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FOT-Net 2 Field Operational Tests Networking and Methodology Promotion



Working Group Additions to FOT Methodology

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Executive Summary

The prime goal of FOT-Net 2 is to maintain the momentum achieved in the previous FOT-Net 1 project for strategic networking of existing and future Field Operational Tests (FOTs) carried out at National, European and Global levels (e.g. US and Japan). During the lifetime of the FOTs, there is a crucial need for a networking platform allowing individual FOTs to benefit from each other's' experiences as well as giving a better overview of the scattered activities.

One of the FOT networking tools used in this project was the **Working Groups (WGs)** which provided an effective channel for the exchange of information between the FOT experts and stakeholders. They debated specific topics which have been explicitly articulated by the FOT network and conveyed meetings and discussions needed to achieve a common European position on the specific WG topics.

Five specific topics studied by the WGs are Data Analysis; Events and Incident Definition; Legal and Ethical Issues; Impact Assessment and Scaling up; and Data Sharing. The deliverable details the findings generated from the WG activities. The key issues addressed are summarised as follows.

WG 1 (Data Analysis)

The working group on data analysis gathered experiences based on lessons learned from conducted FOT or NDS. Most of the collected experience focused mainly on issues with respect to the experimental design, data collection, data processing, data storage, and data analysis. The consequences on the analysis task were analysed and, recommendations based on the experience of the expert group were derived. Key issues are resulting from missing interactions and links to the planning and implementation phase. It is recommended to the analysis team to be involved in the planning and the implementation of FOTs from very beginning of the project. It is recommended to include these interactions and iterations in the FESTA-implementation plan, in order to illustrate that the planning and the definition of the analysis task has to start at an early stage of the FOT.

WG 2 (Events and Incident Definition)

The Events and Incident Definition working group worked on the issue of how to define crash relevant events in NDS/FOT studies. Since the most direct measure of crash risk (i.e. actual crashes) are incredibly rare events, other "surrogate" event types have to be used for assessing the influence of driver behaviour(s) or safety technologies on crash risk. A key challenge to analysis and interpretation of NDS/FOT data is therefore how to couple non-crash events to crash causation mechanisms. A report on the strengths and weaknesses of existing approaches to identifying such Crash Relevant Events was drafted and the reviewed and improved on based on feedback from several webinars and workshops, as well as interviews with some of the leading experts in the area. Unfortunately, as it turns out, precise definitions of Crash Relevant Events with a clear cut, undisputable connection to crash involvement have yet to be fully established. Rather than updating the handbook precise definitions, the WG therefore instead chose to update the FESTA handbook with a distilled version of the report, meant to function as a guide for those in the process of defining Crash Relevant Events.

WG 3 (Legal and Ethical Issues)

The working group on legal and ethical issues collected information from different EU-Member States on the legal issues relevant for FOTs and NDS at national level. This information allows for a first overview over challenges that need to be overcome for specific test-designs if implemented in these countries. It has furthermore led to a broader view on the legal and ethical issues with immediate relevance for the core methodology as well as the handbook.

WG 4 (Impact Assessment and Scaling up)

Within WG4 experiences from FOTs were gathered on impact assessment and scaling up. Major issues that were discussed in the WG were piloting, participant selection and experimental set-up, safety impact assessment, data issues, scaling up and the integration of results. On all topics the FESTA Handbook is improved, by adding new text based on the state-of-the-art, recommendations, and by updating and improving existing sections on impact assessment and scaling up. For piloting the importance to pilot the whole data flow, up till and including impact assessment is stressed, and the recommendation to pilot yourself is given. For participant selection and experimental set-up the issue of seasonal effects and the length of baseline and treatment period are handled. Data issues that are discussed are the collection of explanatory data and the need to specify alternative sources for data (fall-back options). In safety impact assessment and scaling up there are gaps in knowledge and in data availability. The methods currently known are described with some information on which method can be used in which situation. With regard to the integration of results, the difficulty does not lie in the fact that people do not know in theory how it should be done and that it costs a lot of time, but in the fact that in reality things are different and there is not enough time and/or budget to do things as thoroughly as they should be done. This also holds for piloting.

WG 5 (Data Sharing)

A substantial amount of funding has been demanded for performing an NDS or an FOT including preparation work, data collection, data preparation and finally the analysis. To make further use of the data and thereby the invested money, a data sharing platform was recommended to facilitate for additional research re-using the already collected data. The platform spanned from the early pre-requisites in the legal documents to permit data sharing, to recommended procedures and templates to enable re-use and at the same time protect the participants' data privacy and the data ownership rights. The platform also addressed the need for research support services and the issue of funding of the huge amount of collected data after the initial project has ended.

WG Contributions to Other FOT Networking Activities:

The working groups had not only a role in providing new knowledge for the FESTA handbook at the end of the project, but they participated actively in both transferring their intermediate findings as well as taking input from the different FOT-Net seminars and workshops. Intermediate reports from working groups and work-plans were put on the FOT-Net website¹.

¹ http://www.fot-net.eu/en/networking/working_groups/

At each stakeholder workshop a short report about the status of the working groups was given. The working groups participated actively in the organisation of the FOT-Net seminars (see also Deliverable 4.2).

The working group on Impact Assessment and Scaling up contributed to the seminar on Interpretation and presentation of results (Aachen, 29 November 2011).

The working groups on Data Analysis and on Impact Assessment and Scaling up contributed to the seminar on FESTA for Beginners (Pisa, 09-10 May 2012)

The working group on Data sharing moderated the session on data sharing principles for Cooperative FOT data on the Coordination Day for Cooperative FOTs (Brussels, 25 May, 2012).

The working group on Data sharing played a major role in the seminar on Complementarity of different FOTs and re-use of data (Brussels, 26 November 2012). This seminar provided an important input to the proposal for the new support action FOT-Net Data.

The working group on Data sharing lead the discussion on how can we share data among pilots in the stakeholder workshop on Lessons learned from Pilots on Cooperative Systems (26 February, 2013)

The working group on Impact Assessment and Scaling up took a leading role in the special seminar on FESTA and impact analysis for CIP pilot projects (Barcelona, 4-5 April 2013).

The working group on Data analysis contributed to the seminar on Tools for gathering and analysing data, especially in FOTs of cooperative systems (Berlin, 25 April 2013).

The working groups on Data Analysis, Impact Assessment and Scaling Up, and Data Sharing were also responsible for the round tables in the International workshops organised at the beginning of the ITS World Congresses in Vienna (2012) and Tokyo (2013). At this last congress also a special session was organised by these working groups.

The working groups on Data Sharing and Events Definition presented their intermediate findings at the Fast Zero Conference in Nagoya, Japan (22-26 September 2013).

At the stakeholders workshop on Naturalistic Driving (Brussels, 26 November 2013) the WG on Events and Incident Definition made a contribution.

Webinars were organised by the WG on Impact assessment and scaling up (28 May 2013) and Event and Incident definition (3 September 2013).

All the WGs played an active role for conducting the final FOT-Net seminar on the FOT achievements and opportunities for the future (Versailles, 23 September 2013).

The results from these working groups are being deployed by FOTs and NDS. For example the UDRIVE project, performing a Naturalistic Driving Study, is using currently the results from the working groups on Ethical and legal issues and Data sharing for the data protection concept and participant agreements. Results from the WG on Event and incident definition will become useful during the analysis. The Data Analysis WG has worked in interaction with projects such as DRIVEC2X. The WG on Data Sharing formed an important starting point for the FOT-Net Data support action.

Finally the working groups provided the input for the revision of the FESTA handbook, which is available in March 2014 at the FOT-Net Wiki. At a workshop in Torino on 4-6 November 2013, all contributions were discussed and the texts adapted.

1 Introduction

A significant task carried out in the FOT-Net 2 project was to enhance and advance the core methodology (developed in the FESTA support action) for planning, running and evaluation of Field Operational Tests (FOTs). In the previous project FOT-Net 1, we contributed to the transferability study of the FESTA methodology and gathered experiences from FOT stakeholders and experts in identifying the need for revising the FESTA methodology in order to incorporate new challenges and lessons learned from the current European FOTs. In FOT-Net 1, a list of topics was also identified for which the FESTA methodology did not provide sufficient support.

In FOT-Net 2 there are several activities that took up the issues addressed in this deliverable:

- Revision of FESTA: many issues and potential solutions identified in this deliverable have been taken into account in the revision of the FESTA handbook in 2013.
- Work package 6 on Tools for FOTs made an inventory of tools for different phases in FOTs.
- Seminars and workshops were conducted in order to transfer knowledge on the (revised) FESTA methodology and to discuss new issues coming from the FOTs, with special attention for FOTs on cooperative systems and Naturalistic Driving Studies.
- Finally, some topics required more attention and required the generation of new knowledge. For this last category of topics FOT-Net 2 started five working groups.

On 8 September 2011 the FOT-Net "Interactive Workshop on the revised FESTA" was held in Gothenburg, where the new revision of the handbook was discussed. On 9 September the five working groups kicked-off.

This deliverable 3.2 reports the most difficult issues around specific topics that have not yet been treated in-depth, through the creation of five working groups. These topics are *data analysis*, *events and incident definition*, *legal and ethical issues*, *impact assessment and scaling up*, and *data sharing*. The feedback on the FESTA methodology from these WGs formed a major objective of a special workshop on "FESTA Handbook Revision" which was held on 4-6 November 2013, At Torino Museo Dell'Automobile.

The deliverable is organised as follows. First an introduction to the working groups and their general issues are given in Chapter 2. In Chapter 3-7, the five WGs are reported. General conclusions on the WGs can be found in Chapter 8.

1.1 FOT-Net contractual references

FOT-Net 2 is a Support Action submitted for the call FP7-ICT-2009.6. It stands for *Field Operational Tests Networking and Methodology Promotion*.

The Grant Agreement number is 269983 and project duration is 36 months², effective from 01 January 2011 until 31 December 2013. It is a contract with the European Commission (EC), Directorate General Information Society and Media (DG INFSO).

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1.2 **Project Objectives**

The prime goal of FOT-Net 2 is to increase the momentum of the network achieved in FOT-Net 1 by further developing the strategic networking of existing and future National, European and Global FOTs i.e. US and Japan. During 36 months, the FOT Network has met through six bi-annual FOT stakeholders meetings and three international FOT meetings.

FOT-Net 2 also focuses on methodology based on recent FOT experiences. Through a series of targeted meetings, it gathers the relevant experts to revise and adapt the FESTA methodology for FOTs on ADAS, nomadic devices, cooperative systems, and in addition, addresses Naturalistic Driving Studies (NDS).

Five new expert working groups have been created in order to clarify critical topics related to the data analysis, events and incident definition, legal and ethical issues, impact assessment and scaling up, and data sharing. The revised FESTA methodology is promoted through seven seminars supported by webinars.

FOT-Net 2 creates a new web-based inventory of existing tools for data acquisition, database structure, data analysis to facilitate the setup of new FOTs.

FOT-Net 2 continues to act as a multiplier for the dissemination and awareness of FOT activities especially in terms of inter-activities support and outreach.

Finally, FOT-Net 2 evaluates contributions of FOTs to policy goals and market deployment using an improved methodology for stakeholders' analysis.

² The project has been given an extension of three months from 01/01/2014 to 31/03/2014 inclusive.

2 The FOT-Net Working Groups (WGs)

2.1 Summary of the WGs

In September 2011, dedicated FOT-Net Working Groups (WGs) were set up to look into a specific set of issues to further enhance and revise the FESTA methodology for FOTs. These working groups target experts with both a practical and theoretical background and they work together in formulating recommendations for further extension and improvement of the FESTA methodology. A summary of these WGs is given as follows.

- WG 1 - Data analysis (Leader: IKA): This WG dealt with issues on amount, type and characteristics concerned with data generated as a result of FOTs and NDSs, and how the data can be used to define and test research questions and hypotheses, to analyse driver behaviour, and to derive conclusion on impacts of considered systems.
- WG 2 - Events and incident definition (Leader: VCC): This WG addressed the strengths and limitations of previous approaches to analysing traffic conflicts and incidents. It also explored potential opportunities of using naturalistic and FOT data collection methodology to perform quantitative analysis of Crash Relevant Events (CREs) defined by non-destructive variables (e.g. Time-To-Collision, accelerations, lane keeping, steering movements).
- WG 3 - Legal and ethical issues (Leader: BAST): A major drawback for rapid FOT implementation in many European Member States is a lack of precise information on the data protection regulations (e.g. permissibility of video recordings, etc.) and liability, including insurance issues which are different among the EU-Member States. This was the main focus of this WG.
- WG 4 - Impact assessment and scaling up (Leader: TNO): This WG addressed the methodological issues surrounding the impact assessment of systems in FOTs, as well as the translation of the results from the FOT to the regional, national and European levels. It selected a number of relevant FOTs, analysed their approaches in impact assessment and scaling up, and identify gaps in knowledge.
- WG 5 - Data sharing (Leader: SAFER): As data collection in an FOT is expensive, it is important that the data is re-used after the project for additional research. This WG collected knowledge from previous projects and made recommendations for a data sharing platform to be agreed upon in the project, to facilitate data re-use after the project has ended.

The WGs were each led by a FOT-Net convenor with the contribution of other FOT-Net partners. Participation in the WGs was also open to the wider FOT community. The whole FOT community was provided with regular status reports via FOT-Net's Stakeholders and International workshops, culminating in a final report from each group – the key findings of which are summarised in this deliverable. Because of the spectrum of subjects covered by the five Working Groups, it was necessary for them to adopt different approaches to the task and consequently, their final reports differed in format and style. This deliverable consolidates the key findings from each – and in particular, their recommendations for enhancements of the existing FESTA methodology – and aims to provide a unifying summary.

2.2 New contributions to FESTA

In the European FESTA project (Field opERational teSt support Action), a consortium of a large number of partners, both industrial and academic, has developed a methodology to conduct FOTs. Using such a methodology guarantees a sound approach to conducting FOTs and obtaining reliable results, and allows for data and results that may be compared between tests. A handbook was written in which the methodology is described in detail (FESTA, 2008). In FOT-Net 2, in 2011, this handbook was updated (http://wiki.fot-net.eu/index.php?title=FESTA_handbook). A further revision is currently made, also based on the experiences from the working groups and the FOT-Net seminars. The methodology consists of a process which systematically details the steps to be taken to set-up the FOT, the actual data acquisition, the analysis of the data and evaluation and interpretation of the results, see Figure 1.

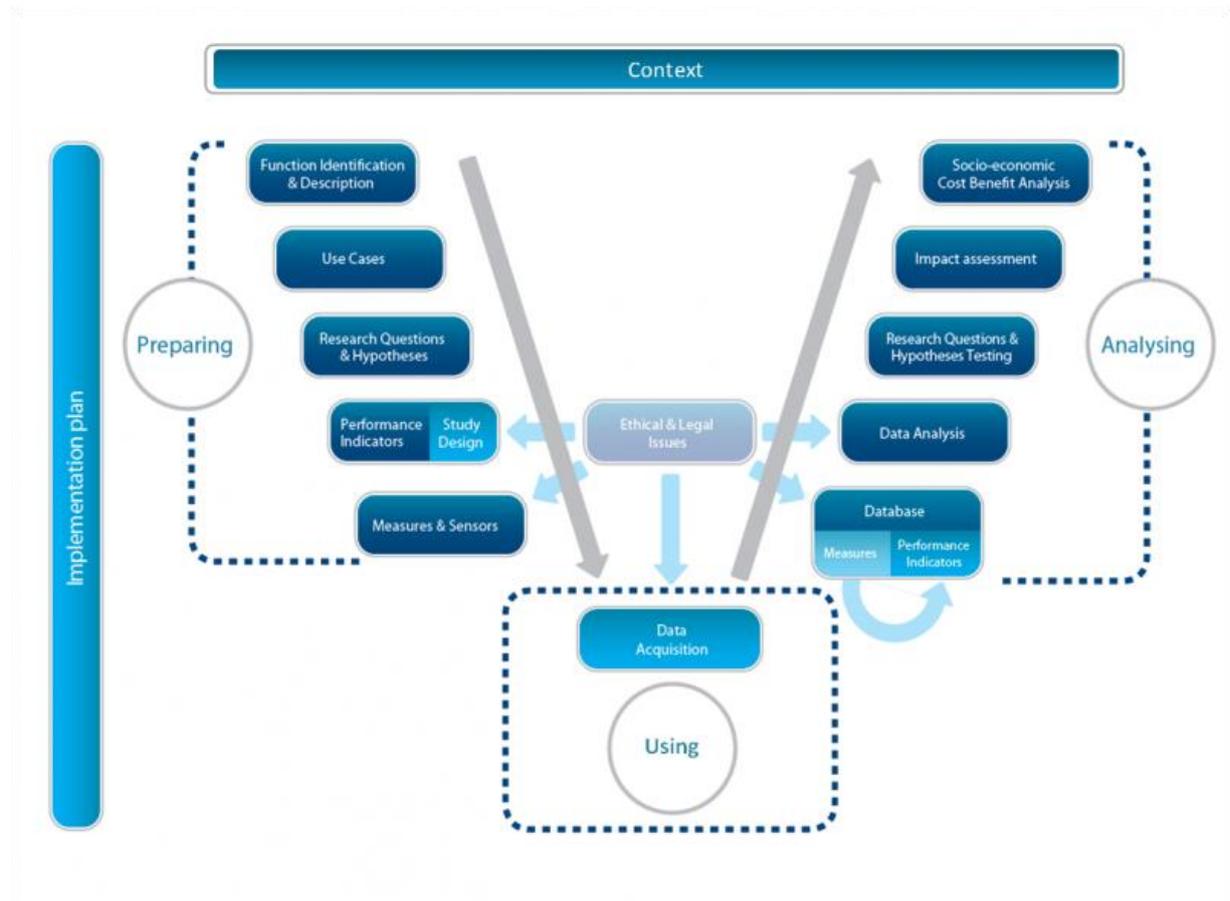


Figure 1: The FESTA-V

The relevance of the WGs to the FOT methodology is illustrated in Figure 2.

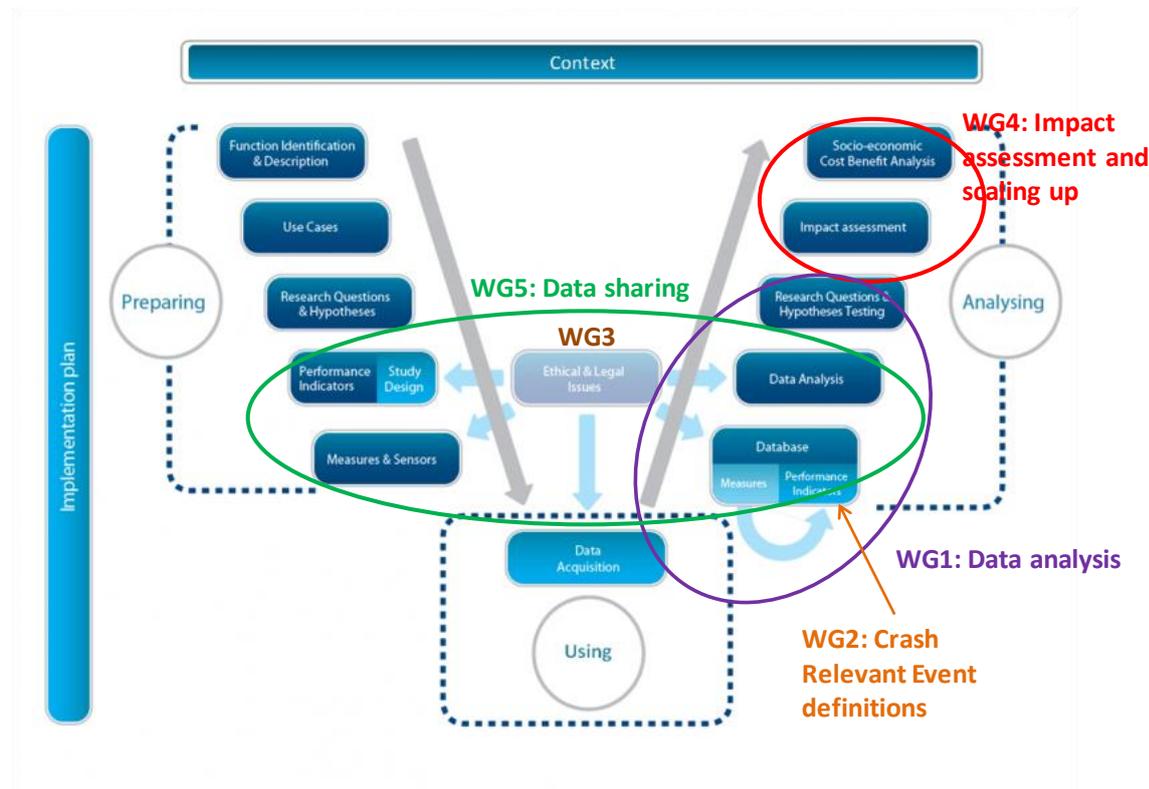


Figure 2 New contributions to the FESTA V by the WGs

2.3 Organisation of the WGs

The WGs were led by FOT-Net 2 partners and consisted of experts from the FOT Network (not necessarily partners of the FOT-Net 2 consortium). All WG activities were announced on the FOT-Net website, in the FOT-Net newsletter and by direct mail to the FOT-Net mailing list. In the beginning of this project, each of the WGs produced a plan for their defined activities, results expected, and meetings to be conducted, as shown below.

Table 1: Activities, Planning, Results, Meetings of WG 1 - Data Analysis

Task	Who	Deadline	How	Result (milestone)
1. Collect relevant issues on data analysis from FOT-Net deliverable 3.2.	WG leader	February 2012	Desktop Work	List of issues
2. Conduct bilateral discussions with experts	Data analysis experts and WG	June 2012	Telephone interviews, physical meetings	New input on data analysis methodology
3. Derive recommendations on data analysis	WG leader and core group	Fall 2012	Desktop work, telephone conference	List of recommendations
4. Revise the FESTA approach based on the	WG leader and core	January 2013	Desktop work, telephone	Draft proposal

results, taking into account the experiences gathered in conducted FOTs and NDSs	group		conference	
5. Common workshop in the form of a webinar or as a side meeting of a conference participated in by some of the experts (if applicable).	Data analysis experts and WG	Spring 2013, e.g. ITS European Congress	Webinar or physical meeting	
6. Consolidation and documentation of the findings and recommendations	WG leader and core group	October 2013	Desktop work, telephone conference	Final report on data analysis

Table 2: Activities, Planning, Results, Meetings of WG 2 - Events and Incident definition

Task	Who	Deadline	Result (milestone)
1. Collect previous work on events and incidents definition	WG leader	Q1 2012	Report compiling existing incident and event definitions
2. Select and invite core group and make list of other members	WG leader	Q1 2012	List of members in core group
3. Brainstorming by inviting to an open meeting for input on the topic	Core group	Q2 2012	
4. Identification of specific items that need to be worked on, and have different categories of people give input on them	Core group and other members	Q2-Q3 2012	List of targeted items
5. Write a proposal for improved event and incident definitions	WG leader and core group	Q4 2012	Draft proposal
6. Arrange workshops/ webinars for additional inputs on the proposal.	Core group and other members	Q1-Q2 2013	Second draft based on informal workshops ready in August. Webinar held in September.
7. Finalize the proposal including identification of issues needing research to be properly addressed	WG leader and core group	Q3 2013	Report on event and incident definitions including recommendations for research on remaining issues

Table 3: Activities, Planning, Results, Meetings of WG 3 - Legal and Ethical issues

Task	Who	Deadline	How	Result (milestone)
1. Formulation and compilation of relevant legal and ethical issues	BASSt legal experts	Dec'11	Desktop work	Expert questionnaire
2. Distribution among legal representatives	FIA	Jan'12	Contact at regular meeting in Brussels	
3. Work on the questionnaire and return to BASSt	FIA legal representatives	Mar'12	Desktop work	Summary descriptions of the legal and ethical situation in responding FIA Member States
4. Evaluation and summary of FIA legal representatives responses	BASSt legal experts	Aug'12	Desktop work	Document
5. Presentation of intermediate report at stakeholder workshop	WG leader or BASSt legal experts	Feb'13	PPT	Intermediate report MS (M21)
6. Revision of the document based on the results of the workshop (if needed)	BASSt legal experts	Oct'13	Desktop work	Revised document MS (M34)

Table 4: Activities, Planning, Results, Meetings of WG 4 - Impact Assessment and Scaling Up

Task	When	Result
1. Define research questions	Q1 2012	List of topics and research questions the WG will work on
2. Invite members	Q1 2012	List of members (to be updated during project)
3. Identify working items from FOTs and other projects, and literature	Q2 2012	List of working items
4. Make inventory of approaches in impact assessment and scaling up related to the research questions, issues encountered, etc. by interviewing experts from the WG	Q3 2012	<ul style="list-style-type: none"> • Document with approaches in projects, difficulties, lessons learned, etc. • Interview reports
5. Identify best practices, issues, gaps in knowledge and recommendations for future work during round table in Vienna (ITS World)	Q4 2012	Report with minutes from round table
6. Make plan on how to include findings in FESTA Handbook	Q1 2013	Document
7. Work on update FESTA Handbook, both by making changes as well as by adding information, based on best practices, lessons learned and recommendations from projects	Q2/Q3 2013	Draft update FESTA Handbook
8. Consolidate findings during round table in Tokyo (ITS World) and finalize update of FESTA Handbook	Q4 2013	<ul style="list-style-type: none"> • Report with minutes from round table • Final update FESTA Handbook

Table 5: Activities, Planning, Results, Meetings of WG 5 - Data Sharing

Task	Who	Deadline	How	Result
1. Collect previous work on data sharing	WG leader	June 2012	Direct contact with projects, FOT-Net Coordination Day in May	Report compiling existing data sharing principles
2. Select and invite core group and make list of other members	WG leader	March 2012		List of members
3. Meeting to define data sharing scope	Core group	Spring 2012	Telco	Definition of scope

4. Identify possible data sharing principles	Core group+ other members	Summer 2012	Telcos, mail	First overview of data sharing principles
5. Presentation of data sharing principles	WG leader and all stakeholders	Oct/Nov 2012	FOT-Net Int. workshop and seminar	Comments on data sharing principles
6. Suggest common data sharing principles	Core group+ other members	August 2013	Telco, mail	First version of data sharing principles
7. Resolving remaining issues	Core group+other members	Oct 2013	Telco, webinar, meeting at conferences	Final version of data sharing principles.
8. Dissemination of results	WG leader	Oct 2013	FOT-Net Int. workshop	Awareness of FOT-Net data principles.
9. Final delivery of data sharing principles	Core group	Fall 2013	Stakeholders meeting in FOT-net 2	Summary of stakeholder's view on data sharing issues that has to be addressed in future FOT projects. Resolved issues should be included in the revised FESTA handbook.

3 WG 1: Data Analysis

The results of the EU project FESTA³ include the data analysis chain starting from available data to the database and ending in the answer to the relevant hypothesis. In the last few years, European and national FOTs have used the FESTA methodology. Experiences from these projects on the topics of data analysis are now available. The working group on data analysis collected the experience and related issues towards the different steps of data analysis with the goal to improve the FESTA Handbook⁴, if necessary.

3.1 *Relevant issues on data analysis*

The relevant issues on data analysis have been collected by FOT experts from different FOT/NDS projects in Europe, US and Japan. Some of the issues have already been reported in FOT-Net deliverable 3.1. By means of bilateral discussion with the experts, further issues were collected and are presented here.

All issues have been clustered into the main categories:

- Experimental design
- Data collection, processing, and storage
- Data analysis

In the following sections the relevant data analysis issues for each category are given.

3.1.1 *Experimental design*

The experimental design defines all necessary steps to be conducted within an FOT. These include the process of how and who to recruit for the experiment, the duration, the data acquisition systems as well as the number of vehicles and drivers to be included.

The definition of the experimental design is conducted early at the beginning of an FOT. According to the FOT experts, the major objective of the experimental design is to ensure that all necessary information is going to be collected, in order to test the pre-defined hypotheses and the research questions. Based on the discussions within the working group the following issues were addressed by the FOT experts:

Distribution of participants (e.g. male/female, age, experience with tested systems)

Issue:

- Selected drivers are representing only a specific type of driver

Consequence on data analysis:

³ Field opErational teSt supportT Action, funded by the European Commission DG Information Society and Media in the 7th Framework Programme.

⁴ FESTA Handbook Version 4, 30 September 2011, from <http://www.fot-net.eu/en/library/deliverables/> (2011 – D3.1).

