem is double faced. From the one side an autonomous car's driving strategy that is much better at avoiding accidents than human drivers may lead to unreasonably over cautious manoeuvring in level crossings. The timid autonomous systems the approach and passing of railway crossings by autonomous vehicles could result in unnecessary traffic slow down or even end up with complete traffic jams because of the bad visibility of most rail level crossings scenarios. The solution is to use the connected car paradigm by extending cars' ability to see beyond line-of-sight and field-of-view with enhanced accuracy.

The scope of the SAFER-LC project is, therefore, broadened from human centric traffic to automated traffic systems.

A series of pilot tests across Europe will be rolled out to demonstrate how these new technological and non-technological solutions can be integrated, validate their feasibility and evaluate their performance in a field where technological crossovers and interdependencies are common. The project will deliver a bundle of recommended technical specifications (also for standardisation), human processes and organisational and legal frameworks for implementation. SAFER-LC will also develop a publicly available toolbox accessible through a user-friendly interface which will integrate all the project results and solutions in order to help both rail and road managers to improve safety design at level crossings.

2.3. SAFER-LC objectives

The main objective of the project is to develop and test new technologies to improve safety and minimize risks at and around rail-road level crossings (LCs) by developing a fully integrated cross-modal set of innovative solutions and tools for the proactive management and new design of level-crossing infrastructure.

Modern vehicles are becoming increasingly capable of establishing connectivity for the exchange of information between vehicles (V2V) and between vehicles and road infrastructure units (V2I) – together referred to as V2X or Car2X. The so-called 'connected-vehicles' paradigm can bring about an enormous potential for safer transportation. However, the safety management at level crossings calls for disruptive new technology and detection solutions, capable of extending the cooperative functionality of C2X systems to support the avoidance of dangerous traffic situations in real-time.

Cooperative perception is the name of a new technology for the exchange of data from a vehicle's sensors with other vehicles or infrastructure via V2X that enhances the event resolution and perception range of a vehicle.

This capability can provide oncoming traffic information beyond line-of-sight and field-of-view with enhanced accuracy which enables better control of both driven and self-driving vehicles. Cooperative perception techniques together with sensor fusion technology provides better situation awareness, improves visibility of both road and rail vehicles resulting in a pre-emptive safety enhancement for rail crossings. Novel methods for information exchange between road and rail vehicles are among the many innovative solutions developed by the project.

2.4. Key project results

One core aspect of the project's practical exploitation will involve the development of a toolbox for relevant actors of the LC safety community. The toolbox will summarise the most relevant and practical information collected and produced during the project. The toolbox will be developed during the project, it will be easily accessible free of charge at the end of the project, and will continue to be maintained, updated and improved by the International Union of Railways (UIC) even after the end of the project for the benefit of the entire road- and railway-safety communities. We trust that the SAFER-LC toolbox will become another good example of exploitable results from EU-funded projects, and will perfectly complete the RESTRAIL toolbox (already acknowledged as a "success tool" by the European Commission).

The aims of the SAFER-LC toolbox will be:

- to provide an integrated overview of the road and rail safety requirements for the relevant actors of the LC safety community (e.g. road and rail infrastructure managers, train operators, engineers, designers, scientists, decision-makers, policy makers and SDOs);
- to provide detailed guidance on the implementation of integrated socio-technical solutions to increase safety at LCs;
- consider human factors (cognitive and perceptive) in the design of LC infrastructures for all levels of the LC ecosystem – for all participants in the system (LC operators, road travellers and train passengers etc).
- to provide a framework for collecting and structuring information in order to feed an accessible and documented database on efficient measures across the road-, rail-, and scientific communities.

The compliance with the above objectives will help to fill the existing gaps between (a) research and development, (b) practical implementation of results, and (c) decision-making. The toolbox will provide a systematic but flexible approach, allowing the end-users to adapt it to their specific needs and according to particular national / cultural problems.

At this point, the existing LC research is somewhat separated between the road and the rail sectors, as well as between technical and human factors research. Through this toolbox everything will be integrated and available for the concerned stakeholders and researchers. To our knowledge the SAFER-LC toolbox is the first attempt to provide an evidence-based practical tool for relevant actors of the LC safety community and a structured research framework for technical and human factors /

behavioural scientists concerned with the continuous optimisation of integrated and connected socio-technical safety solutions at LCs.

