EUROPEAN COMMISSION

DG CONNECT

SEVENTH FRAMEWORK PROGRAMME

INFORMATION AND COMMUNICATION TECHNOLOGIES

COORDINATION AND SUPPORT ACTION

FOT-Net Data

FIELD OPERATIONAL TEST NETWORKING AND DATA SHARING SUPPORT

REPORT ON FOT-NET DATA WORKSHOPS

FOT-Net Data Workshop 3: A common methodology for road automation FOTs and pilots

Date: 3-4 February 2016

Place: University of Leeds, Leeds, UK

FOT-Net Data Workshop 3: A common methodology for road automation FOTs and pilots

In Europe Field Operational Tests (FOTs) and pilots have been designed and conducted using the FESTA methodology, developed by the FESTA consortium and maintained and updated by the FOT-Net support actions. The focus of these projects has been on changes in driver behaviour, and resultant societal impacts due to use of in-vehicle systems and cooperation with the infrastructure and other vehicles. In the coming years large-scale projects will be started for testing automated or even autonomous vehicles.

In this seminar, we went step-by-step through the FESTA methodology, focussing on those issues that need to be addressed in automation FOTs and pilots. Five major areas were addressed:

- Societal scenarios and research questions
- Study design
- Data collection and analysis
- Impact and socio-economic cost-benefit analysis
- Data sharing

The objectives of this seminar were to explain the current methodology, to extend the FESTA activities to automation pilots, and to work together taking the first steps towards a common methodology. The seminar provided both plenary presentations and small group discussions and exercises. We worked with example FOTs, and covered all the methodological steps.

Agenda

On 3-4 February 2016, a workshop was held in Leeds, UK, entitled 'A common methodology for road automation FOTs and pilots'. The agenda was as follows:

Wednesday, 3 February, 12:00 – 17:30

1. Overview of this workshop: Haibo Chen (University of Leeds)

2. FOT-Net Data introduction: Sami Koskinen (VTT)

3. Knowledge exchange activities related to FOTs: Haibo Chen (University of Leeds)

4. Automation FOTs and pilots in Europe: Davide Brizzolara (ERTICO – ITS Europe)

5. USDOT Programs for Collecting Connected & Autonomous Vehicle Data: Cory Krause (Noblis / U.S. Department of Transportation)

6. Current status of the FESTA methodology: Yvonne Barnard (University of Leeds)

7. Societal scenarios and research questions: Oliver Carsten (University of Leeds)

    a. Case introduction: PEGASUS project: Jan Dobberstein (Daimler)

    b. Small group work

8. Study design: Yvonne Barnard (University of Leeds)

    a. Case introduction: Nordic Way Lone-Eirin Lervåg (SINTEF)

    b. Small group work

Thursday, 4 February, 9:15 – 13:15

9. Data collection and analysis: Sami Koskinen (VTT)

    a. Case introduction: Barbara Metz (Würzburg Institute for Traffic Sciences)

    b. Small group work

    c. Impact and socio-economic cost-benefit analysis: Satu Innamaa (VTT)Case introduction: Benefits estimation framework for automated vehicle operations: Scott Smith (Volpe National Transportation Systems Center / U.S. Department of Transportation)

    d. Small group work

10. Data sharing: Helena Gellerman (SAFER)

    a. Case introduction: RDE research data exchange in the US: Corry Krause (Noblis / U.S. Department of Transportation)

    b. Small group work

11. Questions and discussion

12. Wrap-up: Yvonne Barnard (University of Leeds)

There were 31 workshop participants (the list of attendees can be found at the end of this document).

1. Overview of this workshop: Haibo Chen (University of Leeds)

Haibo Chen welcomed the participants and outlined the programme of the workshop. He introduced the Institute for Transport Studies of the University of Leeds.

2. FOT-Net Data introduction: Sami Koskinen (VTT)

Sami Koskinen introduced the FOT-Net Data project that organised the workshop. For the upcoming automation FOTs and pilots data sharing will be an important issue. FOT-Net Data has developed a Data Sharing Framework, which covers e.g. data and metadata description and data protection recommendations (http://fot-net.eu/library/?filter=data-sharing-framework). The

FOT Data Catalogue is ready and we are inviting data owners to create entries to the catalogue: wiki.fot-net.eu.