- Results are not representative, due to limited driver group
- Comparisons between different driver profiles are not possible
- Analysis of whether the determined effect is due to tested function or specific type of driver behaviour is not possible

Recommendations:

- Define required driver profiles at an early stage based on defined research questions by taking into account number of vehicles to be used in FOT
- Selection process needs to be monitored and assessed with respect to consequences on defined analysis process
- Identified deviations need to be communicated at an early stage, in order to adapt the experimental design and data analysis plan accordingly

Selection of test vehicles (e.g. customer vehicles, test vehicles that are already equipped with measurement devices)

Issue:

- Drivers refuse to drive test vehicles equipped with certain measurement devices (e.g. cameras) or refuse installation of devices that require modification on their vehicles

Consequences on data analysis:

- Required information cannot be collected, due to missing sensors
- Customer vehicles cannot be used for integration of extensive measurement devices
- If required sensors (e.g. camera systems) cannot be integrated in vehicles, required information for data analysis might be missing

Recommendations:

- Breakdown hypotheses to the required signal needing to be collected from the vehicle
- Check at an early stage whether all required signals are going to be collected by the selected data acquisitions
- If not all signals are collected, determine consequences on data analysis
- Communicate and raise awareness on consequences of data acquisition process (e.g. hypotheses that cannot to be tested due to missing information)

Duration of the experiment (Duration of baseline and treatment periods)

Issue:

- Data collection phase is too short

Consequence on data analysis:

- Amount of needed information (e.g. critical situations) is not sufficient to derive valid conclusions
- Comparison between different phases due to short duration is not possible (assessment of impact not possible)

Recommendations:

- Duration of data collection needs to consider the type of data analysis and ensure that sufficient data is collected, in order to have enough information to determine valid conclusions
- Duration of data collection needs to be defined in accordance to the number of vehicles to be used in experiment as well as the annual mileage of the recruited drivers (if drivers have a low annual mileage duration needs to be adapted accordingly to ensure collection of required information)
- In general, the driver collection phase should be at least 6 months (depending on defined research questions), because data analysis is focused on relevant scenarios, which are in some cases very rare (e.g. a certain type of incident under specific weather conditions)

Usage of system within baseline phase

Issue:

- Drivers are asked in baseline phases not to use the systems (voluntary basis)

Consequence on data analysis:

- Tested systems are used also during the baseline phase
- Comparison baseline vs. treatment not possible (due to usage of the system in baseline phase), which means no impact assessment is possible

Recommendations:

- If possible, deactivate the systems completely within the baseline phase (no activation by driver possible)
- If deactivation not possible, make sure that drivers are aware of consequences on the experiment if they use the system during the baseline
- Consider online monitoring process of system status (e.g. a warning is issued to data administrator as soon as the function is activated)
- Stay in close contact to drivers, in order to ensure that drivers stay motivated

Combination of functions

Issue:

- More than one function is tested in one vehicle (combined functions are tested)

Consequence on data analysis:

- Testing of individual effects is not possible due to combined functions, because both functions are used at the same time

Recommendations:

- Conduct analysis for bundle of functions
- Define hypotheses and research questions for bundle of functions

3.1.2 Data collection, processing, and storage

The data collection phase starts after the experimental design is defined and all necessary equipment has been integrated into the vehicles. Normally the data collection phase starts with the baseline period, during which the functions are not used. Within this phase normal driving behaviour is observed. Afterwards, the functions are then activated and can be used by the drivers as they would usually.

The data is collected by means of data acquisition systems (DAS). The DAS are configured according to the experimental design and are integrated in the vehicles. After the data is collected by the DAS it is stored either in the vehicle (e.g. storage system in the trunk of the vehicle) or transmitted to a server. At the server side the data is processed for the planned analysis steps. Within data processing, several steps are conducted. Normally the data is converted to a standardized format before being checked with respect to data quality. Afterwards the data is aggregated into relevant events and situations needed for the data analysis. Finally the processed data is uploaded to a database where the data analysis is conducted.

For the data collection phase, data processing and storage, several issues have to be considered in order to avoid that data is missing. According to the FOT experts in this WG the following issues have major consequences on the data analysis task.

Data collection of required information

Issue:

- Not all required data is collected

Consequence on data analysis:

- Analysis cannot be conducted, due to missing relevant data
- Not recorded (obvious) relevant information might be necessary after data analysis started, e.g. for interpretation purposes

Recommendations:

- “Record everything that you can get”
- Check collected data during the piloting phase in order to perform a test analysis
- Use test analysis to assess whether all needed data is collected. If not, communicate consequences and raise awareness
- Make to whole consortium very clear what consequences are expected due to the limited data collection

Data collection needs to consider needed accuracy

Issue:

- Data accuracy too bad (Frequency is too low, e.g. acceleration gathered with 1Hz)

Consequence on data analysis:

- Detailed data analysis not possible
- Time-critical events are not detected due to bad frequency (e.g. abrupt hard braking event (<1s))
- Interpretation of results not always possible, because of missing information due to low frequency (e.g. analysis of causation before event occurred)

Recommendations:

- Adapt the frequency according to the characteristics of the signal
 - e.g. 10 Hz for dynamic signal such as acceleration, speed, yaw rate etc.
 - e.g. 1 Hz for status information such as turn indicator, system status, weather conditions etc.

Event-based or continuous data collection approach

Issue:

- Event-based detected events are not correct (e.g. thresholds are too high)

Consequence on data analysis:

- Data analysis is not possible due to missing information
- Interpretation of results not possible due to missing information on causation of events etc.

Recommendations:

- Event-based data collection requires clear understanding of event definition (detailed information on required thresholds etc.) before data collection
- Continuous data collection results in larger data sets, but it also provides data for other research activities, even after the project end
- Continuous data collection provides data that might be interesting / valuable for interpretation of results
- Complete understanding of results is only possible by continuous data collection

Collection and handling of large data sets

Issue:

- High Frequency of vehicle data or video data as well as duration and number of vehicles generates a huge amount of data that needs a long processing time

Consequence on data analysis:

- Analysis time needs to be reduced, due to of increase of needed processing time
- Analysis time is not sufficient to evaluate all collected data

Recommendations:

- Estimate amount of data at the early beginning of the project, based on the number of vehicles, data collection process etc.
- Estimate time needed to process and analyse data test (test processing and analysis process in advance)
- Monitor status of data collection during the collection phase and start processing of data at beginning of data collection phase (don't wait until all data is collected)
- Develop automated processes:
 - Data processing and data analysis of large data sets by means of automated processes
 - Automated scripts are required, in order to reduce the time for data analysis

Analysis by means of database

Issue:

- Large data sets exceed the performance limits of databases

Consequence on data analysis:

- Limited access to required data causes delay of data analysis
- Provision of requested information can take several days to several months

Recommendations:

- Post-processing: Provision of aggregated data sets based on analysis requirements
- Consider employing experts for relational databases in the project, in order to optimise and tune database according to planned analysis
- Define structure and content of database in advance
- Start testing of database related analysis within piloting phase

3.1.3 Data analysis

The analysis of the data is conducted at the end of the FOT after the data is processed and stored on a database the analysis is started. Normally the analysis includes the testing of hypotheses and the impact assessment based on the defined research questions. The analysis is conducted by means of statistical methods (hypothesis testing) as well as using simulations (impact assessment). Within the data analysis, additional data is used (e.g. data on accidents from an accident database) in order to perform the data analysis. The analysis

is conducted by means of standardized analysis tools (statistical analysis tools) as well as specific developed tools (especially for the analysis of video data).

According to the FOT experts in this WG the following issues have major consequences on the data analysis task.

Development of data analysis tool

Issue:

- Different data analysis tools used within one FOT

Consequences on data analysis:

- Results are not completely comparable
- Analysis tools might be only applicable for one data set
- Not accessible for all consortium members

Recommendations:

- Development of standardised data analysis tools

Availability of standardized tools

Issue:

- No standardized tools are available and hence, different individual tools are used in FOTs

Consequence on data analysis:

- Results of the FOTs are not completely comparable
- Usage of data sets from other FOTs require usage of self developed tools
- Self-developed tools might not be available for sharing with other parties
- Working with self-developed tools requires a manual which sometimes is very poor or even not available

Recommendations:

- Standardization partly available for accident data might be also done for FOT/NDS data in the future
- Comparison of results from different FOTs is not always possible, when the same definitions and tools are not applied, e.g. frequency of data collection, trigger or continuous recording, quality indicators, definition of relevant events

Manual video analysis and annotation

Issue:

- Essential to understand safety analysis, but this produces high costs due to time-consuming manual video analysis by several persons

Consequences on data analysis:

- Reduced time or budget to perform data analysis
- Efforts for manual video analysis could result in reduced efforts for data analysis
- Subjective video analysis by different persons might result in different data sets, which might be comparable and lead to false conclusions

Recommendations:

- Development of automated annotation methods (not all problems will be solved by automated annotation)
- Further research on objective triggers to reduce efforts for video analysis
- Define detailed descriptions how to conduct video analysis, in order to keep results from different persons comparable
- Perform tests on video analysis by means of same data sets and compare results between involved persons, in order to define process for manual video analysis

Analysis of driver relevant data

Issue:

- Usage of expensive Eye-Tracking systems

Consequences on data analysis:

- Different conditions (driver sizes, environment, glasses etc.) lower the quality of data collection possibilities
- Increased efforts and workload for data processing and data analysis, due to video annotation

Recommendations:

- Usage of Eye-Tracking vehicle only in few vehicles (controlled test) where the Eye-Tracking systems can be adjusted to each driver and to environment conditions
- Use monitoring tools to adjust Eye-Tracking systems online over the time

Subjective data from driver

Issue:

- Not all participating drivers fill out provided questionnaires or take necessary time to fill out questionnaire adequately

Consequence on data analysis:

- Subjective data is not from all drivers available
- Answers of drivers are inconsistent and hence not trustable or usable for data analysis

Recommendations:

- Provide incentives and define the process of how to contact drivers, in order to collect questionnaires
- Use an online questionnaire application
- First experience: travel diaries seems to work (experts from TeleFOT)

Data sharing

Issue:

- Due to confidentiality, not all partners have access to data

Consequences on data analysis:

- Data analysis by only a few partners can cause delays

Recommendations:

- Define at the beginning of project process how data will be accessed
- Consequences because of limited or restricted access to data needs to be estimated and presented to the consortium at an early stage, in order to raise awareness and to discuss possible solutions

Usage of data and developed tools after FOT

Issue:

- Follow-up data analysis (e.g. in new project) is only possible if raw data and good documentation is available.

Consequences on data analysis:

- New or other partners cannot use the tools or understand the structure and the content of the database due to missing documentation and hence cannot conduct the analysis

Recommendations:

- Consider usage of the processes and tools in other projects from the very beginning of the project
- Create documentation of each tool and process to be developed within the FOT
- Provide a detailed description of database structure and content, especially the documentation of the aggregated data (definition of events, triggers and thresholds used) which is crucial to re-use the data in a follow-up project

Many research questions

Issue:

- In depth analysis of few research questions (RQ) vs. general analysis of many RQ (especially for uncontrolled NDS data). Due to limited time and resources an analysis of all research questions might not be feasible

Consequences on data analysis:

- Analysing all defined RQ results in very general analysis without any meaningful results

Recommendations:

- Focus on few RQ to get scientific sound results
- Adapt number of research questions to be analysed according to deviations in FOT

3.2 Recommendations for revision of FESTA Handbook

In the following section, recommendations gathered from the different FOT-Net workshops are summarized. The recommendations address issues that are not mentioned or not described in detail in the original version of the FESTA handbook. The majority of the recommendations address planning and interaction issues within the analysis task. Furthermore, additional recommendations on the actual data analysis task, documentation and testing as well as on cooperative FOTs are considered.

3.2.1 Planning and interactions

- 1) Be involved in the overall FOT/NDS process from the very beginning, not only focusing on data analysis
- 2) Make sure that data analysis process is included in planning activities
- 3) Be involved in the interactions and iterations between planning, using, and analysing
- 4) Be part of the project monitoring, in order to be informed about project status
- 5) Adapt regular planning of analysis task according to deviations from original project planning and elaborate consequences on analysis task
- 6) Open communication with regards to project monitoring in order to reduce expectations, if things go wrong in the implementation and data acquisition stage
- 7) Think about processes and tools for gathering questionnaires at the beginning of the project
 - e.g. provide smart phone apps to fill out questionnaires
 - e.g. keep drivers in the analysis loop
- 8) Define all necessary steps including all activities. Even little things can cause big problems
- 9) Consider differences in system-time
 - e.g. GPS, control unit, vehicle CAN-Bus, roadside sensor, operation centre etc.

3.2.2 Data analysis task

- 10) Keep in mind that less is more, since in the end the complete data set cannot be analysed due to
 - delays,
 - missing data,

- bad data quality,
 - budget restrictions,
 - limited time,
 - restricted access to gathered data in database
- 11) Define the process and consequences with respect to in-depth analysis of few research questions vs. general analysis of many RQ (especially for uncontrolled NDS data)
- 12) Focus on few research questions get scientific sound results
- 13) Limit video analysis to minimum and try as far as possible to use automated processes

3.2.3 Documentation and testing

- 14) Create documentations of developed tools and processes in order to enable usage after the project end (e.g. usage in follow-up project)
- 15) Provide a detailed test protocol with all relevant test scenarios and potential risks
- 16) Make sure that the complete data analysis process (data processing and analysis tools) is developed before piloting phase, in order to test and assess all data analysis step within piloting phase

3.2.4 Cooperative FOTs

- 17) Define all necessary activities per Vehicle and to roadside and central stations (cooperative FOT)
- 18) Consider reiteration of tests, in order to compensate wrong settings. A second test more or less can make a huge difference (cooperative FOT)

3.3 Conclusions

The FESTA handbook provides an overview and a description of the necessary steps to be carried out within the data analysis task in FOTs and NDS. However additional information, especially on the interactions between the single steps is not described with all necessary detail. Hence the working group on data analysis gathered experiences gained while conducting an FOT or NDS. Within this working group a specific set of issues to further enhance and revise the FESTA methodology for FOTs have been discussed. An expert group from the FOT community was involved in these discussions, in order to achieve a commonly agreed position on the specific WG topics. The discussions were conducted on different FOT-Net workshops and focused mainly on issues with respect to the experimental design, data collection, data processing, data storage, and data analysis. Within these workshops, the consequences on the analysis task were discussed and afterwards, recommendations based on the experience of the expert group were derived.

One major issue that was discussed in several workshops are missing interactions and links to the planning and implementation phase. Hence it is of major importance to be involved in the planning, implementation, and data collection task, in order to adapt the analysis

according to the specific needs of the FOT. Furthermore it is recommended to regularly monitor the project status and to assess potential consequences on the analysis planning. Hence it is crucial that the analysis team is involved in the planning and the implementation of the FOT from very beginning of the project. It is recommended to include these interactions and iterations in the FESTA-implementation plan, in order to illustrate that the planning and the definition of the analysis task has to start at an early stage of the FOT

4 WG 2: Events and Incident Definition

4.1 *Defining Crash Relevant Events in NDS/FOT studies*

Non-intrusive logging and analysis of real driver behaviour in real traffic comes in two flavours, i.e. Naturalistic Driving Studies (NDS) and Field Operational Tests (FOT). For NDS, the key goal is usually to gain an understanding of crash causation mechanisms and in particular, which driver behaviours are associated with increased crash risk. For Field Operational Tests (FOT), the key goal usually is to evaluate whether one or more (usually in-vehicle) safety technologies has a detectable and significant influence on crash risk (be it positive or negative).

Both these study goals, and thus the surrounding study setup, can be viewed as summative evaluations, i.e. evaluations that take place after e.g. driver education or product development phases are completed. In other words, NDS/FOT methodologies are not designed in such a way that the outcome is very useful as input for driver education or system design improvements.

In this fact lies the first decision point for any potential NDS/FOT study. If the intent of your project is to deliver results that are useful in the design phase (i.e. if you want a formative evaluation) an NDS/FOT study is probably not the methodology you need, at least not without extensive extra work and modifications (see section 6 below). The importance of making an informed decision on this point cannot be overstated.

In NDS/FOT studies, massive amounts of vehicle and video data are usually collected on a continuous basis. Once processed and uploaded, this generates an enormous amount of data for analysis in the database. While this data obviously can be sliced and sorted in very many ways and for many purposes, the focus of this report lies on how to approach the analysis in a way that leads to an understanding of how driver behaviours and/or vehicle systems influence crash risk. Thus this report is safety analysis oriented. To contrast this with other types of analysis, one example would be using the data to identify natural acceleration and deceleration patterns that can be used for fuel economy tuning of vehicle engines.

For NDS/FOT data, there are two general analysis approaches that can be taken toward uncovering behaviours and/or system influences that drive changes in crash risk. The first can be called Aggregation Based Analysis (ABA). The basic principle of ABA is to identify trends and/or patterns in performance measures that have been aggregated over longer time segments. A typical example of such an analysis would be whether average time headway or average travel speed changes when drivers use Cruise Control. If there is a significant change, then that change might in a next stage be used to predict possible changes in crash/injury/fatality risk if the effects were to be extrapolated to the general driver population. However, in this report, ABA types of analysis will not be addressed. The reason for this is that such extrapolations are very difficult to justify, due to the fact that the connection between average measures and crash risk is hard to establish. This will be further discussed below.

The other analysis approach, and also the focus of this report, is Event Based Analysis (EBA). The basic principle of EBA is to identify shorter driving segments (typically in the order of 5-10 seconds), during which the risk of crashing is judged to be higher compared to other driving in the data set, and then to analyse these events further. These events are often

referred to as Crash Relevant Events (CRE), since their occurrence is thought to be indicative of actual crash risk in one way or another.

In NDS, analysis of CREs usually focuses on establishing why they occur from a driver perspective. In particular, the aim is to find out whether some types of driver behaviour are overrepresented in CREs as compared to baseline events, i.e. shorter driving segments where crash risk is judged not to be elevated. If particular behaviours can be identified as occurring disproportionately often during CREs compared to baseline events, then it is generally assumed that they can be viewed as contributing to the elevated crash risk, which makes them targets for countermeasure development.

In FOTs, the focus when analysing CREs is somewhat different. One key question is whether the frequency of various CRE types goes up or down as a function of Advanced Driver Assistance Systems (ADAS), i.e. if drivers experience critical situations less (or more) often when using ADAS. The other key question is whether driver responses during the CREs that occur are different when ADAS are being used. For example, does accelerator release come earlier when drivers are given a collision warning; do they brake harder when warned, etc...). These types of analysis are not the same as looking for risk increasing behaviours, something which is important to keep in mind when setting up an FOT study.

Defining Crash Relevant Events

From the above, it follows that a key element to NDS/FOT success is defining CREs in a proper way. If the events you select for analysis are indeed crash relevant, then extrapolation to the general driver population is indeed both possible and credible.

However, while this is fine in theory, identifying CREs in NDS/FOT data is a bit more difficult in practice. To begin with, the simplest and most direct measure of crash risk (i.e. actual crashes) is incredibly rare events. Even if hundreds of drivers are being continuously observed during several years of driving, the statistically low likelihood of having an actual crash means that the number of crashes in the final database will be smaller than required for statistical analysis, even if the database itself is huge.

It follows that surrogate events have to be used. These events have to have very particular properties, i.e. they need to be critical situations where there is no actual crash, but where the event still unfolds in such a way that its presence can be used as an indicator of crash risk.

The iceberg ratio metaphor is typically used here. For example, if one assumes that there are 100 incidents for every accident in a certain working place, then a measured reduction of incidents by 50% could be used to predict a corresponding 50% accident reduction in the future, even if there's been no accident yet.

A key challenge to analysis and interpretation of NDS/FOT data is therefore how to couple non-crash events to crash causation mechanisms. In principle, if the link between crash causation and a CRE type is weak, then any interpretation of the CREs frequency or behavioural content is correspondingly weak, and vice versa.

Ideally, one would therefore only use CRE types that are known with certainty to be predictive of actual crash involvement, i.e. for which it is legitimate to infer that a change in their frequency corresponds to a (proportional) change in crash risk. Unfortunately, precise CRE definitions with clear cut, undisputable connection to crash involvement have yet to be

fully established (had they done so, a simple list below would have concluded this report nicely).

To illustrate; while hard braking events might seem a plausible candidate, in the VTTI 100 car study (Dingus, Klauer et al. 2006) it was not possible to reliably identify critical driving events based on hard braking alone, since hard braking also occurred in many situations not associated with elevated crash risk.

4.2 Approaches to Crash Relevant Event Detection

This problem of identifying relevant CREs is not new. A lot of effort in many projects has gone into developing algorithms, filtering techniques etc. that allow for efficient yet relevant CRE selection.

The aim of this report is not to list each such developed CRE definition in detail. Instead, the aim is to describe the approaches to data analysis that they represent on a higher, grouped level, and then go through some of the pros and cons that each CRE group, or analysis approach, faces. In this lies the second decision point for your project. Your project must make an informed and conscious decision as to which of the below approaches will best fulfil project goals, and then set up your CREs correspondingly. There are pros and cons to each approach, some of which may have large impact on your results.

4.2.1 Approach 1 - Driver response based identification

The first approach can be called the “driver response based” approach. This approach builds on the idea that drivers prefer to travel in comfort and generally will not expose themselves to kinematically drastic manoeuvres unless necessary. Abrupt velocity and direction changes (hard accelerations /decelerations and/or rapid steering) are thus considered to be out of the ordinary, indicating an unplanned and urgent response to an unexpected situation (of course, this might capture “play” with the vehicle as well).

There are two main ways to identify such drastic manoeuvres. Principally, one can either look for momentary or sustained breaches of defined thresholds. Looking for momentary breaches means identifying all instances where a particular threshold is exceeded, regardless of the excess duration. As an example, one could look for all instances of Brake Pressure Jerk (BPJ), above a certain value.

Just looking at the momentary threshold breaches might however capture many false positives. Kinematic signals can have high momentary peaks within their normal operation interval (e.g. acceleration spikes due to potholes in the road), and vehicle sensors are more often than not rather “noisy”, i.e. signal variation does not correspond to real variations in the parameter. To remedy this (apart from signal filtering, which is more considered signal pre-processing before database upload and hence not covered here), an often used approach is to add a minimum time during which the threshold has to be breached.

For example, for deceleration levels above 0.8G, one can add a criterion that it needs to stay above 0.8G for more than 0.5 seconds for the event to count as a CRE. Of course, if the restrictions put in place are too strict, no CREs will be found in the data. Thus it is always necessary to strike a balance between removing false positives and keeping true positives.

4.2.2 Approach 2 - Function response based identification

If the study is of the FOT kind, i.e. designed to assess the impact of one or more active safety functions, then a very natural approach to CRE identification is to use the function itself to detect CREs. After all, that is what the function is designed to do.

For example, if an FOT is set up to assess the effects of Forward Collision Warning (FCW) on crash risk, the warnings issued by the collision warning system (even though they are not shown to the driver in the baseline phase) can be used as event identifiers.

The downside to this approach is of course that any CRE that occurs outside the function's detection capacity or that occurs when the system is turned off (in the treatment phase) will be missing from the analysis. Relying on the system signals only thus makes it impossible to estimate the frequency of CREs which the function in principle needs to detect, but in practice cannot, though their prevention would enhance traffic safety.

Looking at the other side of the coin, the advantage of the approach is that you do not have to worry about how to factor in function availability and usage in the safety analysis. Since the function only can do something when it is turned on and does detect a threat, warnings/interventions can only occur when the function is capable of delivering them. Hence the true availability and usage rates are automatically represented in the data set.

4.2.3 Approach 3 - Driving context based identification

A third approach to CRE identification is to avoid relying on driver or function responses and instead make it driving context based. The underlying assumption of this approach is that too small margins equal elevated crash risk. In other words, there exist situations where the safety margins are inherently so small that the slightest mistake or variation could lead to a crash. Since mistakes do occur, it follows that crashes will also occur under these vehicle and/traffic environment configurations, and prevention of whatever it is that leads to these small margins thus will enhance traffic safety.

The definition of what constitutes too small margins can be either static or dynamic. An example of a static approach is the one used in the Road Departure Crash Warning System Field Operational Test (LeBlanc, Gordon et al. 2006). When evaluating the influence of a Lane Departure Warning system, the researchers used the lane marker as a static boundary, i.e. something that by definition should not be crossed unless the crossing is intentional.

Following this definition they looked for all instances of driving where the vehicle was travelling at or above the speed where the system would be available and where the vehicle inadvertently left the lane (defined as crossing the lane marker without having the turn signals activated).

An example of a dynamic version of the same approach is Najm et al. (Najm, Stearns et al. 2006), who developed a CRE algorithm that defined too small margins as being within a certain kinematic envelope. CREs were selected by identifying all situations where the vehicles fell below a combined Time-To-Collision (TTC) and Range Rate (RR) threshold in relation to a lead vehicle. The basic idea was that if you are closer than X to another vehicle and simultaneously closing in faster than Y, then you're in a conflict regardless of whether you take action or not.

Four levels of conflict intensity were defined, depending on the precise TTC and RR thresholds. The values for Y as a function of X were selected based on empirical data from normal and deliberately delayed driver responses on a test track in lead vehicle following

situations (Kiefer, Shulman et al. 2003). In other words, they essentially picked a demarcation line which says that if your vehicle is in this dynamic situation, you are by definition in trouble since most drivers would already have braked by now.

The advantage of this approach is that the actual conflict definition is highly objective, in the sense that it is based on vehicle kinematics only and does not depend on how the driver responds to it. Thus, while the setting of the boundaries for the kinematic envelope that defines the conflict might take some discussion, there will not be later disagreement as to whether the event was crash-relevant or not.

However, this also constitutes the weakness of the approach. Most importantly, active drivers who pursue a more kinematically aggressive driving style will be overrepresented in the CRE selection, since they will cross the envelope boundaries more often than drivers who prefer larger margins in general. Of course, if one assumes that aggressive driving is the main contributing factor to traffic accidents then this is OK. If one does not however, then there will be a selection bias in the CRE identification process that has to be dealt with somehow.

For FOT studies, this is actually quite feasible because you can compare CRE rates and dynamics with and without ADAS on an individual basis; thus taking out the effect of individual driving style. In a NDS-oriented study however, there will simply be more CREs for those driving with smaller margins, and some other means of dealing with that have to be identified.

4.2.4 Approach 4 - Driving history based identification

A fourth approach towards CRE detection is to look for unusual events in a driving history perspective, either on the individual or the group level. The idea is that unusual events in a person's or group's driving history are unusual precisely because the drivers try to avoid such events. Hence they can be said to represent situations which the driver is unwilling to enter, presumably because at least a certain portion of them would lead to potentially unsafe situations.

The advantage of this approach is that it will find the most unusual events that occurred during the study for each person or group (depending on the setup), and it is not unreasonable to assume that those rare events were ones which the drivers would prefer to avoid happening in the future. The corresponding disadvantage is of course that those events may be special for other reasons than being safety-critical, so even if drivers in a statistical sense try to avoid them, they may have little or no connection to traffic safety.

4.3 Coupling CREs and crash risk – the CRE causation question

As already discussed in the introduction, due to the very low risk of actual crashes occurring, NDS and FOT data sets typically contain only a few real crashes. Hence, the use of surrogate events like non-crash CREs usually is motivated by referring to some version of Heinrich's classical triangle from his pioneering work on industrial safety in the 1930's (Heinrich 1931). Often, they cite Heinrich's proposed 600 to 1 ratio between incidents and accidents as a reason why incident studies may be a faster way to learn about problems that need solving.

However, what is often less clear in published studies is an exact description of how they connect the CREs they use to real crashes. Questions like whether the causation mechanisms are the same for the studied incidents as the real accidents, and if so, which

data types must be collected to verify that the “right” CREs have been found is usually missing.

In all four approaches to CRE definition outlined above, there are certain underlying assumptions regarding this coupling between the CREs and real crashes. For example, to go with a driver response based CRE identification, you have to assume that kinematically drastic driver responses are predictive of crash involvement, e.g. that hard decelerations are the “bottom” of an iceberg where lead vehicle crashes are the top.

If you instead go with a contextual approach, you have to assume that small margins are predictive of crash involvement, i.e. that small margin situations are the items at the bottom of the iceberg, where “no margin” situations constitute the top (i.e. actual crashes). Or if you go with a driving history approach, you have to assume that rarely occurring combinations of kinematic (and other) values are predictive of crash involvement.

In other words, the approaches represent very different views of the coupling between CREs and crash risk. Which one (if any) is more appropriate remains to be determined on a project by project basis, as they all have different consequences for how the project findings can be extrapolated to the rest of the driving population.

4.4 What do the identified CREs represent?

The approaches described above also have different implications in terms of what the selected CREs represent. In the driver response based approach, CREs are identified based on how each driver evaluates the situation. For example, while one driver may brake hard at a certain time-to-collision threshold, another driver might not brake at all when at that time-to-collision value. Hence a selection of CREs based on this approach will include the first event but not the second (since the driver did not respond, it is by definition not an event).

Driver response based CRE selections will therefore reflect the normal variability in any driver population in terms of driving style, risk perception and capacity to respond. It follows that representative selection of drivers becomes a key issue when using a driver response centred CRE selection approach.

The function based CRE selection approach does present an interesting conundrum in terms of what the identified CREs really represent. Simply put, due to sensing and/or threat detection algorithm limitations, the function may not capture all the critical situations you think it should. Hence it would be preferable if you could write and run your own threat detection algorithm on the collected data in order to avoid what a function limitation based CRE selection bias.

However, this is easier said than done. The developers of the function under FOT assessment are more often than not clever people who have worked on the function for several years. This means that the alternative threat detection algorithm you develop has to beat their algorithm, while still being based on the same sensor data. Unless you're very lucky or a genius, it might be unwise to rely on being able to do that.

Another option here is of course to add additional sensing capability before running the FOT, i.e. sensors which have much better performance than those used by the function being assessed, and then run a threat detection algorithm on that sensor data once collected. However, the additional equipment cost might be quite large, so you really have to believe there exists a class of important CREs outside the evaluated functions current detection

capability. Moreover, it also must be necessary for the project to find them. For example, if you're tasked with defining the remaining safety potential in terms of avoiding rear end crashes given a particular FCW function, then this makes sense. Give this some thought before adding additional sensing to the project cost.

In a driving context approach, CREs are identified independently of how a particular driver responds to the situation. This means all drivers are equally covered by the conflict definition, independently of their capacity or willingness to respond. It also means that drivers with a more kinematically aggressive driving style will be overrepresented in terms of how many events they contribute to the list of CREs selected for analysis. They simply end up in small margin situations more often.