3. PREPARATION FOR EXPLOITATION

3.1. Exploitation strategies

All SAFER-LC partners find real opportunities to leverage the project results in their ongoing and/or future activities whether that be industrial, commercial, research or academic. As SAFER-LC is a RIA action project, the efficient exploitation requires an additional effort by the partners to bring the project results to a level of maturity that can be included in a commercial (or at least close to commercial or prototype) application. The early industrial and academic adoption of the new and effective safety enhancement technologies developed by SAFER-LC may result direct competitive advantages for the SAFER-LC partners. SAFER-LC, therefore, try to catalyse this adoption process by bringing various actors together under the umbrella of this research and innovation action by harmonizing needs and requirements generated by the key players of the field, i.e., build a bridge between basic research and industrial adoption and exploitation.

Potential users of the results provided by SAFER-LC are road and rail transport operators, city authorities, local state organisations and various traffic service providers. Once the SAFER-LC action is successfully terminated, the consortium will invite selected actors from the interested stakeholders and demonstrate them the key project achievements. Exploitation strategies applied by the project are varied and they differ in key concepts characterized by the domain of exploitation as it is discussed in the following sections.

3.1.1. Road and rail infrastructure managers

Road and rail transportations are two rather independent modes of transportation operating on rather separate and independent technological basis. One main objective of SAFER-LC is to bring the requirement specifications and the enabling solutions affecting LC safety, closer to each other, capable to work in a close symbiosis. Infrastructure owners and operators are to be involved in the planning, design, construction, maintenance, and operation of the road-railway infrastructure. They should establish realistic expectations about the available supporting and enhancing technologies when deploying new LC projects and demonstrations. To fully realize the benefits of novel technology elements (such as the ones developed by SAFER-LC) decision makers, operators and users must understand and be wholly comfortable with the new technology.

Infrastructure owners and operators have already expressed interest in more information and guidance on the scope and content of these safety technologies and how to prepare LC deployment and operation. This request will be answered by

- the organization of trainings and workshops focussing on the use of the SAFER-LC toolbox including standardized solutions and technologies,
- providing best practices and policy considerations to support stakeholders as they work to better understand SAFER-LC's achievements, how it may impact their roles and

responsibilities, and how best to integrate the solution approaches into existing and future LC deployments,

- cooperation with stakeholders to maximise interoperability throughout Europe and take advantage of common international interests by leveraging work across multiple markets, regions and properties.

3.1.2. Industrial and SME's exploitation

Private sector leadership is critical to advancing the development, testing, and commercialization of SAFER-LC results. Consortium members, especially the industrial and SME ones, will rely on the SAFER-LC results to cost-efficiently utilize the safety enhancement techniques developed by the project and seamlessly integrate them in their research prototypes (and/or products). Industrial partners' primary goal is to adopt these safety enhancement technologies on a timely basis.

State organisations involved in the SAFER-LC action play a key role both in industry management and also in academic activities. They work close to the railway transport operators to understand their needs for the handling of potentially dangerous situations occurring at level crossings and inform them about the future possibilities regarding new safety enhancement techniques developed by SAFER-LC.

By broadening the knowledge basis in the field of level crossing safety, the project can start strategic partnerships with railway companies, stakeholders and industrial partners and acquire funding for future collaboration.

SAFER-LC's responsibility in industrial exploitation of its results includes effective dissemination of project results to industrial decision makers, transport infrastructure operators by convincing them about the advantages of the adoption of the results. SAFER-LC's key responsibility is to establish POC pilots operated in real LC sites permitting the public evaluation of the technology elements. Sufficiently exhausting and successful POC evaluation opens the gate to full-scale industrialization and real technology deployments.

3.1.3. Knowledge and academic exploitation

The academic partners of the consortium will seek to exploit SAFER-LC results during and beyond the project's timeline in the academic area. The expertise gained in SAFER-LC will be used by the partners through scientific publications, offered as expertise in future offerings and consultancy activities, or used when developing future activities. The consortium exercises continued dedication to the production of valuable knowledge and research results in the LC safety enhancement area.

Rail service providers and road authorities (such as TCDD in Turkey) will be informed about the results of accident analysis which is carried out in the very first part of the project. They will also be informed about the developments and innovations the project produces and also its benefits and compatibility with the state of recent practice.

Brainstorming and knowledge sharing during the workshop can contribute for creating new projects in the future. Also, an abstract related to the SAFER-LC project may be presented in national and global conferences.

IRU as a key player in European road transport will cooperate with the IRU Academy, the branch of the International Road Transport Union devoted to drivers' training, in order to share with the road freight and passenger transport sectors the knowledge gathered and created by the SAFER-LC project. Training material and activities will be developed in that regard to ensure the relevant tools produced by the consortium are used by the road transport industry on a large scale. IRU will also exploit some of the results produced in SAFER-LC in other projects dealing with cooperative ITS and road safety.