3. Knowledge exchange activities related to FOTs: Haibo Chen (University of Leeds)

Haibo Chen presented briefly the knowledge exchange activities of FOT-Net: webinars and workshops. The webinars address the FESTA handbook content, and recordings and materials may be found online at FOT-Net Library (fot-net.eu/library). Presentations and reports from the previous workshops are also available there.

4. Automation FOTs and pilots in Europe: Davide Brizzolara (ERTICO – ITS Europe)

Davide Brizzolara gave an overview on European and national projects and pilots dealing with road automation. Ongoing FP7 projects include:

- AdaptiVe: Automated Driving Applications and Technologies for Intelligent Vehicles

- CityMobil2: pilot platform for automated road transport systems, implemented in several urban environments, focus on public transport

- Companion: developing a framework of co-operative mobility technologies to enable supervised vehicle platooning of heavy-duty vehicles

- iGame: Interoperable Grand Cooperative Driving Challenge AutoMation Experience, with a focus on merging on highway and mixed traffic intersection

- AutoNet 2030: developing and testing a co-operative automated driving technology based on a decentralised decision-making strategy which is enabled by mutual information sharing among nearby vehicles

- Cargo-Ants: Cargo handling by Automated Next generation Transportation Systems for ports and terminals.

National projects include:

- UK: 3 projects from the INNOVATE UK competition: Venturer, GATEway and UK Autodrive

- Sweden: Drive Me

- Germany: PEGASUS

- Belgium: BE Zaventem

- The Netherlands: WEPOD, DAVI (Dutch Automated Vehicle Initiative)

More information about these and other projects may be found at the wiki of the VRA (Networking in Automation) coordination and support action: http://vra-net.eu/wiki.

Davide concluded by discussing the upcoming calls in the Horizon2020 framework that are relevant for road automation.

5. US DOT Programs for Collecting Connected & Autonomous Vehicle Data: Cory Krause (Noblis / U.S. Department of Transportation)

Cory Krause explained the US Department of Transportation (US DOT) programs for Collecting Connected & Autonomous Vehicle Data (CDS) (www.its.dot.gov).

The US DOT's vision is to show how emerging data can transform surface transportation systems management. The CDS Program seeks to develop, test and make available methods to capture, manage and exploit the potential of high-volume multi-source data to enhance current operational practices, and transform future surface transportation systems management.

In 2015, three sites were awarded:

- Wyoming, focused on the needs of the commercial vehicle operator, aiming to reduce the number and severity of adverse weather-related incidents

- New York City: to improve safety and mobility of travellers through connected vehicle technologies

- Tampa: to alleviate congestion and improve safety during morning commuting hours

Big data collected in the Safety Pilot project, held at Ann Arbor, MI, is one of the datasets that is being made available for other researchers at the Research Data Exchange (www.its-rde.net.). This pilot, with 2836 vehicles driving on 73 miles of roads, examines the effectiveness of connected vehicle safety applications.