Now, if you assume that small margins in and of themselves are predictive of crash involvement, it does not matter that some drivers contribute with more CREs than others, since by this logic, these drivers do have a higher crash risk. On the other hand, if you're dubious about this assumption, then this approach might not be for you to begin with.

The advantage of a driving history based CRE selection approach is that one can tailor the CRE selection to each participating individual. Drivers all respond in some way when a potentially dangerous situation is sprung on them; but driver responses can be expected to vary even in complete surprise situations. For example, while 0.7G might be a normal deceleration level for one driver, another might never go above 0.65G regardless of how critical the situation is. Thus, if a 0.65G deceleration occurs only once in a person's full driving history, one might draw the conclusion that it was a special event for that driver and that it warrants further examination.

A prerequisite for the driving history based approach is that basic driver behaviour is fairly stable, i.e. that the distributions are not too "flat". For example, if you drive all over the lane rather than keeping fairly well to the lane centre, the tail of your lane position distribution will include both the situations when you ended up there unintentionally and would have preferred to be elsewhere, and the situations where you just ended up there and it didn't matter. If that is the case, the search algorithm will find most events simply due to a lot of inherent variability in the data, not because the driving situations as such have special, crash relevant, properties.

As an example, a technique called Gaussian Mixture Models (GMM - for an example from another domain, see Reynolds, 1995) was tested in the euroFOT project. Gaussian distributions were fitted to a number of logged vehicle parameters such as brake pressure and pedal positions. Rare situations were then identified by looking for combinations of unusual values; i.e. where the values for several parameters were at the tail of their respective distributions simultaneously.

The GMM approach was found to work much better for truck drivers than for car drivers. For one, truck drivers drive more consistently due to spending so much more time behind the wheel. Furthermore, they also have a much smaller kinematic space to drift around in due to the size and mass of their vehicles. In other words, end points in their distributions therefore are more likely to represent truly unwanted values rather than random occurrences due to normal variability. Hence this approach might be more applicable for professional drivers who show less variability over time, rather than lay people who drive much less.

Obviously, any CREs identified will be more credible if they somehow link to underlying mechanisms related to the driver's control, e.g. over the vehicle, over positioning relative to other traffic participants, etc.

One recent approach that illustrates this is the work by Gordon et al (2011). They assumed that single vehicle crash risk depends on the driver's lateral control. The study assumed that the underlying mechanisms leading to such crashes are the same as those that create variations in normal driving—especially those involving “disturbed” lane-keeping control. The road-departure crash problem was formulated according to the following set of hypotheses:

- Single-vehicle road-departure crashes occur only under conditions of disturbed control
- NDD contain measurable episodes of disturbed control
- Crash surrogates exist and are based on a combination of objective measures of disturbed control, highway geometric factors, and off-highway factors
- Crash surrogates can be related to actual crashes

The study compared lane deviation, lane departure warning and instances of very short distance to the road edge as crash surrogates, and found the latter to be the best, with LDWs as the second best and variability within the lane to be the least successful predictor. In other words, in this study the empirical findings were predicted from theory and also followed the theory.

4.5 Removing false positives

Since there are no perfect CRE identifiers, any event search in a NDS/FOT database is likely to come up with a mix of true positives (i.e. actually relevant events) and false positives (i.e. events, while captured by the search algorithm, turn out not to be coupled to the proposed accident causation mechanism after all). An example would be a search algorithm that identifies hard braking events, but which cannot in and of itself distinguish if there is a lead vehicle in front or not.

Therefore, after a set of what could be called CRE candidates have been identified in any NDS/FOT data set, comes the very important step of weeding out the false positives from the true positives. There are essentially three ways to do this; manual (visual) inspection, filtering based on some logic, or a combination.

A seemingly straightforward way to remove false positives from among the event candidates is manual visual inspection. Researchers review each event based on the video recorded and other available data, and then decide whether the event is truly crash relevant or not.

One advantage of this approach is that variables that might be impossible to capture numerically can be weighed in, such as how startled or scared the driver seems to be. On the other hand, assessing a level of criticality from comparatively low resolution videos is often difficult; video is not reality after all.

From this also follows that the assessment will vary between researchers. Inter-rater reliability thus becomes an important factor. Given that a reliability round 80% is considered a good number in inter-rater reliability studies, one realizes that if one of every five events is potentially misclassified, the statistics used in the final analysis have to compensate for that (if possible).

Another way to go about it is by applying one or more conditional filters. This means that the initial group of CREs is screened based on whether the CREs fulfil certain additional criteria. In the lane departure example, in addition to having inadvertently left the lane, one might remove all CRE candidates where the driver did not respond to the situation by steering or braking within three seconds, on the assumption that if the driver fails to respond the situation is not critical at all (unless there is a subsequent crash of course).

Another example is the filtering applied by Benmimoun et al in euroFOT (Benmimoun, Fahrenkrog et al. 2011), where various combinations of speed dependent yaw and deceleration filters are used to identify lateral conflicts.

The search for a good CRE definition is often an iterative process, where the selection criteria are successively refined to suit the study purposes. As an example of such an iterative process, Fitch et al (Fitch, Rakha et al. 2008) used an iterative process where the initial pool of CRE candidates was screened using one new filter at a time. After each filtering, visual inspection of a randomly sampled portion of the remaining CRE candidates was carried out, and this process continued until the desired ratio between true and false positives was achieved.

Which way to go?

It is not obvious which of these approaches to filtering is the best way to go. What is clear is that they may lead to very different results. In the above study (Fitch, Rakha et al. 2008), it is described that another project (Hanowski, Blanco et al. 2008) used a kinematic threshold + visual manual CRE candidate selection on the same data set as Fitch et al were using. The opportunity therefore arose to compare CRE selections between the two projects. Interestingly, while both projects found hundreds of what they judged to be relevant CREs, only 7 of the 596 conflicts found by Hanowski et al study were identified in the Fitch et al study.

This shows that if anything, the acronym WYLFIWYF (What-You-Look-For-Is-What-You-Find) coined by Erik Hollnagel (Hollnagel 2004)) holds for NDS/FOT analysis and CRE identification as well.

4.6 The problem of Baseline selection

When analysing CREs, whether it is their relative frequency or some particular aspect of driver behaviour during the CREs, one always has to define a baseline, i.e. a comparison situation. This is one of the philosophically more challenging aspects of both NDS and FOT studies.

4.6.1 Naturalistic Driving Study baselines

In NDS studies, a key topic of interest is whether any particular driver behaviours are overly represented in CREs, i.e. whether they can be viewed as crash contributing factors. To find this out, one has to have a set of relevant comparison situations, i.e. a baseline, to compare the CREs to.

There are two principal ways to select baseline events (non-CRE events). One is to randomly sample a number of baseline events from all data that is not part of the CREs. The other is to tailor the baseline selection to the participants. For example, if a CRE occurs on a highway in the afternoon when it rains, then one tries to find a baseline event that also occurs on a

highway in the afternoon when it rains. Naturally, this is easier for conditions that occur more often. Finding one or more matching baseline events for a CRE that occurred while commuting to work is easier than finding a match for a CRE that occurred on a vacation road trip.

More formally, these two approaches represent two types of experimental design (case-cohort vs. case-crossover designs) Rather than going into what can be expected given that either approach is used, the reader is referred to the in-depth comparison of the strengths and weaknesses of each approach when used on the 100 car dataset (Guo and Hankey 2009).

4.6.2 FOT baselines

In a Field Operational Test, the baseline selection problem is slightly different compared to an NDS. The example of Adaptive Cruise Control (ACC) illustrates this point very well. It is relatively straightforward to say that the relative frequency of CREs that occur while ACC is in use constitutes the treatment data. However, what should that be compared to?

One way to resolve this is to focus on the adaptive part of the cruise control functionality. This means one would compare the relative CRE frequency when ACC is being used to the CRE frequency when regular cruise control is being used. Another way is to focus only on CREs that occur in car following situations. Here, the baseline would be all CREs that occur when there is a lead vehicle present and ACC is not engaged.

More examples can easily be constructed, but these two suffice to illustrate that baseline selection inherently depends on the researchers perception of which the relevant accident causation mechanisms are.

As an example of how complex this may get, consider the following approach that finally was settled on and used in euroFOT:

The approach adopted in euroFOT was to exclude all treatment data in which ACC was OFF. This had the advantage that it ensures 100% usage in the treatment portion of the analysed data. However, it caused another problem: the driver selection bias. Since ACC usage is self-paced by drivers, the baseline data should principally be selected to include only driving where the drivers would have opted to use ACC, had it been available. Defining filters for selecting data according to this principle is very complicated and might be impossible, as it involves second guessing driver behaviour. Instead, a set of filters thought to approximate the perfect baseline data selection was used. These filters, which were applied to both baseline and treatment data, and their effect in equalizing the driving conditions, are described in the following:

Car following filter: In terms of safety, ACC is mainly targeted towards reducing the number and severity of rear-end crashes. Hence, only data from driving when a lead vehicle was present in front of the equipped vehicle was included.

Posted speed filter: data in speed limits in which ACC was not used very often (usage below 25%) were discarded.

Vehicle speed filter: When approaching roundabouts and larger intersections, drivers normally brake. As this automatically disengages ACC and hence inevitably excludes this data from the treatment set (ACC on), it had to be removed from baseline as well. A simple way of tackling this issue is to set a limit on minimum vehicle speed. Drivers typically enter

roundabouts and larger intersection with speed equal to or below 50km/h, so by setting a minimum vehicle speed of 50km/h, most junction and roundabout driving was removed from both baseline and treatment periods.

5 seconds wait-and-see filter: as mentioned above, ACC disengages at braking. This means that harsh braking and critical time-gap events that happen right after ACC disengages would not be included in treatment if the ACC ON filter was strictly applied in treatment. To compensate for this, treatment data was selected to include five additional seconds each time ACC disengaged, to make sure these this type of events were coupled to ACC usage and not excluded from the treatment data.

4.7 Potential future caveats for new projects

In the discussions within working groups, some issues have surfaced that need a few words , even though they do not form a clear topic or coherent whole. This section lists them in no particular order, for readers' consideration.

4.7.1 Backwards result compatibility

One issue that came up at the FOT-Net International workshop at the ITS World Congress 2012 in Vienna and in other discussions is the issue of backwards compatibility for NDS/FOT results. Obviously, there are many useful domains where a comparison between new and old NDS/FOT data could help identify interesting changes (for example, do drivers smoke more or less in their vehicles 10 years later?)

However, for such comparisons to be possible, they obviously have to monitor behaviours or features that stay the same over time. For example, if you're concerned with driver behaviour in urban intersections over time, you may find that the cities have quietly converted most intersections to roundabouts while you were raising funds for that follow up study! Or if you're concerned with lane departure warning systems, the road administrations may have decided to put rumble strips on all narrow roads, thus completely changing the preconditions for LDW input to drivers.

The composition of the vehicle fleet is also bound to change over time. As fuel economy becomes more important, the relative proportion of small cars is likely to increase, with all kinds of side effects related to perception and interpretation of the traffic environment (e.g. consider the difference in driver eye point height between a SUV and a Nissan Micra). Expensive fuel will also lead to more Vulnerable Road Users being part of the traffic environment, which is likely to change the vehicle to VRU interaction at least in urban environments.

One also has to cope with increased / decreased levels of accuracy in measurement. The impacts of this may be less obvious, but are nonetheless important. Say for example that your first project has a lane tracker with centimetre accuracy and 50% availability, while the second has a lane tracker with millimetre accuracy and 100% availability. The later project can then legitimately look in detail at the tails and extreme values of lateral position distributions, while the first project has to assume that the other (unknown) half of the data is roughly similar to the half collected. This gives two very different starting points for which assumptions can be made and which statistical models will be valid, among other things.

4.7.2 Fear of death – which drivers should we look at?

The most common approach to CRE selection is to use the driver as a sensor, i.e. identifying Crash Relevant Events by looking for out of the ordinary driver responses. Now, very basically, the driver does need to have some fear of death (or economic damage at least) in order to respond to threatening situations in an out-of-the ordinary way. The question that follows is whether it really is reasonable to try to do representative sampling of drivers, or whether the drivers we need to focus on and develop countermeasures for actually are drivers that in some sense lie in the tails of the distributions? By random driver sampling, chances are that we confuse two accident-involved populations, i.e. the unlucky and the reckless.

Clearly, there is no straightforward answer to this question, but selecting a relevant driver sampling strategy based on explicit and sound arguments seem to be a key issue for successful NDS/FOT studies.

4.8 Conclusions

A lot of effort in many projects has gone into developing algorithms, filtering techniques etc. that allows for efficient yet relevant CRE selection. The aim of this report has not been to list each such CRE definition in detail. Instead, the intent has been to describe the approaches they represent on a higher, grouped level, and list some the pros and cons for each CRE group. The point of this exercise is really to support and motivate your project to make an informed and conscious decision as to which approach to CRE selection best will fulfil your project goals, and then set up your CREs correspondingly.

Unfortunately, there is yet no formal CRE recipe available that allows just for doing and not thinking. Thus, as hopefully has become clear in the above discussion, setting up CREs and the corresponding baseline events requires thinking about crash causation mechanisms, driver selection principles, what actually constitutes risk-free driving, and many other things.

However, do also remember that progress is being made in many concurrent projects. Hopefully, we will see some convergence toward common CRE definitions in the next few years. Also, while most work until now has focused on vehicle-to-vehicle conflicts, there are now also projects underway that will broaden the scope by looking at conflicts with vulnerable road users (pedestrians, bicyclists, etc.) as well as Powered Two-Wheelers. While each of these conflict objects represent new challenges when it comes to defining the actual crash causation mechanisms involved, as well as which surrogate events could be used as indicators of accident occurrence likelihood, they also drive a good portion of creative thinking on the subject, which is a good thing.

5 WG 3: Legal and Ethical Issues

5.1 Introduction

The results of the EU project FESTA⁵ include the consideration of legal and ethical issues which need to be addressed during the preparation and the execution of a Field Operational Test (FOT). These considerations are predominantly based on the legal situation and the legal framework which is applicable for Germany. Consequently FOT studies carried out so far have identified a certain lack of precise information on the legal background in other EU Member States.

As already pointed out in the FESTA Handbook⁶ carrying out an FOT gives rise to quite a variety of legal and ethical issues to be addressed such as obtaining necessary permissions, ensuring that vehicles are safe to operate in public road traffic, going through any required ethical and human subject review procedures, obtaining participants' consent, complying with data protection laws, insuring vehicles, insuring project workers for indemnity and so on. It was also emphasized that it is not possible to provide a comprehensive guide to all the legal issues that can arise in a particular FOT as these may be very dependent on the system(s) to be tested and on the study design adopted. Moreover, national regulations and laws may vary from country to country and even where there are laws and regulations on the European level (as for data protection and privacy or as for product liability) the interpretation of these may also vary between countries. The differences in laws and regulations between the countries were not addressed in the FESTA handbook – in fact, the findings there referred very much to the German legal situation based on the view of a German lawyer.

Nevertheless, national as well as international projects carrying out FOTs in more than one country or carrying out such FOTs which potentially involve cross-border traffic will have to consider the legal implications in all relevant countries. That is where FOT-Net 2 project's approach comes into play in this context – a legal questionnaire was developed considering any legal issue that might be thinkable in the context of an FOT: data privacy, criminal law, liabilities/insurance, ethical approval, special licenses, product liability and contractual agreements. The information necessary in this field is available only from legal experts in the respective EU Member States which were contacted within the framework of the FOT-Net 2 project via the organisational structure of a user association. That is why the aforementioned questionnaire was distributed via FIA to automobile clubs' legal experts from most of the EU Member States. Elaborate answers could be gathered from experts in France, Italy, the Netherlands and Spain. The information contained in this document is based on – and at the same time, of course, limited to – the input and the suggestions given by the experts of the:

- Spanish Clubs RACC (Real Automóvil Club de Cataluña) and RACE (Real Automóvil Club de España),
- Italian Automobile Club ACI (Automobile Club d'Italia),

⁵ Field opErational teSt supporT Action, funded by the European Commission DG Information Society and Media in the 7th Framework Programme

⁶ downloadable via http://wiki.fot-net.eu/index.php?title=FESTA_handbook

- Dutch ANWB (Algemene Nederlandse Wielrijdersbond),
- French Automobile and Touring Club ACAFA (L'Automobile Club, Association Française des Automobilistes).

The present document not only summarizes the answers gathered from the aforementioned experts, but also points out similarities as well as peculiarities of the different national laws so that it provides an overview of which legal issues need to be addressed in different EU Member States when testing within an FOT. On the other hand this document is not meant to replace a detailed legal analysis or legal advice concerning the execution of an FOT which should be sought with regard to each FOT site beforehand. Note must be taken that this document can only describe the legal framework as of the time it is being written – since also law is subject to a permanent and continuous development process involving new or revised legal acts or legal practice (case law) and permanently developing jurisdiction. In so far this document represents a “snapshot” of the legal situation existing in the middle of the year 2012.

5.2 Basic Groundwork: Legal Questionnaire

For a better and more comprehensive understanding of the legal issues addressed by the questionnaire developed within FOT-Net 2 its text is depicted in the following:

“Introduction

A Field Operational Test is “a study undertaken to evaluate a function, or functions, under normal operating conditions in environments typically encountered by the host vehicle(s) using quasi-experimental methods” [FESTA Handbook, 2008]. As far as the technical architecture of data logging equipment in the host vehicle is concerned, the Naturalistic Driving Study involves many elements already present in a Field Operational Test (FOT). Naturally the Naturalistic Driving Study is not meant to “evaluate a function” but focussed on naturalistic driving in public traffic. From a legal point of view on the relevant technical architecture, for an FOT a wider scope of legal issues needs to be covered than for a Naturalistic Driving Study. Naturally this will not exclude the relevance of specific issues.

The legally relevant technical architecture of the host vehicle will include data recording equipment tailored to the research hypothesis. This will usually (but not necessarily or exclusively) cover GPS-Data, video-recording and data on other interactions of the driver with the machine interface. Additionally, from a legal point of view, it must be taken into account that for the FOTs the functions evaluated might be prototype systems.

The corresponding legal issues for FOTs and Naturalistic Driving Studies (NDS) are cross-sectional in nature as this information is necessary to enable testing. The issues legally relevant for test execution (privacy, criminal law, liability, special licensing, ethical approval – if applicable) are still subject to national legislation and will differ to some degree between the EU Member States. The following questionnaire is tailored in order to compile these legal aspects as advice for researchers throughout the EU. The specific questions will allow for a standardised compilation on the aspects covered.

I. Data privacy

1. Is video recording within the vehicle subject to a ban in terms of national data privacy law in your country?

a. *If yes, which possibilities are there to authorise this video recording (is there possibly a “generally” applicable exception due to the research purpose behind a Field Operational Test (FOT) / Naturalistic Driving Study)?*

b. *What would be needed for a valid consent of the user participating in a FOT (e.g. declaration in written form)? Will other passengers in the car be required to consent to video data recording, too (in case they are affected)?*

c. *In case the other passengers in the car are children: Who will be required to consent to the video data recording (the collection of their personal data)?*

2. *Is video recording of the vehicle’s surroundings (i.e. video recording in open traffic) subject to a ban in terms of data privacy law in your country?*

a. *Which possibilities are there to authorise this video recording by law (since obtaining the other road users' consent is not realistic in this case)?*

b. *In case such video-recording cannot be authorised: Will very low camera resolution – no longer allowing to identify a person – still be subject to this ban?*

c. *Will a vehicle’s number plate / registration number be considered personal data under your countries’ data privacy law?*

3. *Would location-data recorded on the vehicle be subject to a ban due to privacy law, too? How can the recording be authorised? (please point to the answers in question No. 1, in case the same applies! – e.g. consent)*

4. *What about behavioural data recorded in the vehicle (speed, indicator-usage, etc.) – would this be considered subject to a ban by data-privacy law in your country, too? How can the recording be authorised? (please point to the answers in question No. 1, in case the same applies!)*

5. *What else can you think of that is relevant according to your country’s data privacy law?*

II. Criminal law

1. *In case of an accident, the data recording in the vehicle will potentially allow to retrieve video and / or behavioural data. Would it be possible for the police or any public prosecution authority (if so, which authority?, please name and provide contact data!) – in case of criminal prosecution – to confiscate this data?*

2. *Would it be possible for the test-management (research organisation) to hold back this data?*

3. *Would there be any consequences according to the principle of “nemo tenetur se ipsum accusare” (the ban of self-incrimination) in case this data would be used for a criminal lawsuit? Please consider consequences not only for the test-participant but also for FOT management. (It may be assumed that the test-participants have been informed in the test-user agreement that this is a possible consequence of test-participation.)*

III. Liabilities/ insurance

1. *Who will be held liable for damages occurring during the FOT, i.e. because of a traffic accident?*

2. *Who must insure the vehicle (third-party liability): is it the owner or the vehicle's registered keeper (the two are not necessarily identical)?*
3. *Is there a regime of strict liability for the use of a road vehicle in your country?*
 - a. *What are the elements of liability? (e.g. in Germany: vehicle operation and causal link of vehicle operation to the damage)*
 - b. *Are there any exceptions from liability? (e.g. in Germany: 'force majeure')*
 - c. *To whom is strict liability assigned? (e.g. in Germany: The "keeper", which is the person who comes up for the vehicles costs and has the economic benefit out of its operation)*
4. *Is the driver liable, too?*
 - a. *What are the elements of this liability?*
 - b. *Is this strict liability?*
 - c. *How is the relationship with liability of other parties (such as the keeper or the insurance) formed?*
5. *How is the insurance involved into the regime of liability? Is an immediate liability of the insurance in place (by law) or is the insurance only obligated by contract together with the driver or keeper, etc.?*
6. *Is there an automobile third-party insurance – compulsory by law?*
 - a. *Are there any exceptions from insurance coverage for damages (apart from gross negligence in case of drink-driving or obviously risky driving manoeuvres?)*
 - b. *Does the third-party insurance cover damages to the other passengers in the car causing the accident?*
 - c. *Will the third-party insurance also cover the risk of an injury of the driver! test-user or damage to his ! her property?*
 - d. *Which insurance will cover these damages?*
7. *Is there usually an exclusion or limitation of liability in the respective insurance contracts in case the vehicle is used (also) for testing purposes?*
8. *What does the comprehensive coverage including collision insurance cover in your country? (Does this type of insurance cover any other damages than those to the vehicle itself?)*
 - a. *Will this type of insurance also cover damages to retrofitted computers etc. (e.g. for data-collection in case of an FOT). Will this insurance also cover the risk of theft of these computers?*
 - b. *If no, which type of insurance would cover this risk? Please name or circumscribe.*
 - c. *Is there any common possibility to insure the risk of a personal injury to the driver (or the passengers, if not covered by the automobile third-party insurance)? Please name insurance or circumscribe.*

9. *Will these insurances cover the risk involved in case of test-vehicles in an FOT?*

(These vehicles might contain prototype systems that are not yet ready for marketing).

a. What are the limiting issues?

b. How would you consider systems that only take indirect effect by informing / warning the driver?

IV. Ethical approval

1. *Testing might involve naive subjects that are confronted with a challenging situation on a test-track. Would this be permissible in your country?*

a. Would such a test-design need to be made subject to an ethical approval according to national law?

b. Please specify the legal background.

c. Please describe possibilities, limits and some details on the approval procedure.

2. *Please name – or give a vivid example – of how the correct authority in terms of ethical approval can be determined in your country (If possible: Name, address link over the internet, etc.).*

3. *Is there any kind of “ethical committee” in your country that needs to be applied to for the testing of systems in Road Traffic as would be the case in FOTs or NDS?*

a. Is the application made mandatory?

b. At which stage of the FOT is this required?

c. Which level of information would have to be provided?

d. Can a negative result or recommendation of the ethical approval hinder the execution of the FOT, i.e. is the ethical recommendation binding in this respect?

4. *If there potentially is a need for an ethical approval in your country in case of testing, please provide additional information on this committee (e.g. Address, homepage, application forms, procedure, etc.).*

V. Special licenses

1. *Will the vehicle-license be affected in case the car / vehicle is retrofitted with additional technical equipment for the FOT? (Explanation: Normally equipment for an FOT will at least require data-recording equipment which will depend mostly on the vehicle’s power supply. Additionally, additional equipment (displays, buttons, etc.) might be fitted to the dashboard, etc. On top of this, some equipment might even need to be attached to the vehicles CAN-BUS, the vehicles “Controller Area Network” which links the different electronic control units in a vehicle to each other. The additionally fitted equipment would then be substantially engaged into the vehicles electronic architecture. Finally, even certain functions might be modified – such as additional speed limiting equipment, etc.)*

a. To whom / to which organisation or administrative body would such a license have to be applied for?

b. Will there be any limitations to the right of “normal” drivers to drive a vehicle modified for an FOT? Is the driver required to have any special driver’s license or would vehicle guidance be restricted to certain drivers only – e.g. test drivers of the vehicle manufacturer, etc.?

c. Is it possible to obtain a special license in terms of regulatory law (the national Road Traffic Code)?

d. How is this achieved and to whom would such a license have to be applied for?

2. In case the FOT covers so called Cooperative Systems, the transfer of information may rely on Wi-Fi-technology involving a radio-frequency presently under standardisation as 802.11p. The use of this radio frequency bandwidth for testing will therefore usually require an exceptional licensing according to national law.

a. What are the respective legal regulations concerning the use of radio frequencies in your country?

b. Where must this special license be applied for? (Organisation, contact details)? Which public authority is in charge of distributing radio frequencies?

VI. Product liability

1. What is the respective legal framework concerning product liability claims against the vehicle manufacturer in your country?

2. Will a prototype – vehicle that is left to naive subjects – be considered a product in the sense of your product liability law? Have such requirements developed according to national jurisdiction?

3. Which additional risks will a vehicle manufacturer or supplier face in case a prototype system is being tested within an FOT? Can this lead to an increased risk of product liability according to your national product liability act or respectively to tort liability for product defects?

4. Are any specific regulations in place as far as instructing the user of a product is concerned?

5. Are there any specific requirements for the testing of prototype systems (apart from the rather general requirement following from product liability to instruct carefully on the system’s limits and features)?

VII. Contractual agreements

1. In general, in contracts, arrangements can be made freely. Which limitations are in place according to your national law and jurisdiction? (e.g. according to the General Terms and Conditions Act in your country, etc.!)

2. Is it possible for the test participants to consent to a full exclusion of liability or is full exclusion of the liability risk limited to property damages only?

3. Which other relevant aspects – apart from the specific issues already addressed above – need to be dealt with in the contractual agreement according to your knowledge on national law and jurisdiction for FOT’s and NDS?

VIII. Open Question

Apart from the issues already covered by your answers given above, are there any further issues that need to be taken into consideration in your country? Please describe.”

Based on the answers to the questionnaire gathered from the legal experts of the automobile clubs in different EU countries the following legal findings have been compiled. This compilation and analysis allows for a rough overview of the legal framework relevant for FOTs in France, Italy, the Netherlands and Spain. The legal framework in Germany was already taken into account for the analysis of the legal issues in the FESTA handbook. Conclusions on which legal issues are likely to be similar throughout the EU can be drawn from the findings in the FESTA handbook as well as on the results of the survey carried out using the questionnaire detailed above. This will allow for a more precise pre-evaluation of the legal issues which have to be addressed at any stage of an FOT (design, preparation, execution, wrap-up). On the other hand, the present document cannot replace a detailed legal analysis to be carried out by a lawyer who studied the law of the country where the respective test site is located. Nevertheless, this document contributes to a better understanding of which legal issues will need to be addressed when preparing and executing an FOT in different EU Member States.

5.3 Data Privacy

Basically video recording within the vehicle as well as video recording of the vehicle's surroundings (i.e. video recording in open traffic) is subject to the different national privacy laws taken into account within the FOT-Net 2 project.

5.3.1 Spain

Generally, Spanish privacy law bans the collection of personal data via video recording. This kind of data collection is included in the definition of personal data laid down in the Spanish Act on Data Protection (Ley Orgánica 15/1999, de 13 de diciembre, de Protección de Datos de Carácter Personal). Therefore the Spanish Automobile Club's (RACC) answer to the legal questionnaire points out the following main legal obligations of those aiming at collecting personal data:

I. Information: the data collector shall inform about which data is collected and processed, as well as about the policies or purposes of the treatment.

II. Consent: the data collector shall obtain the consent of the individual to the collection and processing of his or her personal data, as well as to any prospective communication of data to third parties.

III. Rights: the data collector shall inform the individuals about their rights to access to data files, and to amend or cancel its content.

IV. Technical Protection Measures: the data collector shall devise the necessary technical protection to avoid that the personal data can be accessed by third parties.

V. Registry: the data collector shall inform the Spanish Agency on Data Protection (Agencia Española de Protección de Datos) about the kinds of data collected and the purposes of their processing.

According to Spanish law, consent would be needed to authorize video recording within the car. The Spanish Act on Data Protection establishes two exceptions for statistical or scientific purpose which do not seem to apply to an FOT:

I. Section 11.2.e) provides a safe-harbour for data collectors: it is not necessary to obtain the individual's consent in cases in which the data collector is a public authority and communicates the collected data to another public authority for statistical or scientific reasons.

II. Section 4.2 provides another safe-harbour for data collectors: data processing must be developed according to the policies or purposes that have been explained to the individual. However, it is possible to analyse the data afterwards for statistical and scientific purposes regardless of whether the individual has been informed about such purposes.