In a direct relationship with SAFER-LC's dissemination activity the project results will be presented to the scientific community in international conferences and be published in scientific journals, covering all focussed theoretical, methodological and technological areas of the project.

A key project objective regarding the knowledge and academic exploitation of the results is to bring the most important SAFER-LC's achievements in higher education programs. Academic institutions will enhance the results using the information and analysis of SAFER-LC achievements in specific courses of education and will employ the results, solutions and methodology in master's degree and PhD thesis programs. Moreover, a continuous exchange of related information and communication will be promoted by universities when organizing meetings, publishing newsletters and presentations, and as such, academic partners will promote the importance of the research in this safety-oriented field of transportation by enhancing professional acceptance and public awareness, continuously.

3.1.4. Collaborative exploitation and IPR management

SAFER-LC is a collaborative research and innovation action project. Collaborative efforts help project participants leverage the strength of working in a team having complementary skills, expertise and knowledges.

Any exploitation activity will be subject to the procedures on ownership of results and transfer of ownership as laid down in the corresponding articles of the SAFER-LC Consortium Agreement.

3.2. Market characterisation of key results

Indications on the market needs and trends must be brought in to SAFER-LC, obviously. It's important to apply research in a practical way and not leave it on the shelf. This means that the research on safety enhancement methodology and technology can be made a success, if the results correspond with the needs of the industry from the one hand, and they are parallel with the most recent technology trends, standards and societal developments of the related field, from the other.

To contribute to market analysis, similar on the shelf products and services can be compared. Also, through the face to face meetings with experts for understanding their expectations for the products and needs of the market can contribute to the market characterisation.

Rail and infrastructure operators involved in the project are the main sources of information about these needs.

The cost/benefit analysis (performed in WP5) will provide valuable indications regarding the economic viability of the solution elements developed by SAFER-LC. The analysis will inherently cover market features.

In order to exploit on a large scale some of the solutions suggested by the SAFER-LC project, the innovations proposed will have to be interoperable and cost-efficient. Road transport operators will implement solutions only when have clear and reasonable potential benefits.

Human lives are priceless and road safety is an obvious priority of the sector, however, the safety benefit is very difficult to characterise in general. Moreover, the number of fatalities in level crossings in the road transport sector is relatively low compared to the injuries and deaths occurring as a result of other kinds of traffic.

Due to the ongoing plans in some European countries regarding reactivation of rail lines in rural areas, the development of innovative and cost-effective measures to increase the safety of level crossings, in particular of passive level crossings, is of great relevance. The reactivation of rural level crossings can be made on the price of considerable costs which may hinder traffic projects. The planning and provisioning process of already established technical safety systems for level crossings takes a long time and is very expensive. Especially with an eye on precarious economic situations of many rural municipalities all over Europe, there, definitely, is a demand for innovative low-cost measures to enhance safety at level crossings. As a part of the project SAFER-LC such systems will be invented in WP 2.3 and evaluated in WP 4.3. The market for the distribution of innovative low-cost safety systems is huge, since it comprises all countries with railways and level crossings.

The cost of the developed solutions must therefore be a conscious issue. The favouring price/performance ratio of the technical solutions is a key factor in industrial adoption that paves the way for real deployments in the road-rail transport industry.

3.3. Potential barriers to the exploitation of results

Several factors can be identified as potential barriers to the exploitation of the project results in real conditions

Level crossings represent a very unique type of infrastructure both from rail and road transportation point of view from many reasons. Because of their multimodal nature in design, construction and operation, the nature of their geographical implantation, moreover, the very different social, legal and regulatory frameworks and technical capacities applied by different countries, LC requirements are very difficult to satisfy. All European harmonization and the assurance of technological interoperability of the results applied by LCs are another critical issue.

SAFER-LC will have to overcome the fragmentation of approaches to the different LC situations and deliver results that can be replicated and exported to the different LC situations in different countries. In order to do so, SAFER-LC will include, not only a cost-benefit analysis, but a detailed human factors description so that each solution delivered can be adapted to the different LC situations, no matter the users or environments involved.

Insufficient harmonisation of the rules governing the management and use of level crossings at the European level, or a deficient interoperability between different technical or communication systems developed to improve safety at level crossing would be significant obstacles to the large-scale implementation of the solutions proposed by the consortium. Other major barriers to the exploitation of the suggested tools would be solutions that do not fully meet the requirements of infrastructure managers and rail and road users, or solutions with implementation costs so high that they would prevent stakeholders to adopt them in real life. That is why the development of each of the solutions

has to be preceded by an attentive evaluation of the trade-off between risks reduction and costs, moreover, an attentive market characterisation is ultimately important.