6. Current status of FESTA handbook, Yvonne Barnard (University of Leeds)

Yvonne Barnard presented the FESTA methodology, introducing the need for a common methodology and going through the methodology steps in the so-called FESTA-V (see below). The question to be addressed in this workshop is what the next step will be: FESTA for automation studies. Many practical issues remain the same, designing and performing an FOT, and analysing the results, and the systematic and scientifically based approach to gather sound evidence on the effects of automation. A common methodology is important for being able to study impact of automation, combining all knowledge gathered from different kinds of FOTs. New focusses are needed on users, vehicles and contexts. Sharing experiences, knowledge and data will remain important. The handbook can be found at: http://fot-net.eu/Documents/festa-handbook-version-5-2014/. The handbook will be updated at the end of 2016.
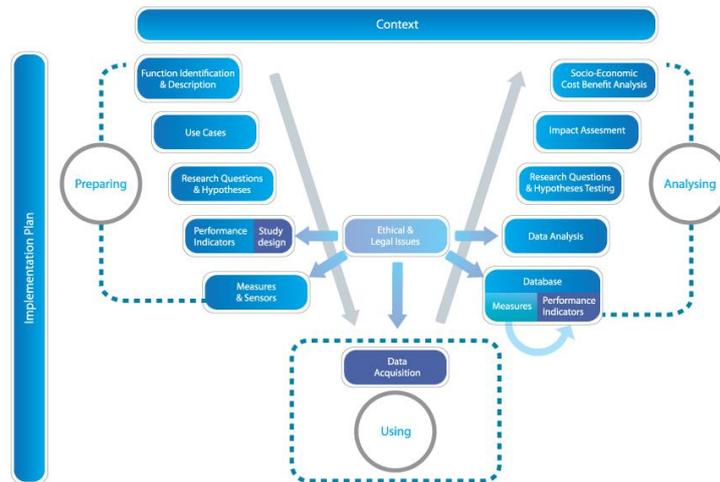
7. Societal scenarios and research questions: Oliver Carsten (University of Leeds)

Oliver Carsten opened this session by addressing the upper left part of the V (for more information see the FESTA handbook). He stated that vehicle automation could become a societal game-changer, the issues being "what are the wider lifestyle, transport, economic and social impacts?" FESTA, addressing its systems, identified as impact areas: safety, efficiency, environment, mobility, acceptance and trust, usage, adoption (making inherent in behaviour). With automation, new impact areas will also become important: transport demand, value of time, travel costs, mode choice, network operation, infrastructure costs, land use, urban planning, environment, and equity.

7a.Case introduction: PEGASUS project: Jan Dobberstein (Daimler)

Jan Dobberstein presented the German PEGASUS project. The core research questions are: What criteria do systems for highly automated driving have to answer to? What is necessary in order to ensure that systems actually fulfil those criteria? The project will perform virtual tests, proving ground tests and field tests. They will investigate socially accepted risk criteria. More information on: www.pegasus-projekt.info.

7b. Group work

In small groups societal scenarios and research questions were discussed, starting from one of the example cases:

- Driverless bus in restricted area

- Vehicle with driver on the highway, lane keeping and forward control fully automated

- Platooning of trucks

- Fully autonomous car in city environment

The following table was used to capture the results.

Questions	Case study	Recommendations for FESTA	Methodological issues
Societal scenarios and research questions			
1. Describe a scenario on which you will focus			
2. What would be the main impact areas?			
3. Define three main research questions			

Groups looked at different scenarios and use cases such as fully automated cars, shared urban transport, driverless public transport, and remote control of vehicles. Impact areas are very broad as we are dealing with very different eco-systems and business models. Next to safety, environment, efficiency, and mobility, also for groups who have now restricted mobility, security is an important area. But also questions about comfort, reliability, trust, vehicle ownership, roads and infrastructure, traffic flow, actual use, vulnerable road users, public health, mode change, willingness to pay and (many) other questions were discussed. In addition, impact on life-styles was mentioned, as well as perception of time and use of time freed up by automation. It was recommended for FESTA to address new impact areas. As methodological issues, it was mentioned that we should go from observation to prediction, and that we need to develop economical models for the automation eco-system. Another issue is the scaling up, what is the testing that is needed for deployment purposes? Different groups, (young, old, disabled…) need to be taken into consideration.

8. Study design: Yvonne Barnard (University of Leeds)

Yvonne Barnard explained the lower part of the left branch of FESTA: study design, specifically the definition of hypotheses, measures and performance indicators. She asked whether we know what the performance indicators will be for automation FOTs as new impact areas and research questions will lead to new types of indicators. In the study design, the experimental set-up of the study, the question will be who the participants are: drivers, monitors in the vehicle, passengers, other road users and general public, traffic managers, ….? An interesting question is that of the baseline. In FESTA the baseline is the situation without an ITS system being active, so comparisons can be made with the situation in which the tested system is active. In automation FOTs this is not so clear: what do we compare automation with? No automation, "normal driving" (findings from naturalistic driving studies), lower levels of automation, individual driver baseline, different penetration levels of automation? Do we need a baseline?