Considerable parts of the following passages referring to Spanish law were implemented directly from the RACC's answer into the present document since they are very condensed on the one hand and very comprehensive on the other hand so that it did not seem to generate any additional value to shorten or rearrange these passages (this also applies to the following chapters): According to section 6.1 of the Spanish Act on Data Protection, any data processing would require the unequivocal consent of the individual, unless another section establishes otherwise. Consent is defined in Spanish regulations as "any sign of an individual by which it may be inferred that willingly, specifically and with sufficient information he/she agreed to the data processing" (section 5.1.d). A declaration in written form is not necessary in each case, although it may be advisable. According to section 14 of the regulations, an opting-out system is available: if the data processor provides comprehensive information about the purposes of the data processing, provides a free and user-friendly tool for opting out the data processing, and the individual does not disagree with the data processing within 30 days, it is assumed that he/she has consented to the data processing. As for other passengers in the vehicle, consent to the video data recording would also be needed. Either asking for a written consent or using the opt-out mechanism would be possible. Section 13 of the Regulations sets out the rules concerning consent for children data processing. Minors aged 14 years old or older (up to 18 years) may directly agree to the data processing, unless a specific rule provides that consent may be obtained from the child's legal representative or custodian. Information addressed to a minor about the purposes of the data processing shall be easily understandable. In case of processing data related to younger minors, consent shall be obtained from parents or guardians. Concerning the recording of the vehicle's surroundings there is no legal exception for similar cases in Spanish privacy law, so that one may resort to the aforementioned opting-out system. However, it must be taken into account that in such cases, the data processor shall provide the individual with a user-friendly tool for opting out the data processing. This latter requirement may become also unrealistic. An alternative solution is to avoid any kind of data processing by using a very low camera resolution – inasmuch as low camera resolution is used and identification of third parties becomes impossible or unreasonably costly no data privacy obligations would be involved in the FOT or NDS. It must be acknowledged that consent is not required in cases in which information or data is publicly available and its processing is deemed necessary for the purposes stated by the data processor. It may be interpreted that the organizer of an FOT or NDS processes data from drivers and passengers for scientific purposes and, in doing so, some ancillary data publicly available (because it is being recorded in an open space) is necessarily recorded and processed as well. Nonetheless, as far as can be seen, there is no Spanish case-law holding such interpretation. A vehicle's number plate / registration number would be considered personal data under Spanish privacy law, because it may indirectly be used to identify one individual or to connect him/her to other data. Spanish data privacy law only applies to the data of individuals, but not to data of companies, associations or other legal entities. Therefore, number plates /

registration numbers of vehicles not owned by individuals would not be controlled by the Spanish data privacy law. Inasmuch as location data or behavioural data (speed, indicator-usage etc.) of a vehicle may be linked to a specific individual (driver or passengers), processing would be banned. Moreover, it should be taken into account that processing of data by third parties on behalf of the data collector as well as communication of personal data to third parties would require separate consent. It is important to take into account further restrictions regarding the international transfer of personal data.

5.3.2 Italy

With regard to Italian law it seems generally difficult to video record within a vehicle in public road traffic. On the other hand, it seems that exceptions are possible in bounded private test areas. With regard to Italian proprietary law all activities taking place in private areas have to be authorized by the owner of these areas – the inside of a car seems to be comparable to the inside of a house in that respect according to Italian proprietary law. Activities taking place in public areas, such as video recording, must preventively be authorized (and can only be authorized for public reasons) by the public authority in charge of protection of these areas. Of course, the public authority has to respect absolute individual rights and privacy rules since each public power serves the public interest which is in charge of. In respect of Italian personal rights, the authorization of the recorded individual has to be obtained, nevertheless this right might be constrained in cases of prior public interest such as possibly road-safety. However, in Italy this kind of public priority does not exist at the moment. Moreover, with regard to video recording, Italian law requires obtaining the written consent of the users participating in an FOT (whether driver or passenger [as far as affected] in the FOT-car). Where passengers in the car are children, the consent has to be obtained from the person(s) who exercise(s) the parental authority. As far as a video record contains persons or personal data, the recording of the vehicle's surroundings (i.e. in open traffic) is subject to a ban in terms of Italian data privacy law. With regard to Italian law, data subjects should be informed that they are going to access or find themselves in an area under video surveillance (according to the Italian video surveillance guidelines issued by the Italian Data Protection Authority 8th April 2010). The ban mentioned before is not applicable as far as a very low camera resolution is chosen for video recording since Italian data privacy law is applied only in cases of personal data and when it is possible to identify a person. A vehicle's number plate / registration number is considered as personal data in terms of Italian law. Location data and behavioural data (speed, indicator-usage etc.) are subject to a ban in terms of Italian data privacy law. Nevertheless, behavioural data recorded in the vehicle would presumably not be considered to be subject to this ban if those data are not traceable to a specific person but used only for statistical purposes. In general, it is possible to use data as far as they are not related to a specific person and used only for statistical purposes.

5.3.3 Netherlands

In general, with regard to Dutch law only anonymous data should be collected. Provided that participants have given their consent, data should only be used for the purpose for which they have been collected and not retained longer than is necessary. In the Netherlands it is possible to authorize video recording within the car depending on various conditions such as what can be seen on the video and if the filmed person has given his/her approval. Dutch law requires consent to video recording to be obtained from any person inside the car (whether driver or passenger [as far as affected]). Consent must be clear, though it is not obligatory that it be in written form. As far as children as passengers in the car are concerned, the

consent has to be obtained from their legal representatives. The Dutch automobile club ANWB advises to consult the Dutch Data Protection Authority (www.dutchdpa.nl) for more information in terms of data privacy. Video recording of the vehicle's surroundings is subject to a ban in terms of data privacy law in the Netherlands if the recording makes natural persons identifiable. So it is recommended that other road users should be unidentifiable. Registration plates can be qualified as personal data in terms of Dutch privacy law. The recording of location data and behavioural data (speed, indicator-usage etc.) is also subject to a ban due to Dutch data privacy law – nevertheless the same possibilities to authorize this recording are applicable as for video data. Such recording which does not allow to identify a person (e.g. due to a very low camera resolution) is not subject to the aforementioned ban. Moreover, in the Netherlands a code of conduct for scientific research has to be accounted for also in terms of data privacy.

5.3.4 France

In France, video recording is subject to a ban in terms of national privacy law as far as it is not a private video recording. It depends on the purpose of the recording of personal data as to whether an authorization or simply a declaration is needed in order to authorize this video recording. The French automobile club ACAFA advises to approach the CNIL (Commission Nationale de l'Informatique et des Libertés, www.cnil.fr) for further information on that point. With regard to users participating in an FOT, French law requires written authorization to be obtained for all passengers in the car who are affected by the video data recording. Moreover, they have to be informed on the data's purpose, what kind of data are collected, the duration for which the collected data may be stored and the persons who have access to data recording. The users participating have to be informed on their rights of access, of rectification and of opposition as well as on the procedure of exercising these rights. If the other passengers in the FOT-car are children, the authorization of the persons having the parental authority is required. Video recording of the vehicle's surroundings is subject to a ban in terms of French data privacy law. This kind of video recording could be authorized by making the recorded persons unidentifiable (e.g. by blurring out other road users' faces or using a very low camera resolution). A vehicle's number plate / registration number is considered as personal data according to French law. With regard to the recording of location data and behavioural data in France, the same applies as for the recording of video data (see above). Moreover, security and confidentiality of the data have to be preserved as well as private life and the protection of personal data has to be respected.

5.3.5 Summary concerning Data Privacy

In summary, all of the four countries' legal systems considered in the FOT-Net 2 project impose a general ban on video data recording, location data and behavioural data (speed, indicator-usage etc.) as far as data is recorded that can be qualified as personal data, i.e. which can be referred to an individual person. However, video data as well as location data and behavioural data may be recorded legally for the purposes of an FOT by adhering to certain procedures detailed above for the four EU Member States considered herein. The following similarities can be deduced (peculiarities in brackets):

- The recording of video data within the vehicle requires the consent of every passenger in the car – including the driver, of course. In case of minors respectively children the parents' / legal representatives' consent has to be obtained (in case of 14-year-old and older minors in Spain only in some cases obligatory). The requirements concerning the consent differ (Netherlands and Spain: clear / unequivocal consent, France and Italy:

written consent) – in favour of the burden of proof of having obtained the required consents it is advisable to obtain the consent in written form.

- As far as the vehicle’s surroundings are subject to video recording it has to be made certain that other road users are not identifiable – e.g. by using a very low camera resolution.
- A car’s registration number / number plate has to be considered as personal data (for Spain this does not refer to company-owned cars) in terms of data privacy law.

However, there are certain national peculiarities which have to be accounted for: In Italy for example, activities taking place in public areas – such as video recording – must preventively be authorized (and can only be authorized for public reasons) by the public authority in charge of protecting these areas.

5.4 Criminal Law

Criminal law may also play a certain role in the context of FOTs in the case of traffic accidents, the data recording in the vehicle will potentially allow the retrieval of video and/or behavioural data (e.g. for the police or for another public prosecution authority).

5.4.1 Spain

In Spain, in case of a crime investigation, certain public authorities can access the data recording and even confiscate the data in some cases. Depending on the stage of the crime investigation, public authorities entitled to access the data may include a judge (“Juez Instructor”), a public attorney (“Ministerio Fiscal”) or the judicial police (“Policía Judicial”). Judicial police may confiscate any object related to a crime scene (section 4 of the Regulation on the Judicial Police (Real Decreto 769/1987, de 19 de junio, sobre regulación de la Policía Judicial). In cases of traffic accidents in which a crime may have been committed, the judicial police are entitled to confiscate a vehicle and any object or system inside the vehicle. Data and elements confiscated by the Judicial Police would not be regarded as evidence in further criminal proceedings but may be used as signs or circumstantial evidence if confirmed by other pieces of evidence. Confiscation of data in the facilities of the organizer of the FOT or NDS would generally require judicial authorization or consent by the organizer (sections 573 to 578 of the Criminal Procedure Act (Ley de Enjuiciamiento Criminal). Any person may be required to show objects or papers which are suspected to be related to a crime (section 575 of the Criminal Procedure Act). If the individual refuses to show the information or the devices in which the information is stored he/she may be criminally prosecuted for disobedience to authority (section 556 of the Criminal Code), unless the individual was the author of the crime, a receiver (“receptador”, sections 298 to 304 of the Criminal Code) or an accessory after the fact (“encubridor”, sections 451 to 454 of the Criminal Code). In such cases, the individual is protected by the fundamental right to not self-incriminate or provide evidence incriminating her (article 24.2 of the Spanish Constitution). If data was obtained during the investigation of a crime by the judicial police, it cannot be used as evidence of a crime; it can only be used as circumstantial evidence. It could be used to initiate criminal proceedings either against the test-participant or the test manager/s. On the other hand, data legally obtained with judicial authorization and compliance with all legal requisites may be used as evidence in criminal proceedings.

5.4.2 Italy

In Italy it is also possible to retrieve and confiscate this data by the police and judiciary. The test-management (research organisation) can get the confiscated data back after the conclusion of the police investigation respectively, in case of prosecution, after the judgment.

5.4.3 Netherlands

In general, in the Netherlands the police or other authorities have the corresponding power of investigation to confiscate the video and/or behavioural data collected during the FOT in case of criminal prosecution. For information on whether or not data can be used by the prosecution authorities and/or the police the Dutch automobile club ANWB advises to contact the Public Prosecution Service (Wetenschappelijk Bureau van het Openbaar Ministerie, Lange Voorhout 7, 2514 EA 's-Gravenhage telefoon +31 - (0)70 - 7569200 fax +31 - (0)70 – 3611469). In general, it is not possible for the test-management (research organisation) to hold back this data unless the authorities request it in a disproportional way. In the Netherlands, little impact is assumed to result from the “nemo tenetur se ipsum accusare” principle (ban of self-incrimination) in this context since the recorder and the recorded data do not belong to the person accused.

5.4.4 France

According to French law it is possible for the police or another public prosecution authority to confiscate this data in some cases. The test-management (research organisation) is not entitled to hold back this data but it can be returned after the investigation or the judgment. Generally, there is a right of silence. The test-management is not liable for the test-participant. It can be emphasized in a formal agreement that the test-management is not liable for offences committed by test-participants.

5.4.5 Summary concerning Criminal Law

As a result it can be stated that all of the legal systems considered within the FOT-Net 2 project show the similarity that the police or another public prosecution authority are authorized to confiscate the data recorded during an FOT in case of an accident.

5.5 Liabilities/Insurance

Liabilities respectively insurance issues have also to be taken into account in the field of FOTs, of course. The first question which arises in this context is who is to be held liable in the case of a damage occurring during an FOT, i.e. resulting from a traffic accident.

5.5.1 Spain

In Spain, liability in this context may depend on a variety of factors including, but not limited to, the kind of damage, the origin of damage, the characteristics of victims and behaviour of the individuals involved in the causation of damage. For instance, if the damage was caused or aggravated by a defective product (e.g. airbags, seatbelts) product liability rules may be applied. If causation may be established between damage and the FOT arrangements, general civil liability would be applied. In this regard, depending on whether the victim was in a contractual relationship with the FOT organizer (e.g. the driver) or not (e.g. other passengers), liability for breach of contract or tort liability (extra-contractual liability) may be applied. Besides, criminal liability may arise in some scenarios. For example, in cases in which the traffic accident was caused by an individual driving under the influence of drugs or alcohol or driving with reckless disregard for driving safety rules, the Spanish Criminal Code

(Ley Orgánica 10/1995, de 23 de noviembre del Código Penal) may be enforced. Sections 109 to 122 of the Spanish Criminal Code govern civil liability arising from a crime. There are some differences with the general civil liability regime. To avoid complexities posed by the heterogeneity of damages that may arise in an FOT or NDS, the following considerations concerning Spanish law will focus on damages caused in a traffic accident in which none of the individuals involved committed a crime. According to section 2.1 of the Spanish Act on Civil Liability and Insurance in the area of Vehicle Driving (Texto refundido de la Ley sobre responsabilidad civil y seguro en la circulación de vehículos a motor, aprobado por el Real Decreto Legislativo 8/2004, de 29 de octubre) the owner must purchase a third-party liability insurance, at least covering the minimum thresholds established in the Act. However, the owner may be relieved from this obligation if the insurance is purchased by any person having an interest in insuring third-party liability, for instance, the vehicle's user or registered keeper. According to section 4 of the Regulation developing the former Act (Real Decreto 1507/2008, de 12 de septiembre, por el que se aprueba el Reglamento del seguro obligatorio de responsabilidad civil en la circulación de vehículos a motor), it is presumed that the owner of a vehicle is the person who registered the vehicle. The Spanish Act on Civil Liability and Insurance in the field of Vehicle Driving establishes a dual liability system. On the one hand, a strict liability rule governs personal injuries. On the other hand, a negligence liability rule governs damages to property. In the case of personal injuries, drivers are held strictly liable for the damages arising from a traffic accident. Vehicle operation and causal link of vehicle operation to the damage are generally required as elements of liability. The rules set forth in the Spanish Act on Civil Liability and Insurance in the area of Vehicle Driving govern liability for damages arising from vehicle operation ("hecho de la circulación"). Vehicle operation is defined in section 2 of the Regulation on Civil Liability and Insurance in the area of Vehicle Driving as "risk-generating events created by vehicle driving activities in parking lots, garages, public or private roads or other traffic facilities and commonly used pathways". Vehicle operation in terms of Spanish law does not include:

- I. accidents in sports and competitions using vehicles.
- II. accidents in the use of vehicles in agricultural or industrial tasks (this exception does not include accidents arising from driving such vehicles in public roads).
- III. accidents in facilities not included in the aforementioned provision (e.g. harbours, airports).
- IV. use of a vehicle to commit a crime.

Liability arising from accidents in which vehicle operation is not established would be governed by other liability rules (Civil Code, Criminal Code and specific regulations).

Two exceptions from liability are legally established:

- I. The defendant may prove that the injury was exclusively caused by the negligence or behaviour of the victim ("culpa exclusiva de la víctima").
- II. Force majeure. A defect in the vehicle or in one of its components and the breakage or failure of one of its devices are not considered as force majeure events.

The contributory negligence of the victim (comparative negligence, "concurrancia de culpas") may be assessed to reduce the amount of damages both for personal injuries and damages to property.

Liability is primarily assigned to the driver but the owner of the vehicle can also be held liable in some cases.

As mentioned before, the Spanish Act on Civil Liability and Insurance in the field of Vehicle Driving establishes a dual liability system (section 1). On the one hand, a strict liability rule governs personal injuries. On the other hand, a negligence liability rule governs damages to property. Owners of a vehicle (different from drivers) may be held liable for personal injuries and damages to property caused by a driver if the owner and the driver are in one of the specific relationships established in section 1903 of the Civil Code or section 120.5 of the Criminal Code. In this regard, owners of vehicles may be held liable for traffic accidents caused by its employees acting under the scope of the employment. Also, a parental relationship or a legal custodian relationship may be used to hold owners of vehicles liable for damages caused by respectively a minor driver or an adult unable to manage his/her own affairs. In case of a crime or misdemeanour committed in a traffic accident, owners of vehicles may be held liable for damages caused by its employees, representatives or any other authorized users. Owner's liability shall cease when the owner can prove that he/she used the diligence of a prudent person to prevent the damage. However, in case the owner failed to purchase third-party liability insurance, he/she would be held jointly liable with the driver for the damages and injuries arising from a traffic accident, unless he/she can show that the vehicle had been stolen.

Section 6 of the Act establishes the immediate and direct insurer's liability ("acción directa"). Therefore, a victim's claim may be brought against the insurer, notwithstanding the possibility that the insurer would bring a further claim for reimbursement against the insured owner, the driver or a third party.

The insurer may not raise the following objections against the claimant victim:

- I. The existence of particular coverage exclusion not established by law.
- II. The fact that the driver had not a valid driving license.
- III. The fact that the insurance purchaser or driver failed to comply with specific technical regulations regarding safety.
- IV. The fact that the use of the vehicle was not authorized by the insured, except when the vehicle had been stolen.
- V. The fact that a contractual exclusion was agreed according to which insurance would not be valid in cases in which the driver had a traffic accident under the influence of alcohol or drugs.
- VI. The existence of a coverage exemption in the insurance contract.

Damages exceeding the amount covered by the compulsory third-party insurance or not covered by the insurance shall be defrayed by the tortfeasor (generally the driver, but other individuals may be also held liable) or through additional voluntary insurance.

The owner of a vehicle must purchase third-party liability insurance, at least covering the minimum thresholds established in section 4.2 of the Act. Compulsory third-party insurance would provide compensation for the following maximum amounts: death and personal injuries – up to € 70 million for each accident (irrespective of the number of victims); damages to property: up to € 15 million for each accident. Compensation for death and

personal injuries is fixed according to a system of caps and schedules (“baremos”). The rules governing such compensation are set forth in the Appendix to the Act.

Some damages are exempted from compulsory insurance coverage (section 5): driver’s death; personal injuries suffered by the driver; damages to the vehicle or other goods inside the vehicle; damages to goods owned by the vehicle owner, the driver or the insured person, as well as by their spouses and other relatives; any damage arising from an accident caused by a vehicle which has been robbed. The concept of robbery (“robo”) – as opposed to theft (“hurto”) – is established in section 237 of the Criminal Code. In such cases, damages to third parties are compensated through a public compensation fund (Consortio de Compensación de Seguros).

Nevertheless, voluntary first-party insurance may be purchased to cover personal injuries or death to the driver, as well as to cover damages to his/her property, including damages to the vehicle. It should be pointed out that insurance contracts can include an exclusion or limitation of liability in case the vehicle is used for testing purposes. First-party insurance is informally known as “seguro de accidentes”.

Comprehensive coverage insurances are not generally regulated in Spain and their content may vary from one insurance company to another. Besides, insurance companies may offer different comprehensive coverage insurance products. Comprehensive coverage insurance is informally known as “seguros de daños” and is usually combined with other insurance products. The combination of first-party insurance and comprehensive coverage insurance is informally known as “seguro a todo riesgo”. Comprehensive coverage insurance usually includes damages to the vehicle caused in a traffic accident not covered by someone else’s third-party insurance, and damages to the vehicle arising from, but not limited to, fires, vandalism, storms, floods or other acts of God. Other possible coverage may include damages to windshields or damages arising from car robbery or theft. Comprehensive coverage insurances usually include damages to the goods inside a vehicle and to its components. That is why insurance premiums usually include a deductible (exempted threshold for damages to property) in order to avoid moral hazard phenomena. Some comprehensive coverage insurance may include losses by theft of goods stored in a vehicle. In this case an exempted threshold would usually apply.

In Spain, voluntary insurance policies may cover the risks involved in case of test-vehicles in an FOT. However, in most cases it might be advisable for the organizer of an FOT to purchase additional insurance coverage to insure eventual damage arising from the uses of prototype systems in vehicles.

5.5.2 Italy

In Italy, according to Art. 2054 of the Italian Civil Code, the driver is liable for damage occurring on public roads. The vehicle’s owner, who at the same time has to be the vehicle’s registered keeper in Italy, is jointly and severally liable with the driver. There is a regime of strict liability, assigned to the vehicle’s owner, for the use of a road vehicle in Italy the elements of which are vehicle operation, causal link of vehicle operation to the damage and a damage resulting on road areas – public or private (only if it is open for public circulation/traffic). Exceptions from liability can be found in Art. 141 of the Italian Code of Private Insurance: “Except in case of fortuitous event, the damage suffered by third transported shall be compensated by the insurance on the vehicle”. Moreover there are contractual terms that exclude coverage of risk and therefore the compensation in the event

of a claim (driver under influence of alcohol or drugs or driving without license). Given these limitations, the insurance company is still forced to liquidate any damage, but the insurance has the right of a claim against the contractor, i.e. to ask the total or partial refund.

The driver's liability includes elements of third-party liability and contractual liability. For the owner this is a strict liability. The owner is obliged to insure against liability towards third parties (third-party liability) by making a contract with an insurance company (contractual liability). The insurance is immediately involved by law; in case of an absence of insurance, the liability is personal. Italian law stipulates an automobile third-party insurance including an immediate liability of the insurance company. Third-party insurance covers the risk of an injury of the driver/test-user or damage to his/her property only as far as it is included in the specific insurance policy. For the direct compensation procedure (d.lgs.n.209- 07.09.2005, entered into force as from 01/27/2007) the driver's insurance will cover the damage suffered by the insured only in case of his total reason or part of reason. The driver's insurance will cover the risk when the injury of the driver does not exceed 9% of permanent disability. It will also cover the damage to the driver's property. Direct compensation can be applied for in the following cases: actors must be identified with the amicable accident report; the accident must not have involved more than two motor vehicles; vehicles must have been registered in Italy or in the Republic of San Marino or the Vatican State (must have an Italian license plate); drivers must also accept a policy of insurance with a company authorized to practice in Italy or with a foreign company which has acceded to the procedure of direct compensation. Regarding serious injury, the risk is covered by the insurance company of the vehicle responsible for the accident. There usually is no exclusion or limitation of liability in the respective insurance contracts in case the vehicle is used (also) for testing purposes because the insurance is compulsory by law and only for the use permitted by law (Highway Code and Criminal Code).

Concerning comprehensive coverage including collision insurance there are several types of insurance policies which usually cover damages to the car and property carried therein only if it is owned by the car's owner or driver. This type of insurance includes the coverage of damages to or the theft of test equipment (e.g. retrofitted computers for data-collection in case of an FOT) as far as it is included in the respective insurance contract. In how far the risk of a personal injury to the driver (or the passengers, as far as not covered by the automobile third-party insurance) is covered, depends on the specific provisions of the insurance contract signed by the FOT management concerning the test program.

5.5.3 Netherlands

In general, in the Netherlands the person/car who/that causes the accident is responsible. But this may be different if the cause of the accident lies in the FOT, e.g. if it overrides the driver's will/intention. The person in whose name the car is registered must insure the vehicle (third-party liability). There is a regime of strict liability for the use of a road vehicle in the Netherlands only in case of traffic accidents between motor vehicles and pedestrians/cyclists (non-motorised traffic participants). The elements of liability are a wrongful act for which the wrongdoer is culpable and for which he can be held accountable and a causal link between the wrongful act and the damage. There are no exceptions from this liability in the Netherlands. Strict liability is assigned to the driver in the Netherlands – it requires a wrongful act for which a person is legally responsible – regardless of personal fault.

The victim has the right to claim his damages directly from the insurer of the responsible party (immediate liability). Third-party motor insurance is compulsory in the Netherlands (Wet aansprakelijkheidsverzekering motorrijtuigen – WAM).

There are no exceptions in the third-party insurance coverage for damages. However the victim can have his/her claim for damages denied if he/she has contributed to his/her damages, for instance if he/she has not used the seatbelt and if this has aggravated the injuries in comparison to having used the seatbelt. The third-party insurance also covers damages to the other passengers in the car causing the accident provided the driver can be held liable. This insurance will not cover the risk of an injury of the driver/test-user or damage to his/her property but a comprehensive motor insurance will cover the damage to his car it will also cover other damages than those to the vehicle itself. The answer to the question of whether there is an exclusion or limitation of liability in the respective insurance contracts in case the vehicle is used (also) for testing purposes depends on the motor insurance policy. It might be that equipment necessary for data collection in case of an FOT is not insured under a comprehensive motor insurance – this also depends on the insurance policy but in general the risk of theft is covered by a comprehensive motor insurance. A first-party motor vehicle insurance and/or the insurance that covers the risk of personal injury of car occupants is a common possibility to insure the risk of a personal injury to the driver or the passengers. The answer to the question of whether these insurances cover the risk involved in case of test-vehicles in an FOT (since these vehicles might contain prototype systems that are not yet ready for marketing) depends on the respective insurance policy – it might be a limiting issue that a test-vehicle is involved.

5.5.4 France

In France the policy holder is liable when damages are caused by his/her vehicle. It can either be the driver who is liable for damages which he/she causes personally if no insurance plays a part in the compensation of the damages. If the driver is not the policy holder, he/she can be liable for his/her acts for damages in case of insurance failing. With regard to penal law the driver is liable for his/her acts anyway, if he/she has committed a traffic offence. It is either the vehicle's registered keeper or the owner who has to insure the vehicle in France. There is a regime of strict liability for the use of a road vehicle in France which can be found in Art. 1382 of the Civil Code which indicates that a person who causes damage to someone has to repair his/her fault ("Tout fait quelconque de l'homme, qui cause à autrui un dommage, oblige celui par la faute duquel il est arrivé à le réparer."). Moreover, there is a specific law (Loi n° 85-677 du 5 juillet 1985 tendant à l'amélioration de la situation des victimes d'accidents de la circulation et à l'accélération des procédures d'indemnisation) which manages the traffic accident to ensure compensation for victims of road. The elements of (the driver's as well as the policy holder's) liability are a damage, an event giving rise to the damage (cause) and a causal link between these two elements. There are exceptions from liability in case of force majeure, fault of the victim and exterior causes. In case of the driver it is necessary to prove his liability of driver – in case of an accident including a pedestrian it is a strict liability except in cases of fault of the victim. In case of an accident it is the policy holder who makes an accident claim to his insurance with all possible elements (name of the opposite side, his insurance, witness). The insurance intervenes when there is an accident claim. Furthermore, in France there is an automobile third-party insurance which is compulsory by law (Art. L211-1 of the Insurance Code) and which also covers damages to the other passengers in the car causing the accident. Exceptions from insurance coverage for damages are (apart from gross negligence in case of drink-driving or obviously risky

driving manoeuvres): false declaration, according to contract options, racing (sport competition). Third-party insurance will not cover the risk of an injury of the driver/test-user or damage to his/her property if the driver is liable for the accident. In case the driver is not liable for the accident the third-party insurance will cover these risks because it is the opposite side who will assume damage. There is no specific exclusion or limitation of liability in the respective insurance contracts in case the vehicle is (also) used for testing purposes but the insurance has to be informed because this could modify the guarantees – this will depend on the insurance contract.

In France the comprehensive insurance covers damages caused by the driver to other vehicles or to persons or objects – depending on the insurance contract. Retrofitted computers in the FOT vehicles can be included in such an insurance contract. The risk of personal injury to the driver or the passengers can be included in the insurance contract too: In cases where the driver or the passengers are victims they can be compensated; in cases where the driver is responsible this will depend on the specific insurance contract. Moreover, in France there is a guarantee fund which can compensate victims in certain conditions. It may be negotiable with the insurance company, with particular limitation (depending on the insurance contract), to cover the risk involved in case of FOT vehicles containing prototype systems. Systems taking only indirect effect by informing/warning the driver do not affect the insurance coverage.