Finally, it has to be noted that the lack of an appropriate communication about the outcome of the project would also limit the use of the results. Market analysis must pre-emptively filter out solutions which are redundant with SAFER-LC development goals in order to avoid double development efforts which may potentially result in attacking the market with a product with similar feature set with already known solutions.

From the academic point of view, an important barrier is the willingness of the solution developers to patent their developments, since this will not allow to publish anything. Regarding raw project objectives, this is not a barrier, since the patent is also a valuable output. In order to better manage these issues, the IPR issue of the project developments should be carefully discussed and agreed between the partners. See Section 3.1.4 Collaborative exploitation and IPR management.

Strict jurisdiction and conservative admission processes for innovative safety systems can be a threat to the impact of the countermeasures of results developed by SAFER-LC.

Another challenge is originated in the rather complex acceptance issue which is characterised by the shared responsibility structure and hierarchy of LC management. Shared responsibility between road and railway management and municipalities can lead to the diffusion of the responsibility for level crossing safety that may cause refusals or delayed decisions.

One of the main barriers, which is the direct consequence of the shared responsibility characterised above, is represented by the lack of cooperation between the road and the rail managers. The difficulties produced by this condition are amplified by the excessive number of stakeholders and, often, the lack of a national and systemic vision about LC safety issues.

Considering that in many European countries the dissemination of the results and solutions proposed by SAFER-LC through a valid exploitation based on scientific papers, conferences with stakeholders, politicians, international and national academic members can provide a decisive inception to reduce the potential barriers.

Further exploitation risks can be identified in the following factors:

- Sensitivity/confidentiality of the data collected during the SAFER-LC project.
- Confidentiality of the solutions developed/tested during the SAFER-LC project.
- Development, implementation and maintenance costs of the developed solutions can be technologically limiting.
- The use and reuse of SAFER-LC collected information affecting privacy.

3.4. Contribution to standardisation

The SAFER-LC project capitalizes on various research approaches and methodologies. Multidisciplinary solutions of safety enhancement techniques, a set of distinct ICT technologies are applied to the LC context to achieve the project goals. They are the intelligent video processing and object recognition systems for detecting various hazardous events which happen in LCs and in their immediate vicinity, the advanced vehicle and infrastructure communication solutions for accessing traffic partners on road and rail in order to share information between one another and interact them

in real-time, moreover, the application of various human decision centric low-cost measures characterize the heterogeneous methods and approaches.

A broad stakeholder set was identified to represent researchers, manufacturers, transit agencies, and infrastructure owner-operators, among others.

The SAFER-LC domain knowledge with distinct technology elements must be integrated in a comprehensive set of interoperable solutions in an attempt to satisfy the requirements of the stakeholders and make LC passing manoeuvres for people, road vehicles and trains safe as much as possible. The primary goal of SAFER-LC is to produce working solutions in this multimodal transportation field that fulfil the agreed needs and requirements of both road and rail transportation.

The use and integration of (vehicular) communications in this heterogeneous environment to provide railway operators with a means to control and manage the train traffic on their networks and assist road users during LC manoeuvres is a must to make the traffic safe and sustainable in the future. The greatest difficulty arises from the application of the multi- and cross-modal set of innovative solutions and tools, especially ones related to information exchange and communication which are not harmonized with each other. Obviously, adherence to standards helps ensure safety, reliability and interoperability in this complex multi-modal situation. Standard compliance increasingly helps in taking-up of the new technologies. Different use and interpretations of terminology regarding LC safety enhancement technologies can be confusing for the public, state and local agencies, and industry. In the interest of supporting consistent terminology, state legislatures may want to use terminology already being developed through voluntary, consensus-based, technical standards.

Historically, standardised solutions and technologies used by road and rail transportation systems have been developed independently and separately from each other. While relying on standardized solutions in such a heterogeneous field of applications is a must, it is not a straightforward task since, sometimes, it depends on contradictory or inconsistent requirement specifications and involves in many cases the agreement of different stakeholders (user communities, administrators, technology providers, road and rail operators etc.) to act in a common strategy.

SAFER-LC's exploitation plan, therefore, should rely on a balanced standardization strategy emphasizing important principles for SAFER-LC standardization endeavours. The research, identification and adoption of existing standards which are closely related with SAFER-LC's objectives should be performed whenever is possible and where it makes sense in order to comply with the broad user requirements.