8a. Case introduction: Nordic Way Lone-Eirin Lervåg (SINTEF)

Lone-Eirin Lervåg presented the study design in the NordicWay project, the pre-deployment piloting of C-ITS services in the Nordic countries. Their goal is to enable vehicles to

communicate safety hazard and road status information using cellular networks (3G and LTE/4G) offering interoperable services to the users on a cooperative road corridor. Technical performance, impacts and user acceptance are evaluated, resulting in a roadmap for large-scale deployment. The ultimate goal is to prepare for road automation in the Nordic countries. NordicWay uses the program theory as the basis for their methodology: how the intervention is expected lead to effects, and in which conditions.

8b. Small group work

Discussions were held on the use cases from the first round of group work, with the following questions:

- Formulate 3 hypotheses and define performance indicators for each hypothesis

- Sketch a study design

- What would be the baseline for your study?

Participants came up with a wide range of options, but it became clear that it was not easy to formulate hypotheses, there are too many options. For the baseline, a study in which commuters could be compared with train passengers (or other public transport) was mentioned. Another baseline could be the experience of (customers of) car sharing companies. Another idea is to study a currently available transport mode and restart a service that is now no longer available (but now in automated form), and see what happens and compare them.

Methodological issues identified were that the impact of automation on mode choice is very hard to study. Sensitivity analysis to identify the most essential parts in the study may be needed. Pre-studies will become more important (for example on current car sharing). Non-users should also be included in the studies.

9. Data collection and analysis: Sami Koskinen (VTT)

Sami Koskinen presented the lower part of the FESTA V: data collection, data processing and the data analysis steps. In automation FOTs, new emphases may be chosen: (1) High emphasis on recording video, with the need to annotate events to learn contributing factors and reasons for incidents, and maintaining privacy. (2) Advanced sensing, the driver's pose and various environmental features need to be recorded. (3) Addressing the question how human driving differs from automated driving (like differences in lane keeping, lane change, speed at intersections, time to collision in some situations). And (4) Opinions, reactions and behaviour of other road users are of interest.

9.a. Case introduction: Barbara Metz (Würzburg Institute for Traffic Sciences)

Barbara Metz presented recommendations for data collection derived by re-analysing euroFOT-data. Examples of research questions are: usage and acceptance of different navigation systems, and impact of navigation systems on driving behaviour, safety and efficiency. For an efficient and valuable re-use of data, more signals should be recorded than needed for primary analysis. Signals should also cover aspects of driving that are not in the scope of the original project (e.g. signals for all available ADAS, air condition, etc.).Video data is essential to develop and validate algorithms for new research questions. They made three recommendations for new approaches in the analysis of FOT data: (1) situational variance should not be controlled through experimental design but through the selection of

relevant data sections, (2) algorithms need to be developed that divide the data into meaningful sections (e.g. driving manoeuvres), and (3) algorithms need to be adapted and validated for every vehicle type.

9b. Small group work

In small groups further discussions were held on data collection and analysis, with the following questions:

1. What kind of data would you collect?

2. What sensors would you use?

3. What would be the main challenges for data collection and analysis?

Next to the usual sensors measuring vehicle behaviour, video was mentioned as a key means to collect data, collection of images in every possible direction. The other major type of data are the experiences and opinions of users. The response of users should be measured before and after experiencing automated transport. Also measuring participants feelings in real-time was mentioned. We also have to be aware that new behaviours may emerge, which are not anticipated, but may be extremely interesting. Data on societal change would need to be collected. In addition, data about the infrastructure and the environment is needed. As one group stated: we need "everything".

Methodological issues identified are: Huge amounts of data will be collected and the filtering of relevant data, e.g. for identifying incidents will become very important. Challenges are in the area of video analysis, automated/intelligent video annotation and interpretation of sensor data. New data analysis expertise will be needed. With (high resolution) video the issue of privacy comes up. Another issue is that long test periods may be needed. Sensor data from OEMs and TIER1s may become an issue, as they may not be prepared to share it. An interesting question is if you do AD simulator or control studies, how will you find participants prepared to do nothing for a long time? The biggest challenge may be dealing with the wide variety of data, maybe it is good to start with small case scenarios.