5.5.5 Summary concerning Liabilities/Insurance

For a better view on the results concerning the answers to the questionnaire's liabilities/insurance-related issues please find the summary in the following table:

Table 6: Summary of Liabilities/Insurance

Liabilities / Insurance	Spain	Italy	France	Netherlands
Responsible for insuring the vehicle (third-party liability)	Owner (may be relieved from this obligation in case the user or the keeper [anyone having an interest in insuring third-party liability] purchases the insurance)	Owner must necessarily be vehicle's registered keeper	Owner or vehicle's registered keeper	Vehicle's registered keeper
Strict Liability	Strict liability governs personal injuries; negligence liability governs damages to property; in case of personal injuries the driver is strictly liable	yes (for the owner)	yes (for the insurance policy holder); also for the driver in case of accidents involving pedestrians except it is the victim's fault	for the driver - only in case of accidents between motor vehicles and pedestrians / cyclists (non-motorised traffic participants)
Elements of Liability	Vehicle operation + causal link of vehicle operation to damage + damage	Vehicle operation + causal link of vehicle operation to damage + damage	Damage + event giving rise to the damage + causal link between these two elements	Wrongful act which the wrongdoer is culpable and can be held accountable for, causal link between wrongful act and damage
Exceptions of Liability	"culpa exclusiva de la victima" or Force Majeure; contributory negligence of the victim may reduce liability	Art. 141 Code of Private Insurance: "fortuitous event"	Force majeure Fault of victim Exterior cause	-
Insurance Involvement	immediate liability	immediate liability	insurance intervenes in case of accident claims	Immediate liability
Third-Party Insurance	compulsory by law	compulsory by law	compulsory by law	compulsory by law
Exclusions / Limitations of Liability in Case the Vehicle is used for Testing Purposes	Insurance contracts can include exclusions / limitations in this case	No exclusions / limitations, because third-party liability insurance is compulsory by law and only for the use permitted by law	Not specifically, but the insurance must be informed because guarantees could be modified - depending on the insurance policy	Depending on the insurance policy

Moreover the liabilities-/insurance-related questions in the legal questionnaire brought up quite a variety of answers which make it clear that whilst of course there are similarities on the one hand there still are details which may be quite different on the other hand.

Vehicle third-party liability insurance is compulsory by law throughout the EU Member States considered herein. Nevertheless, there are slight differences in who is responsible for making the insurance contract — in Germany, the Netherlands and Italy it is the vehicle's registered keeper (who in Italy has to be the owner at the same time) whereas in France it can either be the owner or the keeper; in Spain it may be the owner or another person having an interest in insuring third-party liability. Generally speaking, third-party insurance covers damages to the other passengers in the car causing the accident (this does not apply to Spain in case of a robbery, neither does this apply to Italy in case of a fortuitous event; in the Netherlands this does not apply if the driver cannot be held liable). In Spain, Italy and the Netherlands the third-party liability insurance will not cover the risk of an injury of the driver/test-user or damage to his/her property – this cover would require a specific insurance (voluntary first-party cover / comprehensive motor insurance cover). In contrast to that, in France third-party insurance covers the risk of an injury of the driver or damage to his/her property if the driver is not liable for the accident.

In Spain, France and the Netherlands it depends on the provisions of the insurance contract if liability is excluded or limited in case the vehicle is used for testing purposes; in Italy there usually is no such contractual exclusion or limitation of liability.

Technical equipment the FOT vehicles are retrofitted with (e.g. computers for data collection) can be included in a comprehensive coverage insurance in Spain, France, Italy and the Netherlands if specified in the insurance contract.

Any other potential insurance issues (risk of a personal injury of the driver or of the passengers – if not covered by the vehicle third-party insurance) depend very much on the precise, voluntary, insurance contract which should be negotiable between the FOT management and the insurance company.

5.6 Ethical Approval

The question can be asked as to how far FOTs may require any kind of ethical approval with regard to the different national legal frameworks since testing might involve naïve subjects who are confronted with a challenging situation on a test track.

5.6.1 Spain

According to Spanish law, ethical approvals are only required in some specific biomedical research and clinical trials. Regulations and ethical recommendations would normally not apply to FOT and NDS tests. So, this part of the questionnaire has been left unanswered for the Spanish legal framework.

5.6.2 Italy

The Italian automobile club ACI did not have any information with regard to the questions referring to ethical approval.

5.6.3 Netherlands

The Dutch automobile club ANWB did not have any specific information on the questions dealing with ethical approval either – but it could be stated that testing involving naïve subjects being confronted with challenging situations on a test-track is permissible in the Netherlands provided that the test subjects are fully informed about the test, what it involves, the consequence etc.

5.6.4 France

In France, tests confronting test subjects with a challenging situation on a test track are permissible if the type of testing does not run contrary to human rights. Tests may require the advice of a medical doctor but there is no need for an ethical approval. According to the French automobile club ACAFA, there are no specific laws in that respect but a set of law has to be respected. The correct authority to contact in France is the Comité Consultatif National d'Éthique (www.ccne-ethique.fr). The Committee's approval is not required but it can give its opinion. A negative recommendation of an ethical approval does not seem to hinder the execution of an FOT in France, i.e. the ethical recommendation does not seem to be binding in that respect.

5.6.5 Summary concerning Ethical Approval

Summing up, none of the answers to the questionnaire suggests that an FOT requires ethical approval by a certain institution. In France, the correct authority to contact in this context is the Comité Consultatif National d'Éthique (www.ccne-ethique.fr) whose approval is not

required but can be applied for – on the other hand a negative recommendation of an ethical approval does not hinder the execution of an FOT in France.

5.7 Special Licenses

Usually, FOT equipment at least requires data-recording equipment which will depend mostly on the vehicle's power supply. Moreover, additional equipment (displays, buttons, etc.) might be fitted to the dashboard, etc. On top of this, some equipment might even need to be attached to the vehicles CAN-BUS, the vehicles "Controller Area Network" which links the different electronic control units in a vehicle to each other. The additionally-fitted equipment would then be substantially engaged into the vehicles electronic architecture. Finally, even certain functions might be modified – such as additional speed limiting equipment, etc. That is why the question arises as to how far the vehicle-license may be affected. Furthermore, as far as the FOT covers so-called Cooperative Systems, the transfer of information may be based on wifi-technology. That is why the use of this radio frequency bandwidth for testing might be subject to exceptional licensing.

5.7.1 Spain

For the legal background in Spain the Spanish RACC summed up the situation as follows: According to section 47 of the General Regulation on Vehicles (Real Decreto 2822/1998, de 23 de diciembre, por el que se aprueba el Reglamento General de Vehículos), special permissions may be obtained for testing and extraordinary research trials conducted by vehicle manufacturers and public laboratories. In this regard, permission or authorization may be obtained to:

- Perform exceptional tests on highways, expressways and other roads, for which it is necessary to exceed the speed limitations established for each type of road. In such cases, the competent authority would establish the maximum speed permitted which may not exceed 30 kilometres per hour over the legally established limit which depends both on the specific road and the type of vehicle.
- Drive or use the vehicle with the devices and people needed for testing.

An application for each vehicle should be submitted to the Traffic Department (Dirección General de Tráfico), justifying the need for the requested permission. The Traffic Department, in view of the documentation provided and, if necessary, of a preliminary report drafted by the regional government (Comunidad autónoma), may authorize a modified vehicle. Authorization shall include the description of the testing, activities to be performed, itinerary, duration and other conditions to be developed. In addition to the license plates and permits, vehicles shall be identified with special signs or plates. This special permission only applies to vehicle manufacturers and public laboratories. Moreover, according to section 47.3 of the General Regulation on Vehicles, vehicles for testing purposes shall be driven by the holder of the permit or by one of its employees. In cases in which driving by other parties is required, the Traffic Department shall previously provide authorization.

In Spain, radio frequency bandwidths used for wireless networks and especially the Wi-Fi equipment are legally classified as shared-use or common-use frequencies. Characterization as a common-use frequency allows multiple operators or users to simultaneously use these frequencies, in accordance with the technical standards established by regulation to mitigate the potential for interference between emissions. Unlike other bandwidths in the radio spectrum, a license is not required to operate Wi-Fi technologies. However, the fact that it is

not necessary to obtain a license to operate does not mean that the use of these bandwidths is not subject to specific conditions. Technical regulations set out limits to radiations, and communication protocols may be used to ensure the common use of these frequencies of the radio spectrum without interferences. Most of these use conditions and limitations are established in regulations set by the Spanish Ministry of Industry regarding the use of public airwaves. In particular, the National Table of Frequency Allocations (Cuadro Nacional de Atribución de Frecuencia (CNAF)) lists the conditions of spectrum use, emission power and protocols to be used for each bandwidth. Limiting emission maximum power aims at balancing access-points' coverage and possible interference between providers. In the case of common-use bandwidths, maximum equivalent isotropic radiated power (EIRP) is limited to 100 mW (20 dBm) (Norm UN-85 of the CNAF). Norm UN-128 of the CNAF specifies conditions for using 5 GHz bandwidth for wi-fi networks. The maximum EIRP is limited to 200 mW between 5.15 and 5.360 GHz and 1 W in the bandwidth between 5.470 and 5.725 GHz, provided that power control techniques are implemented. Use of the bandwidth between 5.15 GHz and 5.25 GHz is limited to indoor installations. Licenses for spectrum use, when needed, have to be applied to the State Secretary for Telecommunications and Information Society (Secretaría de Estado de Telecomunicaciones y para la Sociedad de la Información (SETSI)). It is one of the departments included in the Ministerio de Industria, Turismo y Comercio (Contact details: C. Capitán Haya, 41 28046 , Madrid [Spain], Phones: (0034) 902 44 60 06 / (0034) 91 349 46 40).

5.7.2 Italy

The Italian ACI's answer to this point of the questionnaire declares that the Italian Highway Code does not provide for these kinds of vehicle licences, because this kind of vehicle should be considered as a prototype which requires a type approval (Ministry of Transport). There are no special driver's licenses in Italy with regard to driving a vehicle modified for an FOT.

Concerning the use of certain radio frequencies by so-called Cooperative Systems integrated in the test vehicles the ACI points to the Italian Authority for the Communications (www.agcom.it) which manages the respective regulations and the competitive tender for allocation of wave bands.

5.7.3 Netherlands

In the Netherlands, the Rijksdienst Wegverkeer (www.rdw.nl) is in charge of vehicle licenses. If a special driver's license is necessary the Centraal Bureau Rijvaardigheidsbewijzen (www.cbr.nl) is the organisation to issue driver's licenses.

The relevant legal regulation concerning the use of radio frequencies in the Netherlands is the Dutch Telecommunicatiewet. The authorities in charge of special licenses concerning radio frequencies and concerning the distribution of radio frequencies are the Dutch Ministry of Economic Affairs (Minister van Economische Zaken, Landbouw en Innovatie, www.rijksoverheid.nl/ministeries/eleni) and the Antennebureau (www.antennebureau.nl).

5.7.4 France

French law does not seem to require a special authorization in cases where the vehicle is slightly altered. Nevertheless, an authorization for the road use by the French Ministry of Transport is required if the vehicle is strongly modified. The DRIRE (Direction régionale de

l'Industrie, de la Recherche et de l'Environnement – national level) or the DREAL (Direction régionale de l'Environnement, de l'Aménagement et du Logement – regional level) are the administrative bodies to whom such a license would have to be applied for and who can provide the right to drive on public roads. With regard to driving the vehicles modified for an FOT no special driver's license is needed.

As far as the use of radio frequency bandwidth by so-called Cooperative Systems in the FOT test vehicles is concerned the French ACAFA points to the French authority for the communication (l'Autorité de Régulation des Communications Electroniques et des Postes, ARCEP, www.arcep.fr) to obtain the information if special licenses are required and what the relevant legal framework is in this respect.

5.7.5 Summary concerning Special Licenses

Concerning the question as to how far the vehicle-license is affected in cases where the vehicle is retrofitted with additional technical equipment for the FOT, the answers show remarkable peculiarities:

In Spain the Traffic Department may authorize a modified vehicle – authorization shall include the description of the testing, activities to be performed, itinerary, duration and other conditions to be developed. This special permission only applies to vehicle manufacturers and public laboratories. Moreover, vehicles for testing purposes shall be driven by the holder of the permit or by one of its employees. In cases in which driving by other parties is required, the Spanish Traffic Department shall previously provide authorization. In Italy vehicles modified for FOTs may be considered as a prototype which requires a type approval by the Italian Ministry of Transport; no special driver's licenses are stipulated. In the Netherlands the Rijkdienst Wegverkeer (www.rdw.nl) is in charge of vehicle licenses; the Centraal Bureau Rijvaardigheidsbewijzen (www.cbr.nl) is the competent authority in case a special driver's license is needed. Also in France, no special driver's licenses are needed; nevertheless, the vehicle requires an authorization for the road use by the French Ministry of Transport if the vehicle is strongly modified.

With regard to the question of how far the use of certain radio frequency bandwidths requires exceptional licensing the competent national institutions respectively authorities should be contacted beforehand.

5.8 Product Liability

Product liability law might also play a certain role in carrying out an FOT. This field of law has been harmonized throughout the EU up to a certain degree due to the Product Liability Directive 85/374/EEC; nevertheless national law may present certain peculiarities. That is why this aspect was also included in the legal questionnaire.

5.8.1 Spain

In Spain product liability is currently regulated in sections 135 to 149 of the Act for the Protection of Consumers and Users (Texto Refundido de la Ley General de Defensa de Consumidores y Usuarios, aprobado por Real Decreto-Legislativo 1/2007, de 16 de noviembre). These sections are a transposition to Spanish law of the Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products. The producer is held strictly liable for damage caused by a defect in a product. A product is deemed defective

when it does not provide the safety which a person is entitled to expect (consumer expectations test), taking all circumstances into account, including: (a) the presentation of the product; (b) the use to which it could reasonably be expected that the product would be put; and (c) the time when the product was put into circulation. Liability of the producer shall not be reduced when the damage is caused both by a defect in product and by the act or omission of a third party. However, in cases in which the damage is caused both by a defect in the product and by the fault of the injured person or any person for whom the injured person is responsible, liability of the producer may be reduced or even disallowed. According to section 140 of the Spanish Act, the producer shall not be liable if he proves:

- (a) that he did not put the product into circulation; or
- (b) that, taking into account the circumstances, it may be presumed that the defect did not exist at the time when the product was put into circulation; or
- (c) that the product was neither manufactured by him for sale or any form of distribution for economic purposes nor manufactured or distributed by him in the course of his professional or business activity; or
- (d) that the defect is due to compliance of the product with mandatory regulations; or
- (e) that the state of scientific and technical knowledge at the time when he put the product into circulation was not such as to enable the existence of the defect to be discovered. Besides, section 140.2 establishes that in the case of a manufacturer of a component, the producer shall not be liable if the defect is attributable to the design of the product in which the component has been fitted or to the instructions given by the manufacturer of the product. The producer's total liability for damage resulting from a death or personal injury and caused by identical items with the same defect is limited to € 63.106.270,96. In addition, a deductible of € 500 is established for damages to property.

It has to be pointed out that a prototype vehicle would not be considered a product for product liability law purposes in Spain. According to section 140 of the Spanish Act, the producer of a prototype vehicle shall not be liable if he may prove that the prototype was neither manufactured by him for sale or any form of distribution for economic purposes nor manufactured or distributed by him in the course of his professional or business activity.

Liability for damages caused by a prototype (system being tested within an FOT) would be governed by general tort or civil liability law. No requirements regarding prototypes in the field of product liability have been established in Spain. Compensation would include damages not covered by product liability rules but a negligence liability rule would apply. These two elements do not necessarily result in an increased risk of liability.

With regard to user instructions, three possible sources can be described regarding a producer's duty to instruct a user about the risks of a product:

I. Product liability law

A defective product is generally defined as a product that does not provide the safety which a consumer is entitled to expect. Spanish case-law usually distinguishes three kinds of product defects: a) manufacturing defects; b) design defects; and c) warning or information defects. The latter category would include those cases in which a product is considered to be defective because it does not contain warnings, instructions or labels that apprise the user in regard to the dangers or proper uses of the product.

II. Safety Regulation Law

Spanish Regulation on general product safety (Real Decreto 1801/2003, de 26 de diciembre, sobre seguridad general de los productos) is a transposition of Directive 2001/95/EC of the European Parliament and the Council of 3 December 2001 on general product safety. According to section 4.1 of the Regulation on general product safety, producers shall place only safe products on the market. According to section 4.2: "Within the limits of their respective activities, producers shall provide consumers and users with the relevant information to enable them to assess the risks inherent in a product throughout the normal or reasonably foreseeable period of its use, where such risks are not immediately obvious without adequate warnings, and to take precautions against those risks". Besides, producers shall:

- Adopt measures commensurate with the characteristics of the products which they supply, enabling them to be informed of risks which these products might pose.
- Immediately inform the competent authorities, on the basis of the information in their possession or their professional skills, that a product that they have placed on the market poses risks to the consumer incompatible with the general safety requirements.
- Take appropriate actions including warning consumers about the risks of a product and proceeding to the withdrawal from the market or to a recall from consumers.

III. Specific products or services regulations

Specific regulations may set forth other warning and instruction requirements.

Moreover, specific product regulations may define additional requirements for testing a prototype product in Spain.

5.8.2 Italy

All EU consumer protection legislation has been collected into a consolidated Act called "Consumer Code" in Italy (Legislative Decree n. 206, dated 6 September 2005 which came into force on 23 October 2005). It brings together and coordinates all existing consumer protection provisions, synthesising them into 146 articles (the number of articles has been increased to 170 since its 2007 update). The approval of the Consumer Code can be considered a milestone in the consumer protection field in Italy, especially for the importance that the new legislation acquires in terms of public policy law: consumer issues were previously covered by specific regulations that were adopted from time to time, without coordination, mostly to implement EU Directives. For the provision of Art. 114 "producers shall be liable for any damages caused by product defect".

In Italy, a prototype-vehicle will be considered a product in the sense of Italian product liability law. The Italian ACI could not answer if there is any specific regulation concerning specific requirements or additional respectively increased risks resulting from testing prototype systems in an FOT, but as for all tests, the persons involved have to be informed about the characteristics of the test, relative risk and they must give their consensus about the use of the prototype.

5.8.3 Netherlands

The respective legal framework concerning product liability claims against the vehicle manufacturer is laid down in the Burgerlijk Wetboek (Civil Code of the Netherlands) article 6:185 in the Netherlands. Concerning the question of whether a prototype-vehicle that is left to naïve subjects will be considered a product in the sense Dutch product liability law, the answer depends on whether or not the vehicle has been brought into circulation. The producer can be held liable for defective parts which are used in an FOT. The questions if there are any specific regulations in place as far as instructing the user of a product is concerned and if there are any specific requirements for the testing of prototype systems (apart from the rather general requirement following from product liability to instruct carefully on the system's limits and features) have been left unanswered for the Netherlands.

5.8.4 France

In France, manufacturer liability may be brought only on the defects of the vehicle untransformed. If the fault occurs on a transformation, only the liability of the transformer can be pursued. Possibilities of lawsuits are in the civil code, the code of consumption, and European standards. In France, prototypes can be considered as a product; national law considers that a vehicle, even if modified, is a product.

The question of which additional risks a vehicle manufacturer or supplier will face in France in cases of a prototype system is being tested within an FOT respectively if this can lead to an increased risk of product liability according to national product liability act or respectively to tort liability for product defects was answered as follows: Responsibility of the manufacturer or the organizer of the test may be pursued.

With regard to the question of whether any specific regulations are in place in France as far as instructing the user of a product is concerned, the French ACAFA answered that even if instructions are provided, the manufacturer or the organisation may be liable if a fault is committed; there is no specific legislation, only the principle of responsibility. ACAFA is not aware of specific obligations concerning testing of prototype systems; however, it is obvious that the subject must be aware of a maximum of information and must consent to participate in the tests.

5.8.5 Summary concerning Product Liability

With regard to product liability, the question of whether a prototype vehicle left to naïve subjects will be considered as a product in terms of product liability law was answered quite heterogeneously: In France, a prototype (including modified vehicles) can be considered as a product. The same also applies for Italy whereas in Spain a prototype vehicle would not be considered a product for product liability law purposes. In the Netherlands the vehicle seems to be considered as a product not earlier than when it has been brought into circulation.

5.9 Contractual Agreements

Generally, contractual agreements allow for freely chosen arrangements (freedom of contract). Nonetheless the questionnaire also aimed at finding out in how far certain limitations according to national law exist.

5.9.1 Spain

In Spain, freedom of contract is established in section 1255 of the Civil Code. According to this provision, parties to a contract can agree to any term except those that are contrary to

law, public policy and morality. Section 8 of the Spanish General Terms and Conditions Act (Ley 7/1998, de 13 de abril, de Condiciones Generales de la Contracción) establishes that general terms contrary to an imperative legal rule or to a legal prohibition which negatively affect the interests of the adherent party may be reputed null and void, unless the infringed imperative norm establishes an alternative legal consequence. In case of using general terms in consumer contracts, abusive terms and conditions would be considered null and void. Moreover, section 7 of the Spanish General Terms and Conditions Act provides that some general terms shall be considered not included in a contract. This happens when:

- I. The adherent party lacks any possibility whatsoever of effectively knowing the general terms when entering into the contract.
- II. The general terms were not signed by the adherent party when such signature was legally compulsory.
- III. The general terms are illegible, ambiguous or non-understandable.

Exclusion of liability that is negotiated and agreed by the parties to the contract is usually considered a result of freedom of contract and generally enforceable (section 1104 of the Civil Code). However, Spanish case-law and legal commentators resort to a common distinction between liability arising from negligence and liability arising from fraud or a crime. Exclusion of the latter is not permitted because it would involve infringing public policies.

Exclusion of liability arising from negligence is generally admitted except in consumer contracts. Section 86.2 of the Spanish Act for the Protection of Consumers and Users (Texto Refundido de la Ley General de Defensa de Consumidores y Usuarios, aprobado por Real Decreto-Legislativo 1/2007, de 16 de noviembre) states that a general term excluding or limiting liability for death and personal injuries is abusive and, consequently, to be considered null and void.

Limiting liability arising from negligence for property damages is governed by the same rules that apply to exclusion of liability.

5.9.2 Italy

Art. 1322 of the Italian Civil Code, entitled "freedom of contract", says that "the parties may freely determine the content of the contract within the limits imposed by law." In the second paragraph of that article legislature was concerned to clarify the full authority to conclude contracts also do not belong to types having a particular discipline, that does not fall into the category of so-called contracts "typical", as the rental, sale, etc. The only limit is clearly the purpose: contracts must still be directed to realize interests worthy of protection under the legal system.

According to the Italian ACI's answer, it is not possible for the test participants to consent to a full exclusion of liability.

5.9.3 Netherlands

The question of how far the freedom of contract is limited in the Netherlands has been left unanswered. According to the Dutch ANWB's answer it is not possible for the test participants to consent to a full exclusion of liability.

Moreover, the answer concerning the question of which other relevant aspects are needed to be dealt with in a contractual agreement according to Dutch law and jurisdiction for FOT's and NDS emphasizes the questions of whether participants get income or compensation of costs (then to be handled) or if they get an extra insurance.

5.9.4 France

Art. 1101 of the French Civil Code provides the principle of contractual freedom, i.e. anyone can contract with anyone and the principle is the freely agreed. The only limit is that the contract must not contain abusive clauses under the French legal framework.

Concerning the question of whether it is possible for the test participants to consent to a full exclusion of liability or if full exclusion of the liability risk is limited to property damages only, the French ACAFA answered that liability may be limited but that a full exclusion cannot be.

5.9.5 Summary concerning Contractual Agreements

Generally, the principle of freedom of contract underlies all contractual agreements in the legal systems of Spain, Italy, the Netherlands and France (as well as Germany). Nonetheless freedom of contract may be limited in some respects due to national law – at least one limitation seems to be in common: participants of an FOT cannot effectively agree to a full exclusion of liability by contracting with the FOT management (or any other person / institution responsible for the FOT). Moreover, there may be more limitations according to national laws, e.g. that a contract must not contain abusive clauses (French law). It might be presumed to be a common rule that contracts must be directed to realize interests worthy of protection under the legal system – the ACI answered so with regard to Italian law.

5.10 Other issues

Not many additional issues could be identified by the contributors to the questionnaire. Only the Dutch ANWB identified the issues that fiscal authorities can ask for data, too (in order to prove that a person was at a certain location, to prove income sources and to prove the amount of kilometres which are subject to tax).

Moreover, the ANWB criticized that the questionnaire did not cover questions on how the data will be protected, how long for and for which official target the files will be compiled. At this point, it has to be emphasized that these questions would have been out of the scope of the legal questionnaire developed within the FOT-Net 2 project: the questionnaire was meant to examine the different national legal frameworks that FOTs are facing and therefore was addressed to legal experts. It was not meant to define standards on how to protect data in an FOT.

5.11 References to the FESTA Handbook

In the aforementioned FESTA Handbook it was already pointed out that carrying out an FOT gives rise to a considerable number of legal and ethical issues (obtaining the necessary permissions, ensuring that the vehicles are safe to operate on the public highway, going through any required ethical and human subject review procedures, obtaining participants' consent, complying with data protection laws, insuring the vehicles, insuring the project workers for indemnity and so on). It was also mentioned that it is not possible to provide a comprehensive guide to all the legal issues that can arise in a particular FOT since these may be very dependent on the system(s) to be tested and on the study design adopted.

Moreover it was pointed out that those projects carrying out FOTs in more than one country or carrying out FOTs that potentially involve cross-border traffic may need to consider the legal implications in all relevant countries. The differences in laws and regulations between the countries were not addressed by the FESTA Handbook – as an example of what can arise on a national level, the view of a German lawyer was included there for consideration. The present document refers to the respective chapter 3 (Legal and Ethical Issues) and Annex A (Legal and ethical issues in the execution of FOTs – Worked Example) of the FESTA Handbook and gives additional information as far as the legal situation in Spain, Italy, the Netherlands and France is concerned.

5.11.1 Participant Agreement

The important issues to be formalized in a written participant agreement were already detailed in the FESTA Handbook (chapter 3.3). With regard to the findings based on the FOT-Net 2 project's legal questionnaire, it should be added that if including a clause aiming at excluding or limiting the FOT management's liability for damages inflicted on the participants, the respective wording in the agreement has to be chosen very carefully in order to avoid a possible legal ineffectiveness of such a clause. It has to be taken into account that this kind of liability most probably cannot completely be excluded (for example according to Spanish law a general term excluding or limiting liability for death and personal injuries is abusive and, consequently, to be considered null and void [the Section 86.2 of the Spanish Act for the Protection of Consumers and Users [Ley General de Defensa de Consumidores y Usuarios] – there is a similar provision in the German Civil Code [§ 309 No. 7 a BGB – Bürgerliches Gesetzbuch]).

5.11.2 Data Privacy (including Video Data Collection)

The FESTA Handbook (chapter 3.4) already pointed out that an FOT will give rise to data protection and privacy issues – also with regard to the collection of video data (chapter 3.9 of the FESTA Handbook). The compilation of the data privacy related answers to the respective questions in the questionnaire showed that all of the four countries' legal systems considered in the FOT-Net 2 project share the similarity of imposing a general ban on the recording of video data, location data and behavioural data (speed, indicator-usage etc.) as far as data is recorded that can be qualified as personal data, i.e. which can be referred to an individual person. Nevertheless, video data as well as location data and behavioural data may be recorded legally for the purposes of an FOT by adhering to certain procedures detailed above for the four EU Member States considered herein. Similarities and peculiarities in that respect are described in the respective chapter 3 (above).

5.11.3 Approval for On-road Use

With regard to an approval for on-road use of vehicles which are modified for the purposes of an FOT or retrofitted with additional equipment for an FOT the FESTA Handbook (chapter 3.7) emphasized that before it is certain that it is legal to operate a modified vehicle on public roads, a check must be made with the appropriate authorities. The present document provides more detailed information for Spain, Italy, the Netherlands and France in chapter 7 (above).

5.11.4 Insurance

Insurance issues which the FESTA Handbook (chapter 3.8) points to are substantiated in chapter 5 (above) and in the following section 11.6 of this chapter.

5.11.5 Ethical Approval

The FESTA Handbook (chapter 3.10) also mentions ethical approval procedures which might have to be conducted on national level before carrying out an FOT. None of the answers to the FOT-Net 2 project's questionnaire suggests a binding ethical approval procedure in Spain, Italy, the Netherlands or France in the context of an FOT.

5.11.6 Common findings as a basic level

Annex A of the FESTA Handbook includes a worked example on which legal issues will prove to be relevant in planning and carrying out an FOT. In consideration of the legal importance of details in test arrangements, the FESTA Handbook points out that it is vital to involve legal expertise from the country in question when planning an FOT. Even though the present document includes more detailed information on the specific legal background in several EU Member States this advice is still applicable: The overview given in this document cannot – and is not meant to – substitute legal advice in a particular case.

The guidance the FESTA Handbook gives concerning

- the information provided to test persons
- the information on system boundaries
- the information on possible malfunctions
- the information on data recording
- agreements on cost allocation and liabilities
- informing systems
- intervening, overrideable systems
- intervening, non-overrideable systems
- cooperative systems

do not have to be modified or completed based on the information which can be extracted from the answers to the legal questionnaire.

With regard to data privacy, it can be stated that all of the four EU Member States' legal systems considered in the FOT-Net 2 project provide for a general ban of recording of video data, location data and behavioural data (speed, indicator-usage etc.) as far as data is recorded that can be qualified as personal data, i.e. which can be referred to an individual person. Nevertheless, video data as well as location data and behavioural data may be recorded legally for the purposes of an FOT by adhering to certain procedures (detailed above in chapter 3 for the four EU Member States considered herein). The following similarities can be deduced (peculiarities in brackets):

- The recording of video data within the vehicle requires the consent of every passenger in the car – including the driver, of course. In case of minors respectively children the parents' / legal representatives' consent has to be obtained (in case of 14-year-old and

older minors in Spain only in some cases obligatory). The requirements concerning the consent differ (Netherlands and Spain: clear / unequivocal consent, France and Italy: written consent) – in favour of the burden of proof of having obtained the required consents it is advisable to obtain the consent in written form.

- As far as the vehicle's surroundings are subject to video recording it has to be made certain that other road users are not identifiable – e.g. by using a very low camera resolution.
- A car's registration number / number plate has to be considered as personal data (for Spain this does not refer to company-owned cars) in terms of data privacy law.