Key standardization activities during the first two project years, therefore, include research, identification and broad adoption of existing project related standards. SAFER-LC solutions can be successful in the practice in case they are fully standard compliant. Not industrialized research results at least must be aware of the existence of standardised solutions and they have to identify themselves relative to the related standards.

SAFER-LC will officially propose an extension of existing standards in cases when missing features and/or functionalities are identified in relevant standard documents. This includes the monitoring of standardization bodies and their working group activities as well as requires the active contributions from SAFER-LC members in the international standardisation work. Involvement of the standardisation expert from the Advisory Board in this activity is highly recommended.

A high-level view on the adoption activities of standardization is scheduled for the second year of the project, when the SAFER-LC results can already be formulated. A detailed standardisation work plan, as part of this exploitation plan, is submitted on M24.

4. EXPLOITATION PLAN AND FUTURE DIRECTIONS

4.1. Current actions

Sharing of information and objectives of the SAFER-LC project with national road and railway companies and stakeholders is primordial goal of exploitation preparation, which belong to the recent objectives. SAFER-LC partners having the chance to contact the stakeholders, moreover, other research centres and universities in the national and international context prepare the future collaboration with external partners by exchanging information about innovative and technological measures provided by the project. Collection of data and information from different sources, countries, regions and contexts helps conceptualization of the exploitation. One of the plans is to involve road and rail managers proposing their cooperation at all levels of the problem hierarchy to develop policies, low–cost and technological measures and guidelines related to LC safety.

Preparation of development of advanced POC systems and pilots which operate in real conditions is another early objective of the project which, through the effective performance evaluation and demonstration capabilities affects successful exploitation of the project results.

Partners, such as IRU has presented the project to the members of the International Road Transport Union and shared the preliminary results with its internal Commission on Road Safety. Representatives of road freight and passenger transport operators participating in this Commission have been asked to provide input on requirements regarding potential solutions to improve safety at level crossings.

4.2. Short and medium-term actions

On the short and medium-term SAFER-LC evaluates the technical solutions elaborated during the project through the use of cost-benefit analysis to ensure the solutions developed in the project can be realistically implemented in real life. Members with privileged access to regarded decision making and representative forums (such as IRU to various International Road Transport Union related groups and associations) cooperate and to promote the adoption and use of the proposed innovative solutions suitable for road and rail transport operators.

Convincing road and railway infrastructure operators about the benefit of experimenting with and effectively contribute to the demonstration of the innovative new SAFER-LC technology is in focus of the medium-term actions.

Training material and activities will be developed in partnership with academic and non-profit research institutions, with the training branch of other profit oriented organisations and companies to ensure the relevant tools and technologies produced by the consortium are used by the road and rail transport industry in the future.

Presentation of results in national and international conferences and seminars is part of both dissemination and exploitation activities on the long run.

Special attention is payed to the organization of various safety campaigns, demos and participation in other road users' representatives' meetings. One needs to support recommendations on adjustments of the current legal framework to implement the suggested solutions at a harmonized and interoperable Pan-European level. The plan for participation in standardization activities is elaborated in the separate section.

4.3. Long-term actions

Long-term actions are related to post-project exploitation activities when planning future projects and product offerings.

Based on the short and medium-term actions the industrialisation of the project achievements is made with special focus on making the solution elements robust, scalable and on a low price.

Employ the results provided by various SAFER-LC actions to conduct other studies about safety enhancement and risk analysis to analyse other similar situations and prepare forthcoming project actions in the future.

The re-use of the results produced by the SAFER-LC action in future projects, particularly in the fields of cooperative ITS and road safety.

5. EXPLOITATION BY INDIVIDUAL PARTNERS

The defining characteristic of activities regarding exploitation of SAFER-LC results is very much based on the particular scientific or industrial profile and interests of individual partners in the research and development topics. This is formulated in the following partner specific sections.

5.1. UIC

UIC, as the worldwide professional association representing the railway sector and promoting rail transport, has no commercial purposes but has a lot of dissemination capabilities and a very important network of experts from rail infrastructures managers and operators.

The SAFER-LC toolbox to be developed will summarise the most relevant and practical information collected and produced during the project. This toolbox will be easily accessible free of charge at the end of the project, and will continue to be maintained, updated and improved by UIC even after the end of the project for the benefit of the entire road- and railway-safety communities.

The exploitation of the results of SAFER-LC project will be done by UIC at different levels:

- Within the organisation: SAFER-LC knowledge will be integrated in the overall activities of the UIC Security Platform, Safety Platform and Rail System Forum. The project findings, results and recommendations will be presented in the relevant meetings of those bodies. Trainings and workshops for railway experts will be organised to promote the toolbox developed within the project.