10. Impact and socio-economic cost-benefit analysis: Satu Innamaa (VTT)

Satu Innamaa introduced the upper right part of the FESTA V: Impact and socio-economic cost-benefit analysis. This analysis is needed to increase knowledge about impacts of ITS and to provide the impact assessments in numerical estimates for the cost-benefit analysis. It provides information to stakeholders and decision makers about potential business cases and input for future work. Automation FOTs will present new challenges, and many impacts take time to form, like mobility patterns, new mobility services, land use, and public health (accessibility to health services, walking & cycling). How can we measure or assess these and how do we estimate the benefits in financial terms? She discussed the benefits of a common impact assessment framework allowing the exchange of best practices, the designing of tests and studies to maximize insight, and enabling meta-analyses. She presented the Trilateral Impact Assessment Subgroup for Automation in Road Transportation (between USA, Japan and EU), of which she is the EU co-chair.

10a. Case introduction: Benefits estimation framework for automated vehicle operations: Scott Smith (Volpe National Transportation Systems Center / U.S. Department of Transportation)

Scott Smith (the US co-chair of the trilateral working group) presented the development of the Automated Vehicle Multimodal Benefits Framework, the US framework to estimate the potential safety, mobility, energy and environmental benefits (including dis-benefits) of technologies contributing to the automation of the US surface transportation system. The objectives are to identify metrics, develop a framework for quantifying impacts, provide a high-order assessment of the state of knowledge, and incorporate current research by other parties. The final phase 1 report, Benefits Estimation Framework for Automated Vehicle Operations (FHWA-JPO-16-229), is now available in the National Transportation Library (ntl.bts.gov). This research is sponsored by the US DOT Intelligent Transportation Systems Joint Program Office.

There is substantial interest in the framework and a need is identified for a clearing-house on research, to facilitate sharing. We need to understand the big picture to ensure the right data are collected. Data sources and automation applications for initial modelling need to be identified, and linkages between micro and regional mobility models examined. It is necessary to develop AV impact models, starting with safety, mobility and environment, but continuing to other areas. International coordination of evaluation activities is very important.

10b. Small group work

In small groups discussions were hold on impact assessment and the methods and information needed, with the following questions:

1. Select an impact area and discuss where your focus would be

2. What additional information would you need?

3. How would you proceed to determine the impact?

Again impact areas were discussed that were identified in the first group work session. From the group discussion, it became clear that it is not possible to address everything at the same time, some groups focussed on limited scenarios, like parking and found it easier to come up with a plan to determine the impact. Also the group that focussed on accessibility for different groups came up with a plan. These groups combined sensor data with questionnaires and statistics available in the public domain.

Impact assessment is a very difficult, but essential topic, and will require more thought in order to come up with recommendations.

11. Data sharing: Helena Gellerman (SAFER)

Helena Gellerman explained the role of data sharing in the FESTA methodology, and the data sharing framework that is further developed in FOT-Net Data. Data sharing needs to be considered from day 1 in an FOT: in agreements, funding, determining what data to collect, documentation, analytical tools, and data protection. She presented areas where support may be needed for data sharing, like training, financial models, support services, and application procedures. More information can be found in the (draft) Data Sharing Framework available on the FOT-Net website (www.fot-net.eu). Specific challenges for data sharing in automation FOTs are related to the data gathering from competitive systems (sensors, algorithms) and data ownership. Video will be used and will gather sensitive information, also about other road users, so we will need to deal with legal restrictions and

privacy issues.   If we want data to be more open, data protection is of the utmost importance.

11a. Case introduction: RDE research data exchange in the US: Corry Krause (Noblis / U.S. Department of Transportation)

Cory Krause gave a further presentation on RDE. The purpose of RDE is to provide a variety of data-related services that support the development, testing, and demonstration of multi-modal transportation, weather, and environmental applications. RDE enables the sharing of data collected from connected vehicles, mobile devices, and infrastructure. It performs data quality checks, provides clean, well-documented data sets, and integrates data from multiple sources into data environments. RDE provides real-time and archived data, probe data from field tests, and data from research projects including simulations. On the website, it is easy to search for datasets, and they can be downloaded by registered users, the registration procedure is very simple, and a try-out is strongly recommended: www.its-rde.net.