The aforementioned similarities can be considered as a common basic level in the field of data privacy. Nevertheless, still certain national peculiarities have to be accounted for: In Italy for example, activities taking place in public areas – such as video recording – must preventively be authorized (and can only be authorized for public reasons) by the public authority in charge of protection of these areas. Peculiarities with regard to German data privacy law have already been pointed out in the FESTA Handbook.

With regard to the implications of criminal law, the FESTA Handbook points out the results of the FOT-Net 2 project's legal questionnaire show that all of the legal systems considered herein share the similarity that the police or another public prosecution authority are authorized to confiscate the data recorded during an FOT in case of an accident. The FOT management as well as the FOT participants, i.e. the test users, should be (made) aware of this fact.

In the context of criminal law, the FESTA handbook emphasizes the principle that (based on the perspective of a German lawyer) a suspected person always has the right to remain silent in order to avoid self-incrimination i.e. that the accused is not obliged to cooperate actively in the own conviction: "nemo tenetur se ipsum accusare". The different answers to the legal questionnaire from the countries considered herein concerning this topic imply that the "nemo tenetur" principle is not perceived as an issue which may turn out to be a major obstacle to the execution of an FOT. Against this background it seems even more advisable to inform test participants by implementing a respective clause in the test participant agreement which describes the possibility that prosecution authorities might confiscate the recorded data in case of a traffic accident (or possibly even in case of an offence).

The FESTA Handbook's section concerning liabilities and insurance issues goes into some detail into the legal situation in Germany as far as road traffic liability and the associated insurance issues are concerned. The liabilities-/insurance-related questions in the FOT-Net 2 project's legal questionnaire brought up quite a variety of answers so that not too many common findings could be identified – of course there are similarities on the one hand – but the details may be quite different on the other hand. The following sections are meant to illustrate how similar, but also how different insurance issues may be with regard to national law.

It turned out as a common finding that vehicle third-party liability insurance is compulsory by law throughout the EU Member States in which respective information could be gathered. Nonetheless, there are slight differences in who is responsible for making the insurance contract – in Germany, the Netherlands and Italy it is the vehicle's registered keeper (who in Italy has to be the owner at the same time) whereas in France it can either be the owner or

the keeper; in Spain it may be the owner or another person having an interest in insuring third-party liability.

Another common finding is that – generally speaking – third-party insurance covers damages to the other passengers in the car causing the accident (this does not apply to Spain in case of a robbery, neither does this apply to Italy in case of a fortuitous event; in the Netherlands this does not apply if the driver cannot be held liable).

In Spain, Italy and the Netherlands the third-party liability insurance will not cover the risk of an injury of the driver/test-user or damage to his/her property – this cover would require a specific insurance (voluntary first-party cover / comprehensive motor insurance cover). In contrast to that, in France third-party insurance covers the risk of an injury of the driver or damage to his/her property if the driver is not liable for the accident.

In Spain, France and the Netherlands it depends on the insurance contract if liability is excluded or limited in case the vehicle is used for testing purposes – on the other hand, in Italy there usually is no such contractual exclusion or limitation of liability because this kind of insurance is compulsory by law and only covers the use permitted by law (Italian Highway Code and Criminal Code).

Technical equipment the FOT vehicles are retrofitted with (e.g. computers for data collection) can be included in comprehensive coverage insurances in Spain, France, Italy and the Netherlands if specified in the insurance contract.

Further insurance issues (risk of a personal injury of the driver or of the passengers – if not covered by the vehicle third-party insurance) depend very much on the precise – voluntary – insurance contract which should be negotiable between the FOT management and the insurance company.

With regard to the question of how far vehicle-licenses are affected in the case the vehicles are retrofitted with additional technical equipment for the FOT the answers show remarkable peculiarities which make it difficult to draw conclusions in terms of common findings. Considering the question in how far the use of certain radio frequency bandwidths requires exceptional licensing the competent national institutions respectively authorities should be contacted beforehand.

The FESTA Handbook outlined the importance of the 1968 Vienna Convention on Road Traffic which formulates a minimum set of requirements in purpose of free (and safe) flow of cross-border transport between the signatory states. The Convention has had strong influence on the development of national Road Traffic codes and the all-underlying idea of full control of a human driver has thus found its way into many legal provisions concerning road traffic in Germany as well as other countries throughout the EU (and worldwide) – these findings are common for the EU at large and must be taken into consideration, in case a system shall be evaluated in an FOT that overrules full control of the driver (cp. the respective considerations in the FESTA Handbook).

With regard to product liability, the crucial common finding resulting from the legal survey described herein is that product liability law has been harmonized throughout the EU due to the 1985 Product Liability Directive (85/374/EEC). On the other hand the application of the respective national laws which transposed the Directive can largely differ since a prototype vehicle may in some states be seen as a product in terms of national product liability law, in some states not. The respective question was answered quite heterogeneously: In France, a

prototype (including modified vehicles) can be considered as a product. The same also applies for Italy whereas in Spain a prototype vehicle would not be considered a product for product liability law purposes. In the Netherlands the vehicle seems to be considered as a product not earlier than when it has been brought into circulation.

The crucial common finding with regard to contractual agreements is as general as it is for product liability: Generally, the principle of freedom of contract underlies all contractual agreements in the legal systems of Spain, Italy, the Netherlands and France as well as Germany. However, freedom of contract may be limited in some respects due to national law – at least one limitation seems to be in common: participants of an FOT cannot effectively agree to a full exclusion of liability by contracting with the FOT management (or any other person / institution responsible for the FOT). Moreover, there may be more limitations according to national laws, e.g. that a contract must not contain abusive clauses (French law). It might be presumed to be a common rule that contracts must be directed to realize interests worthy of protection under the legal system.

5.12 Conclusions

The evaluation of the legal questionnaire developed in the FOT-Net 2 project and the compilation of the present document showed that – despite several common findings which are applicable for all EU Member States considered herein, there are still remarkable peculiarities concerning the legal framework relevant for FOTs on the national levels. These peculiarities may on the one hand be rooted in the historical development of the several legal systems in the different EU Member States since not all of the national regulations have been harmonized so far, of course. On the other hand, these peculiarities are rooted in the fact that even if and as far as law has been harmonized, law is applied on the national level. Often national courts decide on how a certain law has to be interpreted which does not have to be homogeneous throughout the EU.

As already stated in the FESTA Handbook, prohibitive difficulties neither from a legal nor from an ethical point of view are in so far to be expected. As long as the advice provided in the FESTA Handbook and the present document is considered, potential risks – as far as presently foreseeable – can be addressed adequately. However, it will remain highly advisable to seek for further support on legal and ethical issues within the concrete FOT – this is, last but not least, also due to the fact that law, like many other disciplines, is not static, but is constantly evolving.

6 WG 4: Impact Assessment and Scaling Up

6.1 Introduction

The results of the EU project FESTA⁷ include an explanation on how to carry out impact assessment and scaling up in a Field Operational Test (FOT). In the last few years, European and national FOTs have used the FESTA methodology. Experiences from these projects in carrying out their impact assessment and scaling up work are bundled in the FOT-Net Working Group on impact assessment and scaling up, with the goal to improve the FESTA Handbook⁸ using these experiences. The working group has 24 members.. Main activities from the working group in 2011, 2012 and 2013 have been the following:

- Identification of working items from FOTs and related projects
- Inventory of approaches in impact assessment and scaling up related to the working items
- One-on-one interviews with experts from the WG
- Identification of best practices, issues, gaps in knowledge and recommendations for future work during round table in Vienna (ITS World Congress 2012)
- Making concrete recommendations for changes in the FESTA Handbook

This intermediate report is the result of the activities in the WG and contains a list of topics that the working group has worked on, including an explanation of the topic and an indication of the foreseen improvement in the FESTA Handbook. The topics are:

1. Piloting
2. Participant selection and experimental set-up
3. Safety impact assessment
4. Data issues
5. Scaling up
6. Integration of results

After the topics are described, other conclusions from the workshop and interviews are described.

This intermediate report gives as much as possible concrete recommendations for the update of the FESTA Handbook. The update of the FESTA Handbook (current version is version 4) is prepared in October/November 2013, amongst others in a workshop in

⁷ Field opErational teSt supportT Action, funded by the European Commission DG Information Society and Media in the 7th Framework Programme.

⁸ FESTA Handbook Version 4, 30 September 2011, from <http://www.fot-net.eu/en/library/deliverables/> (2011 – D3.1).

November 2013 where all WGs came together. The FESTA update is to be finalized in January 2014.

6.2 Topics and proposed changes to FESTA

6.2.1 Piloting

6.2.1.1 Pilot whole data flow

In an FOT, piloting is carried out to test whether you can answer your research questions in the end. It is important that piloting is not only technical piloting, but that the whole data flow and processing is tested, until and including impact assessment. It is also important to involve all partners in the project in piloting. Usually the original plan is to check everything (from data collection to data evaluation) but due to time constraints, often piloting the impact assessment is not done or it is done when the FOT already starts and changes are not possible anymore.

Proposed FESTA update: stress importance that whole data chain is piloted (textual change, no major change).

- Relevant section: Section 6.4 Conducting a pilot study to test the evaluation process

This relevant section in the FESTA Handbook is actually quite good, it does describe the whole data chain in piloting (including testing the evaluation process) and it does say that piloting costs a lot of time and is important. It even says that the time needed for piloting is often underestimated. So the problem is not the Handbook, but the fact that in practice piloting is often shorter and not the whole chain is tested. A change in the Handbook does not seem necessary. Some small changes are suggested to point 3 on in Section 6.4:

3. The third level consists of *testing the feasibility of the overall evaluation process* from the selection of the participants through to data collection and evaluation. It is a kind of final rehearsal before the deployment of the FOT. It enables in particular a check of the communication process between the various teams involved in the practical deployment of the FOT, of the robustness of the technical tools designed for data collection and transmission and of the robustness of the evaluation tools used in the assessment.

- Chapter 9 “Data Analysis and modelling” also mentions piloting halfway section 9.1.

Some specific actions are required to tackle the difficulties mentioned above and to ensure the quality and robustness of the data analysis:

1. A pilot study is a prerequisite to check the feasibility of the chain of data collection **and evaluation** and to achieve a pre-evaluation of the usefulness of the system.

- Also add to the FOTIP Activity 17

17.1 Develop protocol for pilot testing FOT equipment, methods, procedures, evaluation tools and materials (including training, briefing materials and data collection, downloading and analysis procedures)

17.4 Fine tune FOT platforms and technologies, systems, procedures, evaluation tools and protocols, as required, on the basis of the pilot data yielded.

6.2.1.2 Pilot yourself

A good practice from one of the FOTs (TeleFOT) from people working on subjective data collection and analysis is to pilot yourself. Drive in an FOT vehicle, answer the questionnaires, fill in the travel diaries, etc. In this way you can test whether what you ask from the FOT participants is realistic.

Proposed FESTA update: new text. The handbook does not address this issue now.

- Relevant section: Section 6.4 “Conducting a pilot study to test the evaluation process”. Add to step 2.

To test whether what you ask from participants is realistic, it is a good idea to pilot yourself before letting ‘real’ participants undergo the testing. Let someone (or several persons) from the project team drive in an FOT vehicle, answer the questionnaires, fill in the travel diaries, etc. This is especially relevant for people working on subjective data collection and analysis.

- Also add to the FOTIP Activity 17

Add a new task:

Pilot yourself: drive in an FOT vehicle, answer the questionnaires, fill in the travel diaries, etc.

Responsible: Project Manager, Research team

6.2.1.3 Feedback loops

In the FESTA-V feedback loops from piloting should be made explicit, as well as making clear that there should be enough time for piloting and the FOT should allow for contingency time. Experience from projects is that there will always arise problems that have to be solved before the FOT starts. Some projects (TeleFOT, euroFOT) had an FOT that lasted a few months, but that even turned out to be too short.

Proposed FESTA update: add feedback loops from piloting and put emphasis on the length of piloting (textual change)

- Last paragraph at the end of the Section 6.4 mentions the possible need to redo some steps (page 68).

The result of the pilot can be a no-go if too many problems are still present. In this case it could be reasonable to delay the start of the data collection phase and to repeat some earlier steps. This means that there are feedback loops in the piloting process.

6.2.2 Participant selection and experimental set-up

6.2.2.1 Seasonal effects

Seasonal effects can really cause problems for explaining the effects that are found (and whether they are caused by the system under test, seasonal effects, or other circumstances). There are ways in which to (partly) deal with this: have a control group, or adjust the length of the test. The latter can mean that you either have a short time period for your FOT, so that baseline and treatment phase take place in the same season, or that you have a very long FOT (for example a year), so that baseline and treatment phase include the same seasons.

FESTA update: add some information on seasonal effects and the trouble they can cause, make recommendations (textual change, no major change)

- Relevant section: Section 6.3.6 Time of day and seasonal effects. It is explained what is meant with seasonal effects and that it has impact on planning and data analysis. What could be stressed more is the impact it has on the result.

Temporal factors such as time of day, and seasonal effects have a considerable impact on the planning of FOTs, and the analysis of data. They can cause problems in explaining the effects that are found (e.g. whether they are caused by the system under test or by seasonal circumstances). In contrast to the weather effects outlined above, the temporal factors can usually be predicted, and so it is usually easier to deal with the issues successfully. The main issues that have to do with the time of day, week, and seasonal variations are:

- ...

Time of day and seasonal effects are different to weather issues in several ways, including:

- Time of day and seasonal effects are much more predictable than weather conditions
- They are often proxies – i.e. not important in themselves, but important because they result in variation of a factor of interest (e.g. traffic levels, or level of the sun above the horizon)

These two factors mean that a greater emphasis should be placed on planning around relatively predictable time of day and seasonal effects, and considering their impact on the FOT. There are different ways to (partly) deal with seasonal effects: have a control group (between subjects design), or adjust the length of the test. The latter means that you either have a short time period for your FOT, so that baseline and treatment phase take place in the same season, or that you have a very long FOT (more than a year), so that baseline and treatment phase include the same seasons.

6.2.2.2 Baseline and treatment period

In quite some FOTs the treatment period is longer than the baseline period. It is debatable whether this is the most robust choice (of course this depends on the type of system and FOT). Why not have a baseline period with the same length as the treatment period?

FESTA update:

- Relevant section: In the Handbook there seems not to be any text on the length of the FOT, length of the baseline and treatment period in the handbook. Suggestion is to add new text at the end of Section 6.2.2.

Baseline and treatment period

The baseline period is often squeezed in the project and is quite short, especially in relation to the treatment period. Ideally, the two would have equal lengths so that there is the opportunity in the baseline period for the same variations to occur that may occur in the treatment phase (such as seasonal effects, see 6.3.6). The more data available the more robust the results are.

6.2.2.3 Sampling

When the experimental set-up is designed, sampling has to be put into the variability. Enough data have to be collected where there is uncertainty. In Chapter 6 of the FESTA Handbook the topic of participants and sampling is handled. Ideally a statistical expert should check specifically on this topic and update the text, or add a new section with an overall look on how to deal with all the (confounding) variables and choice of samples. This is not done within FOT-Net 2.

6.2.3 Safety impact assessment

Safety effects can be split in two types of effects: a change in exposure (e.g. decrease in mileage and therefore a change in number of accidents) and a change in driving behaviour. With regard to changes in driving behaviour, there are gaps in knowledge for safety impact assessment: the relation between measures and (number of) accidents is not known. At the moment different approaches are used, for example:

- Qualitative / expert judgment (looking at the data, e.g. surrogate safety measures, at previous studies, etc.)
- Speed (variance) – accident relationships: there are different relations – models – for different road types, see Table 13 in:
<http://webarchive.nationalarchives.gov.uk/20110304132839/http://cfit.independent.gov.uk/pubs/2008/isa/index.htm>
- eIMPACT method
- Event based analysis
- Risk matrix approach (developed in euroFOT) – for one isolated accident type (rear-end collision) and based on assumptions

All these methods are not perfect and not usable in all situations. Experiences from projects are that a methodology is really missing. That is not something we will solve in this WG. It is a big question what the link between surrogate safety measures and accidents is. A lot of

research is needed for this. Do all the stakeholders want to make this link? Can everyone agree on the set of assumptions?

In the end it is about the relative change (e.g. how much percent of the accidents can be prevented because of a certain system, compared to driving without this system).

Other ways to gain insight in changes in safety are for example looking at the frequency of events (e.g. hard braking) and speed violations. Common definitions of events would be helpful; this is discussed in the Working Group on Events and Incident Definition. From a policy point of view events are better usable than TTC, increase of mean speed, etc.

FESTA update:

In the FESTA update the section on Safety impact assessment (Section 10.3.1) has been thoroughly revised. It is explained in what situations (or for which systems) the different safety impact assessment methods are suitable and the text is updated. The new text is clearer about the difficulty to calculate changes in number of accidents (fatalities and injuries) – managing expectations – and about the different approaches. Deliverable 2.6 of FESTA does not really contain more information than is in the handbook; it is mainly about the Mack FOT (which was carried out more than five years ago).

****In the following a copy of the proposed new version of section 10.3.1 of the FESTA Handbook is reported. Since there are a lot of changes from Handbook rev.4, the changes are not indicated here ****

Safety benefits

The most direct and easiest way to calculate safety benefits would be to compare the number of accidents (and their consequences) happening during the baseline and treatment phase in an FOT. However, usually not enough accidents happen in an FOT to make this approach feasible. Therefore other methods have to be used. Traffic safety is regarded as a multiplication of three factors, namely exposure, accident risk and injury risk (Nilsson, 2004). The assessment of safety impacts has to consider these three effects which can be combined to predict the overall safety benefit, while taking driving conditions into consideration as well. Strategic decisions are highly relevant for exposure, and driving behaviour (on tactical and operational level) is relevant for accident and injury risk. A change in exposure can be measured in the FOT directly: do people drive more or less with the system, do they drive on other road types, do they choose other routes? A change in mileage has a direct effect on exposure so on the number of accidents. Translating a change in driving behaviour into accident and injury risk is less straightforward. There are gaps in knowledge: the relation between changes in driving behaviour and (number of) accidents is often not known. Therefore there is not one method that is recommended to use. In this section a number of approaches to calculate the safety benefits of ITS applications are mentioned, with a (brief) explanation, references and information about in what situations they can be used:

- **Speed (variance) – accident relationships**

Speed has a close relation to safety. The speed of a vehicle will influence not only the likelihood of a crash occurring, but will also be a critical factor in determining the severity of a crash outcome. This double risk factor is unique for speed. The relationship between speed and safety can be estimated by various models such as the Power Model (Nilsson, 2004; Elvik et al, 2004), that estimates the effects of

changes in mean speed on traffic crashes and the severity of those crashes. The Power Model suggests that a 5% increase in mean speed leads to approximately a 10% increase in crashes involving injuries and a 20% increase in those involving fatalities. More examples of models for speed-safety relationships are reviewed in Aarts and van Schagen (2006). In the ISA UK project this is elaborated, different relations (models) for different road types can for example be found in Table 13 in <http://webarchive.nationalarchives.gov.uk/20110304132839/http://cfit.independent.gov.uk/pubs/2008/isa/index.htm>.

The Power Model is valid under the assumption that mean speed is the only factor that has changed. Therefore these models are more suitable for FOTs with systems mainly dealing with speed, and even then they fail to consider changes in the distribution of speed (shape of the speed distribution and changes in speed variance). The model is not suitable for systems that for example influence lateral behaviour.

- You can make it as complicated as you want. Is 70% following the advice, or is it actually 100% in case of a good advice, and 30% in case of a bad advice?
- When time is short, simulations are usually shortened. More simple, less detailed on incorporating driving behaviour.
- Integration of traffic simulation results with the other results is difficult. There is always something to criticize on simulation.

- **Event based analysis**

Crashes are very rare events, thus there is a strong interest and need for the use of crash surrogates or “crash-substitute” events. The basic idea is that less severe events can be used instead of crashes to estimate safety benefits because there is a systematic and well-understood relationship with crashes. Event based analysis (EBA) uses events to estimate safety benefits. The basic principle of EBA is to identify short driving segments (typically in the order of 5-10 seconds), during which the risk of crashing is judged to be higher compared to other driving in the data set, and then to analyse these events further. These events are often referred to as Crash Relevant Events (CRE), since their occurrence is thought to be indicative of actual crash risk in one way or another.

EBA can be used for functions that warn for a certain event (e.g. FCW), not for functions that work continuously.

More information on event based analysis can be found in WG2: Events and Incident Definition.

- **eIMPACT method**

The eIMPACT method was used in the eIMPACT project for the safety assessment of in-vehicle safety systems (IVSS). The complete methodology can be found in (Wilmink et al., 2008). In short it works as follows. Effects of IVSS on traffic safety may appear in many, both intended and unintended ways. It is not possible to define in advance the group of accidents affected by the system, although system developers

typically have as a starting point a target group of accidents for a system. Therefore, it is highly important that the analysis of IVSS covers all possible effects in a systematic manner. The approach was based on the system nature of transport. When one element of the system is affected, the consequences may appear in several elements and levels of the system, both immediately and in the long term, due to behavioural modification. Road safety is regarded as a multiplication of three orthogonal factors: (1) exposure, (2) risk of a collision to take place during a trip and (3) risk of a collision to result in injuries or death. In the analyses, the three main factors of traffic safety were covered by nine behavioural mechanisms as first described in (Draskóczy et al., 1998). Five mechanisms are mainly connected to the accident risk, three mechanisms deal with exposure, and there is one mechanism that deals with changes in accident consequences.

Every mechanism may result in either positive or negative impacts on road safety. In summary, the analyses aims to cover not only the direct intended effects of systems but also the indirect and unintended effects, including behavioural adaptation in long term use. In addition, it was taken into consideration that the effects will vary according to road conditions and circumstances. This should ensure that all effects on safety are covered by the analyses.

The starting point for the safety impact assessment were the system specifications, including detailed safety function definitions. Figure 10.2 (see Figure 3) presents an overview of the phases in the analysis. An important part of the analysis is the use of accident data. For further details the reader is referred to (Wilmink et al., 2008).

Overview of safety impact assessments

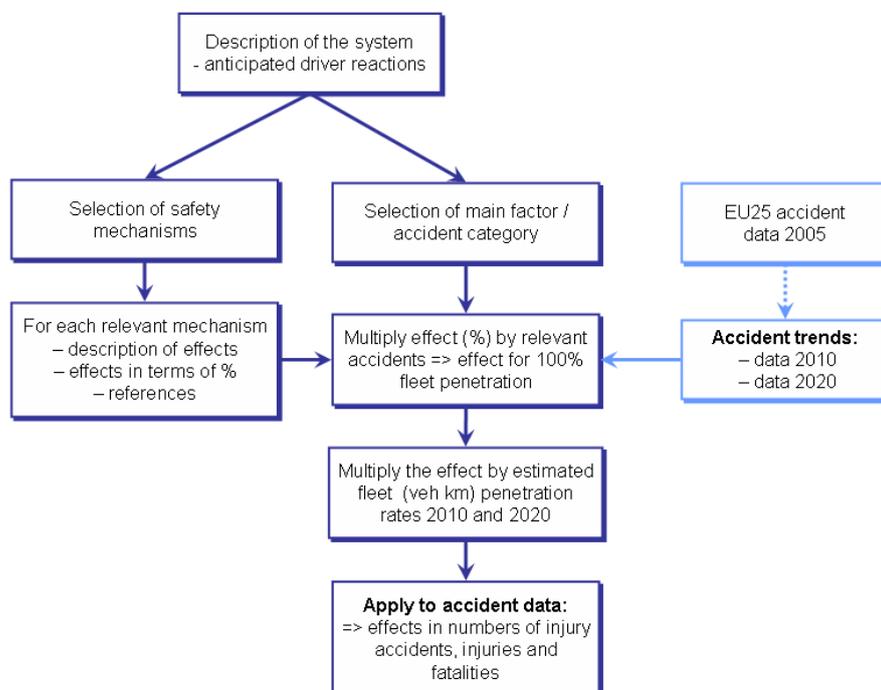


Figure 3: An overall schematic picture of the safety impact assessment in eIMPACT

- **Risk matrix approach**

The risk matrix approach (RMA) was developed in the euroFOT project. Details about the method can be found in (Van Noort et al., 2012). The RMA is developed for systems that function continuously (e.g. ACC) and that address an isolated accident type (e.g. rear-end collisions). The RMA associates a risk to each data point, by assuming a hypothetical accident scenario, developing from this data point. Separately there is a risk calculation from FOT data. Risks are pre-calculated once, and the application of FOT data is quite simple. This method is a variant of a method developed by NHTSA (Najm et al., 2006). The RMA does not rely on video data and is usable without in-depth accident statistics.

- **Expert judgment**

This 'method' can be used when quantitative methods (as described above) do not work for some reason, or in addition to it. Expert judgment usually produces qualitative results. Expert judgment can be done in different ways, for example by organizing a workshop, or by having experts fill in a questionnaire. Expert judgment should be based on the data that are available from the FOT (surrogate safety measures e.g. speed, speed variance, headways) but also from previous studies.

The methods mentioned above are not perfect nor applicable in all situations (for all functions, all types of FOTs). In the end one wants to know the relative change (e.g. how much percent of the accidents can be prevented because of a certain system, compared to driving without this system). Other ways to gain insight in changes in safety are for example looking at the frequency of certain events (e.g. hard braking) and speed violations. More on the definition of events can be found in WG2. From a policy point of view events are better usable than TTC, increase of mean speed, etc.

In the end, independent of the method one chooses, it is important to clearly write down the assumptions that were being made and the consequences of these assumptions. When there is a lot of insecurity in the safety impact assessment, an option is to work with a bandwidth and not deliver one fixed number as a result, but a range. A sensitivity analysis can also help with this.

As an example and representing best practice, the [Mack FOT](#) puts the goals of the safety analysis as follows:

1. Determine if driving conflict and crash probabilities will be reduced for drivers using the system,
2. Determine if drivers drive more safely using the system,
3. Determine reduction in crashes, injuries, fatalities if all fleets operating in the observed area were equipped with the system,
4. Determine if drivers using the system have less severe crashes than drivers without the system.

The first step collects sensor data from each vehicle within the FOT (e.g. brake force, steering angle). Based on earlier definitions the number of driving conflicts can be determined. Thus, two numbers for the driving conflicts – reflecting the with and the without case – are available to calculate the exposure ratio. This ratio reflects the number of driving conflicts in the with case compared to the without case. To provide an example: given a system which maintains the safe distance to a predecessor vehicle, the number of driving conflicts due to close following will be reduced from 10 conflicts per 1000 km to 5 conflicts per 1000 km. Thus, the exposure ratio equals 0.5 which indicates that driving with the system is safer than without the system. In general, an exposure ratio below 1 indicates a safety benefit.

The benefit of lower exposure to accident risk will likely be modified based on adaptations of individual behaviour due to psychological reasons (second step). Behavioural adaptations can comprise e.g. adapting the following distance, adapting the speed variance, adapting the lane change behaviour (risky cut-ins or changing the lane without signalling it in advance). Examples for such behavioural changes can be found in the ITS safety mechanisms ([eIMPACT](#)). In this project, nine mechanisms have been introduced which lead to positive or negative safety effects. In most cases, the motivation for behavioural adaptation is that the driver wants to avoid “public” warnings (noticeable to all passengers) and “education” by the system.

The third step deals with scaling up from the FOT to a wider area (EU, country, region). This process is subject to the procedure proposed in scaling up.

The last step leads to the prevention ratio. In-depth information on accidents is used to calculate the mitigation effects of using the system. Maybe the system cannot avoid the accident but it can mitigate the accident consequences. This issue has to be considered in determining the effects for casualties. For systems affecting speed, the Power Model can be applied to calculate changes in severity.

Combining steps 2 to 4, it is possible to calculate the prevention ratio. For this ratio the probability of having a crash (casualty) when having a driving conflict in the with case is compared to the same probability in the without case. In the above example the number of driving conflicts in the with case was 5 and 10 in the without case. Let us assume that out of the 5 driving conflicts 1 accident occurs and out of the 10 driving conflicts 3 accidents occur. Thus, the probability of having an accident due to a driving conflict is 0.2 in the with case and 0.3 in the without case. These values reflect the prevention ratios.

*** End of copy of section 10.3.1 ***

6.2.4 Data issues

6.2.4.1 Explanatory data

To explain effects that were observed during the FOT (e.g. changes in travel times), explanatory variables (such as surroundings) are very important. The most ideal case is to collect the following data:

- Video data; video processing takes a lot of time so this should be automated as much as possible

- Questionnaires & travel diaries (at certain points during the test), e.g. on multimodal travelling to do mobility analyses – these should be as easy as possible to fill in, using predefined answers, checkboxes
- Data on surroundings (such as surrounding vehicles – headways – and traffic state)
- Meta data; description of data and tests for evaluation, such as who drove the vehicle, which functions were studied in a particular test drive, circumstances when driving, other functions in the vehicle, date and time of the test, etc.
- Audio data; e.g. to give test drivers the options to tell what happened and what their experiences are, to make it as easy as possible for them – voice memo
- Logging of the function (system state, e.g. on/off, what information is presented to the driver)

However, collecting all these data is costly and makes the analyses time-consuming. A possible solution is to collect in-depth data for part of the FOT. This was done in TeleFOT.