- Outside the organisation: UIC will promote the results of the project and especially the online SAFER-LC toolbox in related international events where UIC is participating. All the UIC dissemination capabilities will be used, namely, the electronic newsletter (UIC e-News) that reach globally about 5,000 email addresses, the UIC dedicated website, and the UIC network of experts.

5.2. VTT

In the SAFER-LC project, VTT will exploit its expertise on accident data analysis, driver and road user behaviour, development of risk assessment and safety impact assessment tools, and in-vehicle warning systems for railway level crossings including vehicle positioning, train location determination, arrival estimates and alarms. VTT has a long history on developing both V2X communication and self-driving car technology. Based on the results of the SAFER-LC project, VTT is looking forward to developing integrated safety solution for the self-driving cars and unprotected level crossings.

VTT is a large organisation with a wide area of expertise, such as development of the new technology-based solutions and services for vehicles and transport infrastructure. The knowledge gained within the SAFER-LC project will be exploited through increased collaboration between the transport team and other research teams of VTT.

VTT is heavily involved in transport related research and assists authorities and companies in the various phases of analysis, design, specification, development and evaluation of transport systems and services. The knowledge gained in SAFER-LC will be further exploited in future projects and offerings.

5.3. NTNU

As a research and academic institution, NTNU's main exploitation plan is towards the academic field. New knowledge, newly developed solutions and lessons learned will be used and disseminated to the railway/road educations at various levels. The results will be mainly exploited through integrating and updating the rail/road education module and through publications in scientific journals.

5.4. IFSTTAR

IFSTTAR will take advantage of the technical solutions developed by SAFER-LC to continue developing solutions, particularly in the field of communication. The cost/benefit analysis that will be carried out within WP5 can serve as a basis for future studies regarding railway safety in general.

5.5. FFE

Given the wide reach of FFE´s activities both in the field of R&D as well as providing strategic support and development to the Spanish rail industry, the results of SAFER-LC will be exploited in various ways. On the one hand, the FFE will support its patrons (Spanish Rail Infrastructure Managers, Railway and Metro Operators) and the wider Spanish rail sector in their decision making on investments regarding LC design and associated safety measures and the optimisation of system exploitation. Given the multimodal scope of SAFER-LC, the strategic development support FFE

offers will seek to extend beyond rail to also reach stakeholders in the road and intelligent transport system sector. In this framework, various meetings have already been held with key Spanish stakeholders from rail and road (Adif, Renfe, DGT and AESF) with a view to setting up an informal work group to monitor safety issues regarding LC safety in Spain and disseminating SAFER-LC results. A first result of this contact culminated in two organisations delivering presentations at the SAFER-LC Mid term conference and all of them participating as members of the audience.

In order to further support stakeholder engagement and promote FFE´s work in the line of LC safety, a SAFER-LC leaflet has produced in Spanish which had a first round of dissemination at the recent SAFER-LC Mid-term Conference and SAFER-LC Website.

On the other hand, SAFER-LC will contribute to the current activities of technical support and studies that FFE performs addressing the whole Spanish railway sector. In this sense, it is especially important to underline that one of the research areas of FFE is dedicated to Safety and Sociology of Transport. Due to its expertise, this group has developed different projects focusing on the human perspective of rail safety, and specifically on LC users from a preventive and educational point of view. As part of its national activity FFE has developed for ADIF (Spanish National Rail Infrastructure Manager) the “YoCruzoseguro” project, with the objective of developing and implementing a prevention and safety awareness program regarding rail in Spain, along with the development of a framework for evaluating and monitoring the impact on end users, enhancing self-explanation of LC in Spain. The in-depth knowledge acquired about LCs in Europe and beyond together with expertise on human factors at LCs, resulting from SAFER-LC, will help improve the projects developed in this area and, therefore, deliver a wider range of solutions on LC safety measures to Spanish decision makers.

5.6. CERTH-HIT

The exploitation plan of the SAFER-LC results at CERTH-HIT will have two major focuses, one short and one long term. The short-term focus is a scientific one: the dissemination of the project results in scientific fora, while the long-term in a more technological one: the inclusion of the alert system at LCs in the suite of cooperative and traveller information services offered by CERTH-HIT in Thessaloniki. CERTH-HIT will promote the project results by participating to scientific fora and congresses, technical workshops as well as to other events. The main results to be presented will be related to the implementation in Thessaloniki as well as the situation in Greece with regards to accidents in LCs. CERTH-HIT hosts a suite of cooperative and traveller information services which are provided in Thessaloniki in collaboration with other organizations, such as the Region of Central Macedonia and the Municipality of Thessaloniki or the TaxiWay association. This suite is the results of various EU funded projects (Mobithess, COMPASS4D, COGISTICS, and C-Mobile) and will be enriched with the service developed within the SAFER-LC project.