ITS researchers are invited to submit data sets to RDE. US DOT assesses potential data on value and quality, and when a data environment passes this assessment RDE management adds the data to RDE.

11.b. Small group work

In small groups questions about data sharing were discussed:

1. What data would you be able to share?

2. What would be obstacles to sharing?

3. What would be the enablers for sharing?

Discussion centred on data and privacy protection, anonymization of data and permission from participants. The other discussion issue was the sharing between organisations, such as the problems manufacturers have in sharing data sensitive to their products and business. Enablers would be techniques for anonymization, which are currently not yet good enough, legislation/regulations and data sharing agreements.

12. Questions and discussion

In the discussion it became clear that thought about the impact of automation and the way in which to investigate it is moving in the same direction in the EU and the US, although sometimes different wording is used. It also became clear during the workshop that automation can mean very different things and multiple future scenarios are possible. The challenges are not only technological, but travel in the future may be quite different from what it is today. Nevertheless, we should focus on the next level of automation, becoming available in the near future, and for which FOT data may provide insights that are useful for the further development of automated vehicles. A concern for automation FOTs is the authorisation needed to conduct FOTs in Europe on the public road. The nature of FOTs may change. FOTs are not just about research per se, but also about gathering evidence that these systems/vehicles are safe. We may conclude that while recommendations from FESTA are still very useful, "FESTA for automation" is not "business as usual".

13. Wrap-up: Yvonne Barnard (University of Leeds)

Yvonne Barnard concluded the workshop remarking that there is still a lot we don't know about how automation FOTs will be or needs to be designed and conducted. But in terms of FESTA we know that the context will be on a societal level (not just looking at specific systems or traffic environments) and will be constantly changing and at different speeds. The impact will be also in new areas, including areas outside the transport domain. The research questions may be hard to define at the beginning of a FOT and may be changing during the studies. Only a limited set of questions can be addressed, which will not cover all impact issues. We discussed whether we are ready to formulate hypotheses and determine a baseline (baselines may be divers). Many performance indicators will be related to user behaviour and attitudes.

Data collection was discussed. Maybe we should try to collect as many data as we can, we may need them to analyse the impacts. Also a large number of data will be needed from the environment, infrastructure etc. This brings us to the question of whether manufacturers will be willing and able to provide data. New expertise for analysts will be needed to deal with data and to draw conclusions about the impacts. We may need more visioning methods, to be able to predict the future consequences of automation. To complicate impact analysis even further due to automation values may change, such as the value of time, land use, ownership, etc. International sharing is the only way forward to tackle all these difficult questions, not only of data but also of data strategies and insights.

Participants FOT-Net Data workshop

Last name	First name	Organisation
Barnard	Yvonne	University of Leeds
Brizzolara	Davide	ERTICO - ITS Europe
Carsten	Oliver	University of Leeds
Chen	Haibo	University of Leeds
Dobberstein	Jan	DAIMLER AG
Dodsworth	Joel	ITS Leeds
Franzen	Stig	Chalmers
Gellerman	Helena	SAFER
Hibberd	Daryl	University of Leeds
Hill	Allan	Transport Scotland
Innamaa	Satu	VTT
Jackman	Gavin	telent
Koskinen	Sami	VTT
Krause	Cory	Noblis / USDOT
Landau	Andreas	WIVW GmbH
Lervåg	Lone-Eirin	SINTEF Technology and Society
Levin	Tomas	Norwegian Public Roads Administration
Madigan	Ruth	ITS
Merat	Natasha	ITS, LEEDS
Metz	Barbara	WIVW GmbH
Page	Yves	RENAULT SAS
Pampel	Sanna	University of Nottingham
QUINTERO	Karla	CEESAR
Rial Martínez	Moisés	CTAG
Romano	Richard	University of Leeds
Smith	Scott	United States Department of Transportation
Stephenson	Scott	AECOM
Thomasson	Erik	University of Leeds
Welsh	Ruth	Loughborough University
Willey	David	Jaguar Land Rover