FESTA update: the need for explanatory data is explained in the FESTA handbook so not much new text is needed (only the suggestion to collect in-depth data for part of the FOT) (textual change, not major)

- Relevant section: Section 5.3.5 “Situational Variables” (new text):

Data on Situational Variables are essential to collect, since this explanatory data helps to explain the effects that were observed in the FOT. Ideally a lot of in-depth data is collected, such as:

- Video data (video processing takes a lot of time so this should be automated as much as possible)
- Questionnaires & travel diaries (at certain points during the test)
- Data on surroundings (such as surrounding vehicles – headways – and traffic state)
- Meta data; description of data and tests for evaluation, such as who drove the vehicle, which functions were studied in a particular test drive, circumstances when driving, other functions in the vehicle, date and time of the test, etc.
- Audio data; e.g. to give test drivers the options to tell what happened and what their experiences are, to make it as easy as possible for them – eg using a voice memo
- Logging of the function (system state, e.g. on/off, what information is presented to the driver)

However, collecting all these data is costly and makes the analyses time-consuming. A possible solution is to collect in-depth data for part of the FOT (e.g. for part of the vehicles).

6.2.4.2 Alternative sources for data

When data needs are written down, including the way in which they will be measured, it is good to identify alternative sources for data measurement and provide parallel back-up systems (possibly with lower accuracy), so there are fall-back options and the FOT does not rely on single data collection.

In the FESTA Handbook, all possible sources of data are mentioned in the D2.1 sensors sheet. What could be added to FESTA is the planning for alternative sources/fall-back options, and identification of 'must have' data and 'nice to have' data. Possibly less detailed data are needed in some situations. This is also taken up in WG1 Data Analysis. A suggestion for new text from this WG is (not included in FESTA update):

Besides having a good data plan with a list of measures and indicators and specified how they will be measured, it is recommendable to identify alternative data sources for the most important measures, and to have parallel back-up systems (possibly with lower accuracy), so there are fallback options and the FOT does not rely on single data collection. In order to do this, it is useful to identify 'must have' data and 'nice to have' data. Possibly less detailed data are needed in some situations.

6.2.5 Scaling up

With scaling up we mean the translation of small scale traffic effects (e.g. for a city or region, or even a road stretch) to large scale societal benefits (e.g. for country or EU). Different scenarios can be used for scaling up, for example with different penetration rates and future years (these scenarios also have to be used then in the impact assessment). The results of scaling up sometimes feed into a cost-benefit analysis.

6.2.5.1 Sampling

For scaling up, the sample that was chosen for the FOT is very important. Getting a representative sample of the whole population (probability sampling, perfect sample) is impossible. However, it is okay to have an imperfect sample (non-probability sampling), as long as you know the limitations of your sample. When scaling up, keep it conservative but do not be afraid to draw conclusions. FESTA could help here by saying something on how imperfect the sample can be, and by clarifying the limitations of the study.

FESTA update: new text on this topic (new text)

- Relevant section: Section 9.4
- Something should be added to this section about imperfect sampling, representativeness and limitations of the sample. We have to look for sources that say something on where the variability is (e.g. male vs. female, age, education). Then in the FESTA handbook we can give some sort of advice on what the most important aspects are in the sample population.

For scaling up, the sample that is chosen for the FOT is very important. For example, if the FOT was carried out with mainly male participants between the age of 25 and 45, the results can in principle not be extrapolated directly to the whole population of drivers. Getting a representative sample of the whole population is impossible. However, it is okay to have an imperfect sample, as long as you know the limitations of your sample and describe this in your end results. It is still desirable to try to have a sample as representative as possible (gender and age are important).

6.2.5.2 Scaling up methods

At present scaling up is done in a direct (rough) way: for example in euroFOT this was done via an extrapolation of effects experienced on different road types (and traffic state – congestion vs. free flow, cars vs. trucks) to a yearly mileage driven on these road types in the EU. In ISA UK it was also done by using the proportion (by vehicle kilometres) of road for certain speed limits. Can more be done? There is not yet an approach ready to use. Time is also a problem (since scaling up is usually done at the end of a project), as well as the availability of external data (for example on EU level). Policy makers want concrete statements, but it is difficult to meet their needs. A possible solution could be to keep it more as a ‘discursive’ analysis in terms of trends, and not to over quantify it.

FESTA update: new text on scaling up (new text)

- Relevant section: New Section 9.4.1 “Scaling up methods”. In the older version of the Handbook some examples (but not a method) were provided in Section 9.5 and in Section 9.6 the representativeness of the FOT participants for the overall population is explained, direct and indirect methods, traffic efficiency scaling up using micro simulation (so not to country or even EU scale) and safety assessment. There is no information about the use of situational variables in scaling up as was done in euroFOT (see next bullet).
- At the moment, FESTA does not provide any method for doing scaling up (except for the first step of going from FOT data to network level assessment in Section 9.6), and this should be added (more in the form of best practices than a method). For example the method that was used in euroFOT and ISA UK can be added. Something about the use of situational variables should be added as well (maybe also something about priorities). And the use of external data (and where that data can be found).

Suggestion is to add some text on scaling up, based on how it was done in euroFOT. This method is also explained in the following paper, together with an approach using a macroscopic model: D. Mans, E. Jonkers, I. Giannelos, D. Palanciuc, *Scaling up methodology for CO₂ emissions of ICT applications in traffic and transport in Europe*, ITS Europe congress in Dublin, 2013.

This paper is specific about scaling up CO₂ emissions, but the method is in principle the same for scaling up other indicators.

*** Copy of section 9.4.1 from the FESTA Handbook – this is a completely new section ***

In the Amitran project work has been done on scaling up (methodology and data collection). More information about this can be found in (Mans et al., 2013).

There are two methods of scaling up that can be used. The first method is a direct method, using statistical data information. The second method is performed through modelling using a macroscopic (multimodal) traffic model on EU 27 level. The choice of scaling up method is based, among others, on the availability of models and the type of effects expected.

Scaling up using statistics

The scaling up method using statistics, initiates from the impacts on CO₂ emissions at a local level as distinguished for different situations (such as traffic state, vehicle type, etc.), coming from the FOT. In case it is not possible to directly use the local effects of the system to scale up with the use of appropriate statistical datasets, then the use of models (e.g. microscopic traffic models) is necessary to transpose this impact to a more appropriate format for scaling up. The definition of situations depends on:

- the system characteristics
- the situational variables that are expected to have the largest impact (e.g. a night vision system will only be active during driving in the dark)
- the possibility of measuring the different situations and the model capabilities.

Data for the same situations is needed on the large scale level that is targeted. Then, the impact on a local scale are scaled up using statistical data (for example on kilometres driven for the different road types) under the specific situations.

Scaling up using statistics is applicable when interaction and second-order effects (i.e. latent demand induced by the improvement of the service level, caused by a system) can be expected to be insignificant, or when there is a clear effect at certain traffic situations for which data on higher level are available, or even at the mere event that no appropriate macroscopic model is available to perform the model-based methodology. A drawback of this method is that data sets need to be available for the countries one wants to scale up to. At present there is very limited measurement data for some countries in Europe plus, a (software) tool for this approach does not exist yet. The Amitran project is collecting statistics for scaling up from various European countries in a knowledge base. This knowledge base will be made public around Summer/Autumn of 2014.

Scaling up using a macroscopic (multimodal) traffic model

The network of a macroscopic (multimodal) traffic model determines the level on which the results are calculated. Ideally the model is available on country or EU level. Scaling up using such a model can be done in two different ways:

The calculation of the impact is done with a model other than the macroscopic traffic model. The local effects of the system are in this case determined (e.g. via a microscopic simulation tool). These effects can be used as input for the macroscopic model on country/EU level. One run is performed for deriving the direct effect to a larger scale.

The calculation of the impact is performed directly with a macroscopic traffic model. In this case, should the model be at the required level (country/EU), the direct effect of the system is calculated. This can be done performing a run of the macroscopic model. A limitation to this approach is that microscopic effects of ITS cannot be taken into account, e.g. changes in driver behaviour. Therefore it can only be used to determine the effects of ITS that mainly affect macroscopic mechanisms in the network, such as mode or route change.

Optionally (for both cases), the economic effect can be calculated with an appropriate model. Then a second run is performed with the macroscopic model to account for the second order effect.

Scaling up using a macroscopic model is a good method to apply when second-order effects are expected and/or when the effects of the ITS system can be used directly as an input parameter for the macroscopic model. Also, this method can be used only if such a large-scale model is available. Being a more elaborate method than scaling up using statistics, it allows taking into account specific circumstantial differences especially if there are interaction effects. A downside of scaling up with a macroscopic traffic model is that urban roads are usually not part of the network on such a large scale, and also, that it requires more effort than scaling up using statistics.

Limitations of scaling up

The methods described above explain how scaling up can be applied theoretically. In practice, scaling up is a big challenge. It is important to consider the goal one wants to achieve. Scaling up is not a goal on itself, but is rather a means to answer a certain question or to achieve a certain result.

*** *End of text about scaling up* ***

6.2.6 Integration of results

6.2.6.1 Integration between impact areas

The integration between impact areas (insights on usage, surroundings, links between safety and efficiency results, etc.) is often missing, due to time constraints. Both euroFOT and TeleFOT have worked on a template for the harmonization of results. An example of such a template should be filled in so that the person filling in the template knows the level of detail that is expected. Ideally there are two versions available – one ‘management’ version for the main document and one detailed one for the annex with technical details etc., and for internal reports or underlying deliverables.

For the experts it is important also to include insights discovered during the analysis, even if not always statistically confirmed.

FESTA update: add text about the integration of analyses (new text)

- Relevant section: Section 10.3 Analysis of impacts (new section 10.3.4)
- In Section 10.3 it is described (quite briefly) for the separate impact areas how the impact assessment is carried out. At the end of this chapter a section on the integration of results should be added. Also the templates for harmonization of results should be shown in an easy to comprehend and clear overview. Add the statement that insights discovered during the analysis should be written down as well.

Integration of results

FOTs should make sure that there is enough time for the integration of results. At the end of the analysis phase, there are results for traffic efficiency, behaviour, safety, environment, acceptance, etc. This has to result in overall conclusions about a system, where the different impact areas are interwoven. However, this requires sitting together with the experts, and having time to let the results 'sink in'. Often this time is not available.

It is recommended to make a template for the reporting of results early on (for both external and internal reports), so researchers know what is expected from them. Reporting in a clear and systematic way helps with the integration of results and the overall view on the effects of the system.

It is very useful to make room for analysts to add insights discovered during the analysis phase (internal reports). It is a pity if these lessons should be lost as they could prove highly valuable to future FOTs

6.2.6.2 Involvement of analysts

Analysts (including analysts well familiar with statistics) should be involved from the beginning of the project and work together with people collecting the data, setting up the tests, etc., to improve the integration of results later in the project. This is also taken up in WG1 Data Analysis. It could be highlighted more in the FOTIP. At the moment no change is made in the Handbook.

6.2.7 Other conclusions from workshop and interviews

This section contains some 'loose' remarks and comments which do not belong to the topics mentioned above.

6.2.7.1 Managing expectations

With regard to safety impact assessment, the expectations of policy makers have to be managed. Coming up with numbers of accidents, fatalities and injuries that can be prevented by certain ITS applications is very hard and will not always be possible. The same holds for the topics of scaling up and debundling effects.

FESTA update: add some text about managing expectations in the handbook (textual change, not major)

- Relevant section: Chapter 10 (new text)

Managing expectations

It should also be considered that policy makers expect concrete results from an FOT, such as a reduction in number of accidents caused by a system, and scaled up costs and benefits (on a European level). This is often promised in project proposals. However, these are results that are very difficult to get and there are various reasons why the FOT does not deliver these results in the end (or at least not with the completeness that policy makers desire). Managing expectations is important, throughout the project.

6.2.7.2 Debundling

With debundling we mean disentangling the effects of bundled functions (functions tested at the same time, together in the car or on the road). In debundling the analysts are dependent on the experimental set-up; analysts can only analyse what is tested. This means if a bundle is tested, only the entity of the bundle can be analysed, and if one function of the bundle should be tested, it can be only analysed by conducting a separate test on the specific function.

The relevant section is Section 4.1.4 Combinations of functions. The text in that section is quite good as it is, so it is decided not to change it.

6.2.7.3 Structure of Chapters 9 and 10

The structure used in Chapters 9 and 10 and the headings used are not always clear. This is improved in the update of the FESTA Handbook.

6.2.7.4 Other issues

This section contains a list of other issues. They are not taken into account in the update of the FESTA Handbook in FOT-Net 2.

- In euroFOT and TeleFOT the FESTA methodology was not followed very strictly. Not because they had something against the methodology, problem was that it was not detailed enough. It describes the main steps, but does not specify in detail how an FOT should be conducted. FESTA was used as a basis, and it was partly adapted.
- euroFOT has a methodology deliverable which could be used for the revision of FESTA. Some things that they did are not specific for euroFOT so could be reported in a general form.
- euroFOT has an advice from the analysis point of view: put enough time in developing the methodology for impact assessment. There is no standardized methodology, and in the end the results are as good as the methodology and assumptions are.
- Timing: impact assessment is at the end of the FOT, and it deals with all the problems caused in other parts of the projects, and with the delays. In most cases time for data analysis and impact assessment is reduced. All FOT projects say they had too little time in the end.
- Difficulties in traffic efficiency impact assessment:

- There can be different results on different parts of the network (e.g. road types). How can this be taken into account in the best way using one indicator (speed, travel time, amount of congestion, delay)?
- What assumptions to use in case of simulation? Would it help to make a set of assumptions that FOTs should take into account (such as penetration rates, advice on network choice, traffic volumes, ...). This is something we have not discussed further in the WG, so do not have a suggestion right now for the FESTA handbook.
- Mobility impact assessment: TeleFOT has done a lot of work in this and developed a new theoretical model. This could be included in FESTA.

Impact assessment depends on a lot of things that happen earlier in the project, such as experimental set-up, participant selection, data measurement, piloting and bundling of systems.

7 WG 5: Data Sharing

7.1 Introduction

During the past 15 years, we have seen a fast growth in the number of Field Operational Tests (FOTs) and Naturalistic Driving Study (NDS) that have been performed worldwide. The need to better understand the causal factors behind incidents and accidents together with the availability of technology with cheap enough storage capabilities and sensors have been the main driving forces for the development of the methodology from the start.

The data which has mainly been collected through naturalistic driving by volunteer drivers have been used to answer the research questions in the original project. The size of the datasets varies, from below 1TB to several PB, mainly depending on if the data is collected continuously and if it includes video.

The largest datasets have so far been collected in the US (e.g. IVBSS, SHRP2 and on-going DriveCAM and Safety Pilot) and in Europe (e.g. euroFOT, DriveC2X and on-going UDRIVE). In Japan, large data sets based on event recorders have been collected and Australia has several interesting datasets. It is especially interesting that data collection also have started in Korea and China, as the traffic environment and traffic culture is so different from other countries.

As the number of different datasets has increased and so also the awareness of the substantial effort and funding needed to do these FOT/NDS, the interest in data sharing has become more and more in focus worldwide. Data Sharing (including Big Data and Open Data) was also a key theme arising from the latest ITS Congress 2013 in Tokyo. Numerous presentations addressed the issues on all kind of data, not only from FOT/NDS, but the key problems were the same; who should provide the data and how?

Most of the earlier projects focused on learning the FOT/NDS methodology and to answer the research questions set out by the project. That was a major achievement in itself. There was an unawareness of the requirements for data sharing after the project. Many projects do not therefore have the necessary pre-requisites in place in the consortium agreement and the consent form to be able to share the data, at least not outside the former project partners. Due to lack of time and funding, much data is not documented to a proper level which further hampers its re-use. Also, if tools are developed in the project, they are often tailor-made, to suit the needs of the project and the tool requirement sheet did not include the view of a non-partner user. The awareness has increased regarding the personal data and the need for data protection and security measures. And finally, many projects did not discuss the nature of a data sharing procedure and how to approve and assist new projects in re-using the data.

There are different views on the value of data sharing depending on if you are a data provider or a data user. The owner of the data has spent large amount of effort (and usually also their own funding) to collect data and build up the data infrastructure and tools. It is also an extra effort to provide data, especially if there is no basic funding for keeping the data up and running. It is therefore important to find win-win situations between the data provider and data user in further re-use of the data, to compensate the effort done to provide easily accessible data. This would also increase the number of data providers who are interested in opening up their datasets.

Apart from the more general possibilities to share, there are different constraints that could make it difficult to open up datasets. The legal and ethical requirements in each country, where an organisation is involved in either data collection and storing or analysis of the data, will have an impact on the data sharing conditions. As mentioned earlier, the content in the consortium agreement and the consent forms signed by the participant might not have had data sharing in focus when they were written and could make data sharing impossible after the project. Also the availability of funding, both for the new research project as well as for the data provider can set considerable constraints of the re-use of the data.

Still, there are several advantages to share collected data, where some of them are pointed out in section 7.2 “Why data sharing and re-use of data?”

This report is based on information collected during the last three years within the FOT-Net 2 activities, at various conferences and through discussions with people from the US, the EU, Japan, Australia and China. During three FOT-Net workshops in conjunction with ITS World Congress 2010, 2012 and 2013, data sharing has been a topic for a separate session, where the participants from different countries all over the world openly shared their experience from FOT/NDS. During the CS Coordination day 25/05/2012, the seminar on Complementarity of different FOTs and re-use of data 26/11/2012 and the meeting on Lessons learned from Pilots on Cooperative Systems 26/02/2013, the sessions on data sharing gave valuable input to the report. On several occasions, representatives from the EC participated actively in the discussions and expressed their views and expectations as a funding organisation.

Different conferences such as the SHRP2 Safety Research Symposiums 14/07/2011, 12/07/2012, 11/07/2013 and VTTI conference 28-29/08/2012 in the US, the ITS World Congress 14-18/10/2013 and the Fast Zero symposium 22-26/9/2013 in Japan and the DDI conferences 5-7/09/2011 and 4-6/09/2013 in Sweden have all given input to the report. During these seminars and conferences and also on other occasions, separate discussions outside the sessions and workshops with different people have given in-depth knowledge of their views on data sharing.

The foundation of the suggested platform comes from hands-on experience and discussions in many different projects, such as SeMiFOT, euroFOT, DriveC2X, SHRP2 and UDRIVE.

7.2 Why data sharing and re-use of data?

Performing an FOT/NDS demands considerable amount of time and effort. Sharing the data after the project also requires devoted persons to bring the data and tools to a level, where they are easily understandable for someone not having participated in the project. To stimulate more data providers to take this step, it is essential to understand the possible benefits of sharing the data.

The data provider is usually, at least up until now, also performing research and the chances of getting additional funding to do further analysis is probably the factor that gives the highest motivation to provide data for data sharing. By opening up the access to the dataset, a larger variety of possible research projects would be suggested and the possibility of additional research funding is increased.

The original project usually only performs a small part of the possible research that could be done on the collected dataset. From a funding organisations point of view, utilising the already collected datasets for further analysis is an efficient return on investment. Also for

project partners, knowing the data, it is also a good payback on invested efforts, to be able to further explore the data. During this second phase of data use, the funding organisation could require that additional partners are brought in, to open up the use of the data.

Due to the amount of data available from different parts of the world, meta-analysis cross FOTs and NDSs could provide a more quality assured result compared to drawing the conclusions from a single dataset.

Using global datasets for research on the comparisons of specific groups in different contexts and countries, e.g. older drivers, could provide insights in cultural differences in traffic behaviour for the specific group.

If funding for additional research is conditioned by international collaborations and data sharing, the global research community will be strengthened, as the flow of ideas and knowledge will be enhanced.

Research collaborations create trust between organisations and promote thereby an increase in the willingness to share data.

7.3 Content of a common data sharing platform

The availability of a common data sharing platform, where projects are set up in a similar manner with the data sharing pre-requisites integrated into the project agreements from the start and using procedures/templates with the same content, will highly facilitate a larger use of the collected FOT/NDS data. The researchers setting up new FOT/NDS do not need to go through the content of yet another special framework for a specific project, but can focus on the project specific questions such as research questions and study design. Also, researchers wanting to re-use already collected datasets or maybe several different datasets in the same research, can utilise a more or less standard application procedure, rely on already done training that are widely accepted and plan for the costs that using a specific dataset might cause the project.

In the following section, the suggested content of such a platform will be described. On an overall level, the following seven areas need to be addressed by a data sharing platform:

- Project agreements, such as the grant agreement together with the description of the work, the consortium agreement, the participant agreement and external data provider agreements set the pre-requisites and the borders for data sharing together with legal and ethical constraints.
- The availability of valid data and meta data, including a “standard” description of the documentation of the data, e.g. standard format and the related attributes (sampling frequency, accuracy,).
- Data protection requirements both on the data provider and the analysis site, including security procedures.
- Security and personal integrity education for all personnel involved.
- Support and research functions, to facilitate the start-up of projects and also e.g. offer processed data for researchers not so familiar with FOT/NDS data. The support also includes the availability of analysis tools.

- Financial models to provide funding for the data to be maintained and available and access services.
- Last, but not least application procedures including content of application form and data sharing agreement.

Another way of describing the common data sharing platform is by its content of documents.

Table 7: Data sharing platform documents and content

Document type	Content
Procedures	Application and approval, support/research functions, data extraction and download
Templates	Application form, Data description, Consent form, Data sharing agreements, Data sharing text for Consortium Agreements, Data security presentation, Approved training certificate Financial models, Data protection implementation, Data extraction request, NDA for analysts/visitors, Application to ethical review board, Description of content to be funded
Standards	Data protection - data provider/analysis site, Data extraction format, Data and metadata description, Level of security education

Generally, the data itself could be either managed by the project itself or by an external data provider. A central data provider could also just provide test samples of the different datasets and guide the interested researchers to the organization hosting the complete data set. The general recommendation however, is to let one or more project partner(s) from the original project maintain the data, possibly with test samples as described above, as analysis of the datasets in most cases require a deeper knowledge of the data and the way it was collected.

7.3.1 Data sharing in project documents

The initial process of setting up a project is crucial to the possibilities to share data during and after the project. Agreements can of course always be renegotiated, but the time and money consumed could be substantial, especially in large consortia, as the partners have entered the consortia on the conditions stated in the agreements, and alterations could lead to reconsiderations. The project agreements cover many different topics, but just a few of them are related to data sharing. Therefore, the time spent during the project application and in the beginning of the project, to agree on the conditions for data access and use including data re-use after the project, are well invested.

The main documents to focus on are the grant agreement, if the project has external funding, including the description of the work, the consortium agreement among the project partners, the participant agreement and potential agreements with external data providers to the project.

7.3.1.1 Grant Agreement – Description of Work

In the grant agreement and the description of the work, the result of the project and the funding is agreed upon. It is important to be aware of the topics and issues to be discussed in relation to data sharing and re-use of data and to focus them during the project application and also during a possible negotiation phase. It is especially important to pay attention to the possibilities to provide open data after the project, based on the scope of the project and the data to be collected.

The description of the work could include most of the topics listed in 7.3.1.2. One topic that is especially important to address during the project application phase towards the granting organisation, are the possibilities for post-project funding and other conditions for keeping the data available for data sharing after the project, if there is such a requirement on the project.

7.3.1.2 Consortium Agreement

The consortium agreement is the most important document next to the consent forms in 7.3.1.3, in setting the conditions and requirements for data sharing and re-use of the data. Numerous topics need to be discussed and decided to set a legal platform for the handling of the data during and after the project. The following table provides guidance to the topics to be handled in the consortium agreement.

Table 8: Data sharing topics within the consortium agreement

Topic	Comments
Ownership and access to data and data tools	<p>Will all partners own all data/part of the data? How could it be used and on what conditions? May the data be licensed to third parties? Will all partners have access to all/part of the data? May third parties have access to the data and on what conditions? Constraints due to personal data, especially video? Are there future agreements with data providers to take into account? Who will own the data tools and on what conditions are they licensed during and after the project? How can data be re-used if the data is owned by one partner and that partner cease as company?</p>
Storage and download of data	<p>Where will the data be stored, centrally or distributed? What are the requirements on data protection and how are they assured? Shall all data/part of the data be downloadable for all partners and if so, under which conditions? Shall all data/part of the data be downloadable for third parties and if so, under which conditions? Is there a time limit to request data for download?</p>
Access methods	<p>Shall a specific access procedure be used and by whom? How will the data be accessed? Can it be remotely accessed, downloaded or only accessed</p>

	<p>at the premises of any partner? What are the requirements on data protection for partners/third parties analysing the data?</p>
Areas of use	<p>Shall it be possible to use the data for both research and commercial purposes? Are there special conditions for the commercial use? In which research/commercial areas could the data be used? (i.e. safety, mobility etc.)</p>
Post-project re-use of data	<p>Which partner is responsible for maintaining the data after the project? Shall a non-partner be the data provider of the project data during/after the end of the project? Which application procedure shall be used? Who will grant access to data after the project? Are there conditions, such as legal and ethical constraints and availability of funding for data storage and access services to be considered?</p>
Post-project financing	<p>How will the storage and support services for data re-use be financed after the project? How will this funding be distributed?</p>

7.3.1.3 Participant Agreements including consent forms

The participant agreement explains the project to the participant and it is vital that the participant understands the use of the data during and after the project. From a data sharing standpoint, it is especially important to describe

- What data is collected?
- Where will the data be stored and who is responsible for the data?
- Who are the project partners?
- Who (project partners/third parties) will have access to what data and on which conditions?
- How are the access procedures (overview description)?
- The possibility to consent to the three topics described as YES/NO options below, directly related to data sharing.

As the participants allow the project to follow the participant's private life for a period usually from a few weeks up to a year, it is important to be very clear on the use of the data. A recommendation is to have the participant make an active consent to the most vital topics for data sharing. Common consent needs for data sharing are the following topics, where an example text is provided for European conditions;

I hereby agree to participate in the above described research study. I consent to have the material transferred and shared with research partners in a third country (e.g. country outside EES)

Yes No

I also consent to have video recordings or pictures being published or shown in public events (e.g. research reports or conferences)

Yes No

I also consent to have collected data (including video recordings and pictures) to be reused in other research projects focusing on factors regarding:

- *The driver (e.g. drowsiness, distraction, driving style) and/or*
- *Vehicle behaviour (e.g. fuel consumption, system activation) and/or*
- *Environmental factors (e.g. road geometry, weather conditions)and/or*
- *...*

Yes No

7.3.1.4 External data provider agreements

External data providers could be companies providing sensor systems, map data, weather data or other services that the project needs to enhance the data set. Non-disclosure agreements and contracts should be signed and it is important to be aware of the topics that can affect future research, due to possible restrictions in data use. Attention from a data sharing perspective should be given to the following topics.

- What is regarded as confidential information?
- If data is regarded as confidential information, could it be changed/aggregated, to allow for more open access?
- Can the data be accessed by another project partner/third party?
- Can the data be transferred to another project partner/third party?
- Are there special conditions for what the data could be used for?
- Are there special conditions for sharing and re-using the data after the project?
- What happens if the external data provider is bought by another company?

7.3.2 Valid Data - Descriptions of data and metadata

The core of data sharing is that the data provided is valid or at least are documented to a level where an assessment of the level of validity could be performed. This is potentially problematic if one has not been part of the project and does not know the way the tests were performed in detail, which sensor/version was used or how the data was processed from raw data. The main problem is usually that the data itself is not sufficiently described.

The FOT/NDS data is often referred to as the data that is actually collected during the tests including questionnaires and interview data. To be able to answer almost any research question, a vast number of other data is needed. In 7.3.2.1, an overview of data types are provided, which may/may not be part of a projects complete dataset. In 7.3.2.2, a list of items needed to describe project measures, is provided.

7.3.2.1 Collected data to share

There are different ways of describing the collected data. One is to cluster the data by the same category of data or ownership. The category usually determines the level of protection, see 7.3.3.1, whereas the ownership is more related to the readiness to share the data. If a data type already is jointly owned, it is easier to share it with a wider research community.

Table 9: Data classification

Data type	Data category	Ownership
Questionnaires- and interview data	Personal	Jointly
Video	Personal	Jointly
GPS	Personal	Jointly
Vehicle mounted sensors (eyetracker, lanetracker, radar, etc)	Sensor	Jointly/supplier
V2V and V2I data including "activity" data	System/sensor	Jointly
Enhancing data – road attributes, weather	Infrastructure/sensor	Jointly/supplier
"Open" and aggregated CAN-data	System/sensor	Jointly
Closed CAN-data	System/sensor	OEM

An overview of the variety of possible data to be collected and later shared is seen in the table below.

Table 10: Data that can be collected and shared

Data	Specification
Measures	Measures pre-processed and derived from the data collected.
Processed data	Data that has been produced using available data in order to enrich the data set; derived measures, events, locations, situations, performance indicators.
Positional data	GPS positions related to measures and processed data.
Geographical attributes	Data properties attributed to geographical locations. The data is retrieved using GPS positions and can include properties such as traffic situation, speed limits, road information, weather conditions, etc.
Video	Video data collected from cameras covering both exterior and interior environment.
Annotated data	Data produced by annotators.
Questionnaires and interview data	Questionnaires and interview data (with potentially personal data) answered by the participants during the study.
Communication data	Data from monitoring the V2V or V2I communication, e.g. latency.
Participant meta data	Meta data on drivers; driver profile, selected information from questionnaires. De-identified.
Non-participant meta data	Meta data on drivers not selected for participation. De-identified. This data is used for exposure analysis.
Participant consent data	Selected consent form data for participant. May include information on usage restrictions, consent withdrawal, etc.
Vehicle meta data	Meta data on vehicles where data is collected. De-identified.
Test meta data	Meta data on the performed FOT/NDS, such as study design, location, test period etc.
Annotation meta data	Information about the code book, the book stating how the annotators should code the different events.
Created data	New data created by analysts; either private, shared with analyst group, or shared with analysts in organisation.