Apart from the above, CERTH is taking all the necessary steps in order to implement the above-mentioned alert system at selected LCs close to Thessaloniki.

5.7. TRAINOSE

TRAINOSE will proceed with a pilot in the second biggest city of Greece, Thessaloniki. The pilot will be implemented in freight, regional and suburban trains. The main idea is the development of a system that will connect the TRAINOSE fleet with a taxi fleet. The taxi drivers will be notified if a train

reaches the level crossing point. This solution can help the city of Thessaloniki and TRAINOSE to reduce the accidents in level crossings. Upon a successful validation, the solution is planned to be implemented in all major regions of Greece. The railway network in Greece passes all of the main cities. The developed solution will be extended for the benefit of truck operators, taxi operators, leasing companies and busses which can extensively use this platform solution.

5.8. INTADER

The results of SAFER-LC at INTADER will be exploited in the preparation of scientific presentations, plan future activities and establish new projects. On the other hand, by sharing SAFER-LC results with main Turkish stakeholders and transfer new safety enhancement techniques and other project related knowledge to the industry underlies the application of SAFER-LC results in the practice.

5.9. CEREMA

CEREMA (in the close cooperation with UTBM) develops a smart detection system composed of specialized hardware and software. It is intended to patent the system and the possibility of knowledge transfer will be examined for direct industrial exploitation.

5.10. GLS

GLS is a service integrator with specific competences in transport and ITS solutions. Our first specific action will be to add the SAFER-LC developments into our V2X stack but also in our android app for vehicles and on our Cooperative ITS platform. As a system integrator, another action will be the integration of the C-ITS development with the smart detection system developed by CEREMA. Concerning exploitation, we will add two elements to our catalogue. The first one being the specific C-ITS SAFER-LC solution which could be of interest to other integrators and the second one being the complete SAFER-LC solution including C-ITS and the smart detection system. As system integrator, the second solution is the one we prefer, and we will propose it to railroad crossing managers.

5.11. RWTH

RWTH is a teaching and research institution. Results from SAFER-LC will be disseminated through journals and conference participations and used in teaching of students and junior researchers. Within the scope of student activities and scientific research assistance, students will be offered the possibility to actively participate in ongoing research projects and gain experience in current scientific topics.

5.12. UNIROMA3

Uniroma3, as an academic organization, covers the key role of the research in the national context. The innovative and technological measures are evaluated and used in detailed studies to increase the progress, the chance to improve safety on every transportation systems, the efficiency and the strength of the scientific process and methods. Uniroma3 will put effort into extending and exploiting the obtained results also beyond the project's timeline through meetings, courses and conferences

involving experts, road and rail managers and academic members of the international and national context.

The results and the methodology applied in the different phases of the project might be used for PhD thesis and scientific papers on in-depth analysis, studies based on the human factors on transport systems' safety issues and impact of low-cost and technological safety measures.

Uniroma3 will promote the dissemination in Italy of SAFER-LC project in terms of solutions, results and recommendations with the aim of creating the condition for the development of the solution proposed in the real market of road and rail operators.

5.13. COMM

Commsignia, being a key supplier of automotive V2X solutions for OEM trials and road and smart city deployment projects will embed newly developed SAFER-LC solutions into its platform solutions offered to the market and will emphasize them as key features. Commsignia will focus on the automotive / industrial segment's stakeholders emphasizing the importance of the global use and uptake of cooperative ITS solutions (e.g., the use of V2X technology) to supporting safety in automated transportation systems. SAFER-LC experiences will help to explore the interaction between autonomous vehicles and other vulnerable road users and road-rail level crossing infrastructures and identify what information automated vehicles will need in order to negotiate road-rail intersections for safety enhancement. Commsignia will develop specific communication scenarios to demonstrate a concept of operations, including system requirements (technology and sensors) for the effective safety enhancement of LC traffic.

Commsignia software team will implement selected and safety validated elements of the various enhancement technologies developed by SAFER-LC for connected and autonomous cars that will be part of the company's standard product offerings. Demonstrative examples and tools will be provided to help third party implementers and users to understand and utilize the subjected new safety features. The company's training and support team will incorporate the required knowledge and materials to aid customers with applying these features in their daily practice. The project will allow Commsignia to continue and extend research on safety enhancement technologies based on cooperative vehicle and infrastructure communication. More specifically, the cooperative perception safety enhancement technology recently under development by SDOs and tested in the V2X area will be extended with rail level crossing specificities and SAFER-LC domain knowledge. SAFER-LC will facilitate real life experimentation with the cooperative perception basic service thus contributing to the validation of the new facility extension of fundamental V2X services. Based on SAFER-LC technology experiences Commsignia will contribute to the technical specification of the new Urban Rail CBTC communications technology in harmonization with road ITS communications. This item belongs to strategic part of standardisation in various SDO's work program.

By using SAFER-LC knowledge, Commsignia is preparing for the future automated transportation to supporting the safe, reliable, efficient, and cost-effective integration of automation into the broader multimodal surface transportation system in which rail-road interoperability will be a primary condition.

5.14. IRU

IRU Projects is Belgian non-profit legal entity established to support the road transport industry to reach the goals of sustainable road transport, increased road safety and security. By working closely with the International Road Transport Union and its members present in over 75 countries, IRU Projects will use its communications channels and its large network of national associations across the globe to make sure road transport professionals are aware of the outcome of the SAFER-LC project. The toolbox gathering all the information produced during the project will be presented to the relevant internal commissions tackling technical and road safety issues. IRU will urged the road transport sector to adopt the proposed innovative solutions suitable to road users. Training material and activities will be developed in partnership with the IRU Academy and its associated training institutes (ATIs) to ensure the tools conceived by the consortium are used in the most efficient manner by road transport operators on a daily basis. Recommendations on adjustments of the legal framework to implement the suggested solutions will be actively supported by IRU at the international and European level, as well as by its members nationally. It will also be in the interest of IRU to promote harmonised measures at all European level crossings. Parts of the outcome of SAFER-LC will be re-used in future projects, especially in those dealing with cooperative ITS and road safety matters. Besides, the close cooperation between IRU Projects and CEDR – The Conference of European Directors of Roads – will also ensure that road infrastructure managers implement and benefit from the results produced during the project life span.

5.15. SNCF

SNCF is interested in research and evaluation of safety enhancement of trains, rail vehicles and other technology related systems and especially methods and technologies connected to the level crossing domain. Depending on the nature of requirements and SAFER-LC proposals, SNCF will carry out tests on rights of way outside the national rail network in order to propose an SIL 4 system, to demonstrate data security and safety satisfying both national and international specification and requirements.

5.16. DLR

Due to the ongoing plans in Germany to reactivate rail lines in rural areas, the development of innovative and cost-effective measures to increase the safety of level crossings, in particular of passive level crossings, is of great relevance. The reactivation of rural level crossings causes considerable costs and hinder traffic projects. The planning and provisioning process of already established technical safety systems for level crossings takes a long time and is very expensive. Especially with an eye on precarious economic situations of many rural municipalities all over Europe, there definitely is a demand for innovative low-cost measures to enhance safety at level crossings. As a part of the project SAFER-LC, such systems will be invented in WP 2.3 and evaluated in WP 4.3. The market for the distribution of innovative low-cost safety systems is huge, since it comprises all countries with railways and level crossings. Promising measures could be patented and be part of future technology transfer projects from science to industry. Based on patents, licenses could be granted to industry partners that generate dues for research partners. These dues could be a basis for further research activities in the field of traffic safety. Based on the findings and competences that will be generated in SAFER-LC, DLR will be able to improve its competence in the field of human factors in transportation systems. The visibility of the project all over Europe will improve the chances to acquire future projects and have an impact on the scientific community.

Research results will be exploited by DLR from a scientific perspective by broadening the knowledge base, publishing articles and participating in national and international conferences.

5.17. UTBM

UTBM develops a smart detection system (with the cooperation of CEREMA) composed of specialized hardware and software. Depending on the actual TRL achieved it is intended to patent the system and the possibility of knowledge transfer will be examined for further industrial exploitation. UTBM develops a video-based risk evaluation system. Industrial transfer should be operated in collaboration with SAFER-LC and/or external partners. Obtained results and capitalized experience should be exploited to extend the approach in other environments like pedestrian crossings, route intersections, etc.

6. CONCLUSIONS

This document is an incrementally advancing (evolutionary) deliverable for the SAFER-LC project which proceeds with the project lifetime. It describes the way how the consortium as a whole but also each individual participant envisions the exploitation of its own involvement and the results what is expected to achieve. This Month 18 release of the deliverable is the second edition of this plan. Each SAFER-LC partner is aware of the importance of the efficient exploitation of the results and have action plans for it. They will be included in later editions and further detailed when the results of the project are handily available.