7.3.2.2 Description of Data and Metadata

One of the most important factors to make a FOT/NDS dataset that can be reused is the simplicity in which the data set can be understood. The collected data need to be described in such a manner, that a person from a research discipline not familiar with this kind of data would be able to understand the data and any issue related to it. At the same time, it needs to be described in such depth that it is possible to verify that/if the data is good enough to be used for specific research, e.g. 1) if the quality of the collected signals are good enough, or 2) if there is video without disruptions accompanying all interesting trips.

Most projects use internal project-specific descriptions and description formats of the collected data. A few have been based on concepts used in earlier projects, but then often somewhat extended or modified. The latter is mainly the case when an organisation is doing an FOT/NDS for the second time and wants to re-use tools, database structures etc. As most projects use their own description of the data, it might take a large effort to re-describe the different, already collected datasets in a common format, and be even harder to re-use available tools with a new dataset.

If the data collected in the project shows a large variability in quality or consists of data collected through separate FOTs not using the same data format, the description of the metadata is even more important. For the individuals involved in data collection and analysis in a specific project (i.e. the projects partners) the metadata is implicit during and shortly after a project, as they have performed the project and for them, the description of the collected data feels more urgent. For the organisations attempting to re-use the data however, the need for description is often the other way around. The metadata is essential to know if the dataset could even be used for the new research purpose. Metadata on a higher level include information about the experimental protocol used, the subjects and vehicle collecting the data, and video annotations in the form of the code book which states the rules which the annotators had to follow etc. At a lower (more detailed) level the metadata involves all information that describes how the data was collected, how it was derived and what other properties it has (e.g. resolution, frequency, resampling and smoothing strategies, details of algorithms and even how quality metrics were calculated).

At the end of the project, usually the last resources are used for the analysis, which means that there is little possibility to do a thorough job of documenting the data and metadata, especially not through the eyes of a re-user of the data. It is therefore important to do the documentation early on in the project.

The attempt to standardize the formats and content of descriptions of the data and metadata presented in section 7.3.2.1 is a larger effort, and has therefore not been targeted in the work done by the working group on Data Sharing. This is thought to be an important next step, as this standardization task could provide a platform for e.g.

- a harmonized interface for analysis tools reading both data and metadata, making it possible to use the same tools for different datasets (even if the data itself may be different),
- a standard description of the data at a data broker with different datasets available to new data users, and a simplified process for projects when describing their data, i.e. for new projects to state the fulfilment of the data and metadata description as a goal and deliverable of the project.

- a suggestion for a minimum requirements in terms of data characteristics (e.g. sampling frequency, accuracy, delay, age) in order to ensure a reasonable confidence that the data set can be really useful to future project. This standard should take into account technological evolution and consequent more demanding characteristics in the future.

It is important that any description format can handle data protection appropriately. Preferably data description formats should provide a way to describe different layers (or tiers) of processing on top of the originally collected data. That is, to go from several measured metrics to a derived measure using these metrics may include several layers of processing i.e. resampling, filtering and merging algorithms. Metadata description formats should allow for descriptions of all these layers/tiers. Care should be taken to keep units and other metadata consistent through the tiers.

Finally, it is important that data from all projects can be read in a “raw” and clearly described format directly from the data storage source (e.g. database or file storage) regardless of what analysis tools are used in a project (with appropriate access restrictions). That is, both within a project and after it finishes (re-use of data), there are many different types of analyst who will need and want to access the data in different ways. At lowest level the users should be able to get data and metadata in as “raw” data as possible from the data source. Any tool can and should build on these formats and users that require graphical user interfaces can then use those formats, while other users would develop analysis based on direct data access without such graphical interfaces. Examples of different ways to analyse data are:

- to use as close to original data as possible and do on-the-fly processing of all or most derived measures events etc., or
- to calculate all derived measures and events and push them back into the database (or whatever storage is use), and then to apply a more simple set of algorithms.

For the first method, the core is a set of validated functions or algorithms that are consecutively applied for each analysis, while for the latter the derived measures and events pushed back into the database is the core. Data description formats and data formats will have to deal with both approached to be acceptable and used by as large community as possible. Preferably the data formats should be the same across projects, but at least the data description and metadata formats should be the same (as described above).

7.3.3 Data protection

Data protection is the key to create the trust needed between the data provider and the researcher to make the data owners provide access to their data. If the data provider knows that the researchers have good, proven procedures in place to keep control of who is accessing the data and that the researchers have knowledge in the legislation surrounding the handling of personal and IPR data, the more data they are willing to share.

There are different levels of research co-operations, which demands different levels of protection. The example where the data is collected and used within the same organisation is not considered here as the data is not shared externally. As soon as the data is shared between two organisations, the reasoning below becomes valid. How is the data going to be accessed between the partners? Should each partner have a data set? How can the data be transferred? Which demands on the physical/logical access must be in place? etc.

The data could be downloaded via a website, transferred on hard drives to the research organisation, remotely accessed at the data provider or only be accessed from the premises of the data provider. Each method has its own implications and it is usually the data type that has a large impact on the conditions for which method that is used.

In this section, the demands on data protection for different kind of data will be discussed. The section 7.3.3.2 includes a suggestion for requirements on data protection both at the Data Centres (DC) and at the Analysis Sites (AS), to facilitate the set-up of the necessary framework, to prevent unauthorized access to the collected data.

7.3.3.1 Data protection level depending on data type

The data protection level needed depends on the harm the revealed data could do. There are especially two categories of data that need protection, personal data and data that, if revealed, could potentially harm a commercial company. The provision of the latter data to projects is usually accompanied by agreements, stating the conditions for access and use.

Personal data that needs protection

The European Directive 95/46/EC Art. 2 contains a definition of the term “personal data”:

‘Personal data’ shall mean any information relating to an identified or identifiable natural person (‘data subject’); an identifiable person is one who can be identified, directly or indirectly, in particular by reference to an identification number or to one or more factors specific to his physical, physiological, mental, economic, cultural or social identity.

And also defines specifically sensitive personal data in Art. 10:

“1. Member States shall prohibit the processing of personal data revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, trade-union membership, and the processing of data concerning health or sex life.

2. Paragraph 1 shall not apply where:

(a) the data subject has given his explicit consent to the processing of those data, except where the laws of the Member State provide that the prohibition referred to in paragraph 1 may not be lifted by the data subject's giving his consent”

The personal data is therefore divided in two categories, sensitive personal data and more general personal data. The suggested data protection requirements stated in 7.3.3.2 have the aim to guide the data centres and the analysis sites towards setting up a data protection concept that would guard the will of the participants as stated in the consent form. As the FOT/NDS data often is collected including video and GPS, special precautions might be needed if the participants have given their consent to the collection of sensitive data, to guard the anonymity of the sensitive data. These precautions might exceed the requirements in 7.3.3.2.

Commercial data that needs protection

There are several different kinds of commercial data that might need protection. When signing contracts for provision of such data, it is advisable to discuss the foreseen protection level, so that both parties could agree on a suitable level of protection.

Several things affect the protection level. A way to categorise the commercial data could be:

Table 11: Categorisation of commercial data

Data Category	Access	Ownership
Open	Open for all analysts/all project partners/certain project partners	Owned by all/part of the project consortium
Closed	Open to all project partners/certain project partners during the project. Available on a per project approval by the owner.	Data provider
Proprietary	Data is never shared, as the commercial value of the data is too high for data sharing.	Data provider

The closed data could be made more open via the agreement, through aggregating the signal to a higher level, thus avoiding any commercially harmful misuse.

7.3.3.2 Data protection at Data Centres and Analysis Sites

Two sets of requirements are suggested below, one for the Data Centre (DC) and one for the Analysis Site (AS). Related documents to both the DC and the AS are listed. Depending on the data type involved in the data sharing, the needed level of protection will vary. The data protection recommendation is related to a data set including both video and proprietary sensor data. If the data to be shared is anonymised, several of the requirements are not applicable.

Data Centres (DC)

List of data protection requirements

- DC1: Data stored and processed at a DC must be protected from unauthorized access.**
Servers, computing environment (also physical), and network connections must be protected using measures sufficient to prohibit access to unauthorized parties.
- DC2: Data stored and handled at a DC must be protected from accidental deletion or corruption.**
Sufficient backup and disaster recovery solutions must be in place, and also protected from unauthorized access.
- DC3: The DC must document its data protection implementation.**
The data protection implementation description must be documented and it is recommended that it should be presented by the DC to the AS.
- DC4: Confidentiality agreements for any involved personnel must be in place.**
The DC must require signed confidentiality agreements with all involved personnel before they start handling the FOT/NDS data. Agreements can be either specific for the project (for guest researchers, students, etc.) or implicit through means of employment contracts.

DC5: Data protection must be ensured by the DC after end of project.

The data must be stored and protected at the DC after the end of the project, to facilitate data re-use and sharing after the project.

DC6: Data sent between DC and AS must be encrypted.

Data may be transmitted between DC and AS by electronic means, or alternatively transported on physical media. The DC must ensure that the data cannot be accessed during the transfer.

DC7: Data downloads are regulated by the Project Agreement(s) and the informed consent of the driver.

Data sharing could in some cases involve actual downloading of part or the whole set of a project data. The Project Agreement should regulate the possibilities of downloading the data. Also the participants must have given their consent to spread the data outside the project partners.

DC8: Data extractions for specific purposes must be in accordance with the consent forms and project agreement and the extraction must be documented.

Depending on what the participants have agreed to in the consent forms, different extraction policies can be used. Especially video and GPS extraction is to be treated with special care and the recommendation is to anonymize the personal data content in the videos, especially faces and vehicle number plates. Each extraction must be in accordance with potential content in the project agreement. All extractions must be documented.

Documents

The following specific documents within the context of the Data Center are identified:

- Agreement with external IT infrastructure provider (if applicable)
- Confidentiality or Non-Disclosure Agreement (CDA or NDA), for involved personnel
- Data protection implementation documentation signed by DC leader.

Analysis Sites (AS)

List of data protection requirements

AS-1: The AS organisation must document its data protection implementation if handling data within their organisation.

In order for data access to be granted to the analysts from the research organisation, a data protection implementation description must be documented and it is recommended that it should be presented by the AS to the DC.

AS-2: The analysis work stations must be physically protected.

Analysis work stations used for either remote virtual access to the DC or for handling downloaded data must be protected in such a way that unauthorized access is prohibited. Work stations must be placed in either locked rooms, or by other means placed so that contents on screens can be seen only by the analyst or annotator.

AS-3: Analysts must have received relevant training in data protection and integrity issues.

Before data access can be granted, analysts must present proof that mandatory training, possibly prescribed by the initial project, i.e US NIH education (<http://phrp.nihtraining.com/users/login.php>) has been followed.

AS-4: A confidentiality agreement for any involved AS personnel must be in place.

The research organisation must require signed confidentiality agreements with all analysts (researchers, research assistants, students), before data access can be granted. Agreements can be either specific for the project (for guest researchers, students, etc.) or implicit through means of employments contracts.

AS-5: The AS leader administers access requests and forwards to the DC authentication manager.

When the AS has presented its data protection implementation to the project management, access requests for personnel may be sent directly to the DC.

AS-6: Specified procedures for data extraction must be used.

Extraction of a portion of the data must be according to the participants consent and the data extraction procedures must be used. Video snippets and screen shots are also subject to this requirement. All extraction is administered through the DC.

AS-7: The analyst must not extract or re-distribute data.

As regulations for data extraction procedures are in place, the analyst must not circumvent these procedures nor disclose data outside of the AS in any other way

AS-8: The project data must not be used for research areas not covered by the consent forms in the project.

The data must not be used for any other purpose than those stated in the consent forms, except if given an Ethical Review Board approval. In the case national law has required approval from ethical review board (or similar) for the project, other usage of personal data is normally not permitted, and must be sought explicitly.

AS-9: Visitors/guests to the AS must sign a non-disclosure agreement.

If any portion of the analysed data is presented for a visitor, the visitor is required to sign a non-disclosure agreement. By definition visitors do not have access to the data, and are always accompanied by an authorized person.

AS-10: All post-project research must investigate the need for approval

With the drivers consent forms, national ethics regulations on research together with project agreements set the conditions for post-project research. All research, but especially if not previously covered by the project, might need to be submitted to local ethics committee and/or competent national authority for approval or additional consent might be needed from the drivers. Project agreements including agreements with sensor providers, might restrict the use of the data.

Documents

The following specifically required documents within the context of the AS were identified:

- Confidentiality or Non-Disclosure Agreement (CDA or NDA), between analyst/visitors and AS organisation.

- Approved training certificate for analyst.
- Data protection implementation documentation signed by the AS leader.
- Approval from ethics committee for intended research (if applicable).
- Data extraction request.

7.3.4 Education on data protection related to personal data and IPR

The addition of video can add substantial value to a data set. The reason for a sudden brake or steering manoeuvre can easily be understood by simultaneously looking at the video. The inclusion of video in the data set brings at the same time another level of need for protection of the data. Especially for those data sets where video is present, training on integrity issues needs to accompany the general training on data security.

There are different kinds of personal integrity training available, e.g. the US NIH training course (<http://phrp.nihtraining.com/>), where the analyst gets a certificate at the end of the web course. At the same time, it is important to get information regarding the local implementation of the security precautions, such as the data protection procedures and the analysis environment set-up together with more general information and rules following the specific dataset at hand.

The content of such an education could involve

- Description of the data with special focus on personal data and Intellectual Property Rights (IPR)
- Requirements on the data handling from a legal point of view
- The content of the consent forms, especially the specific active consents related to data sharing
- Data ownership and access rights for partners/third parties
- The set-up of the physical workspace
- Local procedures on how to perform analysis

All training needs to be documented, most conveniently done by an analyst's information sheet, which the participant needs to sign. Though the analyst might have a non-disclosure agreement in his/her certificate of employment, the signing process of the document enhances the protective level of the data.

7.3.5 Support and research services

Huge data sets have been collected worldwide and in the future, even larger datasets will have to be handled. The data is rich and can be used for research in a number of different research disciplines, such as safety, mobility, eco driving, traffic planning, infrastructure etc. Most importantly for many research questions, multi-disciplinary joint research is needed to be able to answer the questions. .

The support and research services is one of the cores of data sharing, which was pointed out by both data providers and researchers during the discussions in FOT-Net 2. Depending on the knowledge of people re-using the data, either just support is given or both support and

research services. As examples, SHRP2 and SAFER have both of these services. The support services will assist the researchers during the process, while the researcher is doing the actual work. The analysis tools are an integral part of the support services. The research services are more targeted to perform the research itself or extract usable datasets.

7.3.5.1 Support services

The support service targets the researcher and his/her possibilities to perform analysis. The support starts already at the application stage with discussions on the usability of the data to answer the specific research questions at hand. If the data application is approved, the researcher is given training in security and integrity matters, thus providing a deeper understanding of the sensitivity of the data. The analysis platform is described and training in using the tools is also included in the education. After having signed a document, stating that the analyst has understood the set-up, he/she is given access to the data. The support could give some additional support at this stage, but in general, here is where the research service takes over. After the analysis is done, the support services could offer a discussion on the result of the analysis, to enhance the result of the project and also see to that no misunderstandings have led to wrong conclusions.

The tools are an integral part of the support services. The tools could consist of a viewing and annotation tool, scripts to extract useful datasets from the database, MATLAB and other licensed SW, such as SPSS, but can also include entire frameworks for both retrieving, processing and pushing data back into the “database”. However, it is important that the analysts can choose what tools to use and that they are not dependent on complex frameworks with graphical interfaces or other constraints other than the raw data formats and data descriptions. That is, as mentioned in 7.3.2.2 “Description of data and metadata” it is important that data from all projects can be read in a “raw” and clearly described format directly from the data storage source (e.g. database or file storage) regardless of what analysis tools are used in a project (with appropriate access restrictions). This is important since different analysts have different ways to analyse data. Support services should impose as few constraints as possible to what processes analysts can analyse the data (within the data protection framework). Examples of different ways to analyse data are given in 7.3.2.2 “Description of data and metadata”. Data description formats and data formats will have to be able to deal with different analysis processes to be acceptable and used by as large community as possible. It is also important that the dependency on third party software for access is kept to a minimum. The support function could also include basic maintenance of the analysis platform, also including further development of the tools.

7.3.5.2 Research Services

The research services are beyond the initial start-up provided by the support services. In this case, the data provider takes a larger part in the actual research to be performed, depending on the needs of the analyst. If the analyst comes from another discipline and/or is unfamiliar with the type of data and therefore would like to have it aggregated to a more suitable format, the research services, in this case sometimes called the data extractionist, can assist. From this level, the work performed by the research services could stretch as far as performing a complete package of analysis, answering specific research questions.

7.3.6 Financial models for post project funding

Many FOT/NDS datasets have been collected and the issue of post-project funding is a shared issue. Some projects are fortunate to have supporting funding, but it seems to be a key issue that the vast majority do not have the finances to keep the data available for further research. The waiting and search for new projects to come and finance the revival of the data is not fruitful, as it seldom happens - the start-up cost is too high. The data also need to be taken care of directly after the project, while the persons having worked with the data are still present. They need to do the final clean-up of the data, before they start with new project. In the case where no additional funding is available, the data might just be taken off the infrastructure and hopefully stored in a structured way. Another factor is the time period, where the data set is still interesting enough to attract a larger quantity of research projects. All these factors point in the direction of planning for data availability funding to be present directly when the project ends.

The next section elaborates on the items to take into account to have a successful funding of the data after the project. The items to be funded are identified, the interest from the financing bodies is investigated and finally, different funding models are discussed.

7.3.6.1 Items to be funded

There are several tasks to be performed if a dataset is to be easily accessed. The following identified cost items are to be funded. The research services are not included, as they are directly linked to the research and should therefore be paid by the applying project directly. The most urgent datasets to receive funding for re-use are the FOT/NDS that has been collecting continuous video. The amount of data could be more than tenfold that of the project collecting only signals, based on experience from euroFOT and SHRP2.

Table 12: Items requiring funding

Research infrastructure for FOT/NDS data	Comments
Management & coordination	Management of the infrastructure
Analysis platform support	Data management – expert knowledge Tool support - further develop and adapt the analysis tools to new types of analysis Access management
Facilities & analysis work stations	Physical secure work space
IT operations	Database servers, storage and licenses
Data documentation	Post-project clean-up and structuring of data

7.3.6.2 Financing bodies

There are different financing schemes for the projects applying to conduct an FOT/NDS. In Europe, it is common that the partners pay part of the cost of the project and own the data after the project, which results in that the data ownership often are un-evenly distributed across the project. This makes the ownership issue in the US, generally, a bit easier as the

large FOT/NDS projects are fully paid and the data belongs to the authority. The projects are requested to hand over the data or may receive money to keep the data available.

Both on a national level and internationally in Europe and also in the US, the awareness of the value of the data is rising. Many countries, such as the US, Sweden and Finland, have written policies on making data open and available. This would imply that funding is redirected to hosting of and provision of data, which is the case in the above-mentioned countries. By doing so, the use of the data is facilitated, as the project does not have to pay for data, and thereby the re-use of data is enhanced. The former/current situation with the projects having to pay for accessing the data, is not sustainable, as the projects are unaware of the funding issue for data and the data provider is often not participating in the project application. This is born out of the many international discussions and also expressed by people outside of Europe. People wanting to re-use data has no or too little money to pay for data, only man hours to use it.

7.3.6.3 Financial models

There are several different ways of funding the cost of maintaining and providing data for re-use. The following models are widely used among the data providers giving access to external users, for instance for accessing data from SHRP2, euroFOT and data at JARI.

Per project

The infrastructure gets funding by the projects utilising the data. In conjunction with the application, the cost is discussed. The cost is usually a generalized cost split per year, distributed over the estimated amount of projects, but it is hard to estimate the number of projects. The problem is that the projects often have not planned for these additional data costs. Another drawback from this solution is that if there is a gap between projects, there is no funding to pay for the infrastructure.

Base funding and per project funding

Base funding will cover the basic running costs and gives the opportunity to put some money into marketing the infrastructure to attract more projects. As the projects do not get any data cost, they are more willing to re-use the data on a larger scale. This model seems to be the most appreciated, based on all discussions during FOT-Net 2 with different organisations hosting data for re-use and people wanting to re-use data. It usually includes some paid maintenance work as well and there is stability in knowing there will be a base funding over a few years.

Base funding with specific purposes

The platform is funded for a specific purpose, where many co-financers split the cost, e.g. through member fees. The funding is sometimes used for assigned research for the members as a whole. These users appreciate the focus on large volume of specific data, e.g. event recorded data. Most users are though not part of such homogenous groups, focusing on a specific matter.

7.3.7 Application Procedure

The project should agree early on in the project on an application procedure for re-use of data, so that all project partners and possibly also third parties know the conditions for additional research using the specific dataset. This will facilitate that new research

applications which want to utilize the data, will have taken the data application time and potential costs for re-using the data into consideration already during the proposal phase, before the application is sent to the targeted call.

The application procedure shall at least address the following items:

- Where to apply
- Which information is needed to be provided to be able to evaluate the application?
- Who can approve an application, response times, conditions to be taken into account in the approval decision?
- Requirements on mandatory training in data protection and integrity issues
- Information on the data access procedure
- Requirements on data protection
- Potential costs for data access, support and research services
- Requirements on acknowledgements on publications, reports and presentations
- Documentation of data applications and the related approval decision(s).

The suggested list of information to be provided by the applicant for a decision within the set response time is:

- Applicant details
- Short project description
- Requested data set
- Use and expected results
- Information on the intended publication of the data
- List of persons to get access and the related access time period
- Need of training in data protection and integrity issues
- Need of support and research services

7.4 Overview of procedures, documents, templates and standards related to data sharing

The framework of documents, providing assistance in preparing for data sharing, consists of a variety of different procedures, templates and “standards”. An overview is presented in the table below, where some of the content is provided in this document and others need to be developed.

Table 13: Procedures, documents, templates and standards

Data sharing area	Procedurs	Related project documents	Templates	”Standard requirements”
Project documents		DoW, CA, PA	Template text in CA and PA	
Data description		DoW, data description deliverable, CA	Data description and data format	Data and meta data description, data format
Data protection	Data extraction request, data download request	DoW, CA, PA	Data protection implementation documentation, data extraction request, NDA for analysts/visitors, Application to ethical review board	Level of protection at data providers/ analysis sites, data extraction format
Education		DoW, CA	Data security presentation, approved training certificate	Level of data security education
Support/research functions	X	CA	X	
Financial models			Form to describe the content to fund	
Application	X	DoW, CA	Application form, Data sharing agreements	X

7.5 Main Challenges

There are several large challenges in setting up a common data sharing platform. To make the platform really attractive, it should be usable on a global level, as the datasets are collected in different parts of the world. This raises even more issues.

Looking globally, the project funding schemes lead to a difference in ownership of the data. In the US, many projects are fully financed by the authorities who thereby claim the ownership of the data, while as in EU-funded projects, participating organisations pay between 50-75% of the cost and also own the data. This leads to different situations when it comes to the

possibilities to gather and share the data after the project. Also the legal setting differs between countries, which put different requirements on the handling of the data depending on where it is collected, stored and analysed.

The efforts to create and maintain such a platform could not be underestimated. As the research field of collecting and analysing FOT/NDS data is fairly new, there are still huge changes to be expected in the way research will be performed and the platform must be able to incorporate such developments. Examples of challenges to address are data mining methods, image processing, new data types, continuously larger data sets and thereby the need for new database structures and search methods.

Funding to keep the datasets available for research needs to be solved. The mechanisms for this base funding needs to be developed and decided upon, otherwise the data will not be re-used and a tremendous waste of money will occur. The money to fund additional projects using existing data is just a minor additional part of the cost already used to collect the data.

Documentation of data and metadata, the most essential part of data sharing, is usually not performed to a sufficient level in the projects. How could this be improved, to facilitate and enhance the sharing of data? A further related concern raised within projects is that data protection procedures need to be reinforced because even when procedures are in place, they can be quickly forgotten and undermined by those people handling and subsequently exchanging the data.

Working Group discussions suggest that perhaps the largest issue is to persuade the data providers to share their data. They are often more interested in additional or new research than to work on documenting the existing data to permit other researchers to use their data, especially as there are usually no funding left for thorough data documentation. Therefore, maybe the highest priority should be to focus what motivates a data owner to share the data.

7.6 Conclusions

The goal for the data sharing group was to create common data sharing rules for European projects. This report sets out the elements of a data sharing platform that would be required to facilitate re-use of the large amount of FOT/NDS datasets, stored in databases around the world. Such a platform would also facilitate data sharing within new projects, as the content of the platform is general and could be used whenever data sharing is performed.

The report constitutes the essence of the discussions made during the FOT-Net 2 time frame and there are many hands-on recommendations in the text. Through all the discussions, it is obvious that the text is universal, not only useful for European projects. At the end, it is always up to the specific project, national or international, to decide on their data sharing strategy and what parts in this data sharing platform that is applicable for their project.

The platform consists of the following seven items: pre-requisites that must be part of project documents such as the consortium agreement and the consent form, if the data should be able to be shared, descriptions of data and metadata, data protection, education on data security, support and research services, financial models for post project funding and the content of the application procedure. All parts need to be in place to efficiently form a data sharing platform.

The concept needs to be further developed and to be more in-depth adapted to the different national laws and research settings worldwide in order to be usable in as many FOT/NDS

countries as possible. In particular, the data description of the list of possible FOT/NDS data types needs to be developed in close connection to the developments of the data protection concept. Still, if using this concept, with the suggestions and requirements involved, future FOT/NDs will be much better prepared for data sharing during and after the project than previous projects.

8 General Conclusions

The Working Groups on addition to FESTA were installed to ensure a good exchange of information between the FOT experts and stakeholders. They debated specific topics which have been explicitly articulated by the FOT network in FOT-Net 1 and which needed common European positions. Specific experts from FOT community were invited to participate.

WG 1 (Data Analysis) collected a specific set of issues from conducted FOTs to further enhance and revise the FESTA handbook. These enhancements focused mainly on issues with respect to the experimental design, data collection, data processing, data storage, and data analysis. One major issue was missing interactions and links to the planning and implementation phase. Hence it is of major importance (for data analysts) to be involved in the planning, implementation, and data collection tasks at an early stage of the FOT, in order to adapt the analysis according to the specific needs of the FOT.

For **WG 2 (Events and Incident Definition)**, the main challenge has been the difficulty of coupling non-crash events to crash risk. This is an area that definitely needs more research. As for now, at the end of the day, what surrogate events one chooses more comes down to the researcher's own beliefs regarding crash causation mechanisms rather than empirical science pointing in a clear direction. However, much effort is directed toward this problem, so with time more precise and less subjective definitions are likely to emerge.

The key contribution made by **WG 3 (Legal and Ethical Issues)** was to add relevant information on the legal situation in other European Member States (Spain, Italy, Netherlands and France) which are highly relevant in case of FOT's and NDS. The effect is twofold: Specific legal information on the situation to be expected in these countries can be accessed very fast and is now immediately available for Spain, Italy, Netherlands and France. This level of information will usually be sufficient to plan FOT's and NDS with the amount of certainty necessary at this level. Apart from this, the information already provided in the FESTA Handbook in the past has shown to be valid beyond the scope of information that could be accessed initially where it has been restricted to German legal expertise only. In so far the amount of certainty on the legal issues identified therein has substantially increased. However, it must be pointed out that it is always necessary to involve legal expertise at national level when accomplishing an FOT or a NDS. This remains necessary due to a great number of specific issues and advice that is needed to deal with very detailed questions of test design. These details have tremendous relevance for legal permissibility in the single case.

WG 4 (Impact Assessment and Scaling up) gathered enormous experiences from FOTs and studied a number of key issues including piloting, participant selection and experimental set-up, safety impact assessment, data issues, scaling up and the integration of results. For some of the issues (e.g. piloting, integration of results) the difficulty does not lie in the fact that people do not know in theory how it should be carried out and that it costs a lot of time, but in the fact that in reality things are different and there is not enough time and/or budget to do things as thoroughly as they should be done. In safety impact assessment and scaling up there are gaps in knowledge and in data availability. On all topics the FESTA Handbook is improved, by adding new text based on the state-of-the-art, recommendations, and by updating and improving existing sections on impact assessment and scaling up.

WG 5 (Data Sharing) extensively reviewed the existing data sharing principles and proposed a FOT-Net data sharing framework. The purpose of the data sharing platform recommended by WG 5 was to facilitate preparation for data sharing, to enable more collected data to be available for multi-disciplinary research. It brings up the topics to be discussed and agreed upon in the project, all divided into seven categories; pre-requisites that must be part of project documents such as the consortium agreement and the consent form, if the data should be able to be shared, descriptions of data and metadata, data protection, education on data security, support and research services, financial models for post project funding and the content of the application procedure. All parts need to be in place to efficiently form a data sharing platform.

If using this concept, with the suggestions and requirements involved, future FOT/NDs will be much better prepared for data sharing during and after the project than previous projects.

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List of abbreviations

ACC	Adaptive Cruise Control
ADAS	Advanced Driver Assistance System
AS	Analysis Site
CA	Confidentiality Agreement
CRE	Crash Relevant Event
DC	Data Centre
FESTA	Field opErational teSt support Action
FOT	Field Operational Test
FOTIP	FOT Implementation Plan
IPR	Intellectual Property Rights
ITS	Intelligent Transport System
ND	Nomadic Device
NDA	Non-Disclosure Agreement
NDS	Naturalistic Driving Studies
RMA	Risk Matrix Approach
RR	Range Rate
TTC	Time-To-Collision
WG	Working Group