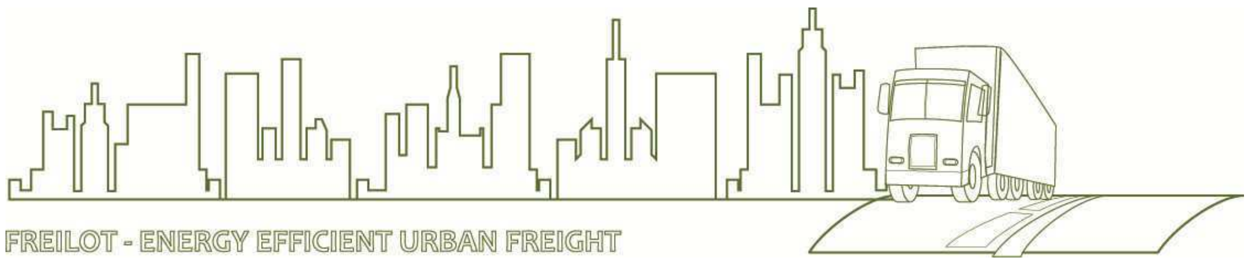
FREILOT. Urban Freight Energy Efficiency Pilot. D.FL.4.1 Evaluation methodology and plan

Rosa Blanco, Eva García, Rocío Rodriguez, María Tevell, Jean-Baptiste Thebaud, Siebe Thurksma, Eric Koenders, Ainara Uriarte, Jesus Gonzalez-Feliu, Pascal Pluvinet, et al.

FREILOT

Urban Freight Energy Efficiency Pilot

D.FL.4.1 Evaluation methodology and plan



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Prepared	Rosa Blanco, Eva Garcia	20090730
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Authorised	Zeljko Jeftic	

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Authors (full list)

Rosa Blanco, CTAG
Eva García, CTAG
Rocío Rodriguez, CTAG
María Tevell, Volvo Technology Corporation
Jean-Baptiste Thebaud, Interface Transport
Siebe Thurksma, Peek Traffic
Eric Koenders, Peek Traffic

Ainara Uriarte, GERTEK

Jesus Gonzalez-Feliu, CNRS-LET

Pascal Pluvinet, CNRS-LET

Fernando Zubillaga Elorza, Cluster TIL-ITS Euskadi

Project co-ordinator

Zeljko Jeftic

ERTICO – ITS Europe

Avenue Louise 326

1050 Brussels, Belgium

Tel.: +32 2 300 07 31

Fax: +32 2 300 07 01

Email: z.jeftic@mail.ertico.com

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Table of Contents

Table of Figures

Tables

Abbreviations and Definitions

Abbreviation	Definition
ACAS	Automotive Collision Avoidance System
ACC	Adaptive Cruise Control
AL	Acceleration Limiter
CAN	Controlled Area Network
CWS	Collision Warning System
DAS	Data Recording System
DSB	Delivery Space Booking
EDS	Eco Driving Support
ECBS	Electronic Controlled Braking System
FCW	Forward Collision Warning
FESTA	Field operational test support Action
FOT	Field Operational Test
GPRS	General Packet Radio Service
GPS	Global Positioning System
HVG	Heavy Goods Vehicle
IC	Intersection Control
INC	Intersection Control
ID	Identification Number
ISA	Intelligent Speed Adaptation
ITS	Intelligent Transport Systems
IVBSS	Integrated Vehicle-Based Safety Systems
IVSS	Intelligent Vehicle Safety Systems
LCM	Lane Change Merge
LDW	Lane Departure Warning
LDWS	Lane Departure Warning System
LIN	Local Interconnect Network
MOST	Media Oriented Systems Transport
PI	Performance Indicator
RQ	Research Question
SL	Speed Limiter
USB	Universal Serial Bus
Wi-Fi	Wireless Fidelity

Executive Summary

The document Evaluation Methodology and plan identifies the concrete objectives of the evaluation in order to establish the evaluation hypothesis and the measurements needed to the final assessment of the services in the four pilot sites. The final part of this report includes a description of the set of data to be logged and the main requirements of the data logger systems. Finally, the general data management process is indicated. All this work was carried out taking into account the state of the art and based in the FESTA methodology, developed to support the development of FOT projects in Europe.

This document is foreseen during the first year of the project in order to describe more in detail the methodology, but it is really relevant to have it in this early phase of the project to establish the base of the evaluation. For the whole FREILOT project is important to have a good understanding of the evaluation method.

1. Introduction

The current document, Evaluation Methodology and Plan, describes the methodology to be used in the four FREILOT test sites (Bilbao, Helmond, Krakow and Lyon) for the evaluation of the FREILOT services. The aim is to offer to the four pilot sites a common methodology and evaluation plan to provide the same evaluation framework. At the same time another goal is to present our work to a wider community of urban freight mobility stakeholders in order to first have a discussion and later on wide acceptance of the FREILOT outcomes.

During this first phase of work, a revision of other pilot studies was made in order to have a base of knowledge to define the evaluation plan for FREILOT. The work performed and the main conclusions obtained from this revision are described in the next section of this document (State of the art).

Besides the indications obtained from the state of the art, the FESTA handbook has provided the best practices to follow on the evaluation of field operational test. This handbook FESTA was created under the 7th Framework Programme as the action to support Field Operational Test. Although the FREILOT project is a pilot, the FESTA methodology could be a reference to draw up an evaluation plan and to identify which behavioural measures should be took into account. FESTA is a set of guidelines and offers a common methodology for the conduction of FOTs in Europe (FESTA Handbook). In section 3 of this document a general description of this methodology is included in order to explain the steps to be followed in the definition of the methodology.

The next parts of the document are dedicated to the description of the services functionality, use cases and pilot sites conditions. In this report is included a summary of the pilot sites conditions from the point of view of evaluation. A detailed description could be found in the D.FL.2.1 Implementation Plan.

The last chapters of the document describe the steps followed for the definition of the methodology (taking as reference FESTA):

- Identification of Research Questions.
- Definition of Hypothesis for each service.
- Identification of measurements for the systems evaluation.
- Data management process.
- Evaluation plan.

Finally, taking into account the relevance of the fuel consumption and CO2 emissions evaluation, a specific chapter describing the procedure for the evaluation of them is included. This chapter describes briefly the models used for the estimations

The document is produced in an early phase of the project and some decisions are still to be taken. So, this document is foreseen to continue the specification of the methodology during this first year of the project.

2. State of the art

This chapter summarizes the relevant information extracted from the state of the art of pilot tests carried out until this moment. A total of twelve FOT projects or studies were identified as Field Operational Test although a couple of them make reference to the same FOT. In the annex I a table summarizes the authors and year, number of participants and trucks, mileage for each study, experimental design, parameters, measures, and other important characteristics.

Most of the studies are related to the assessment of safety aspects and how to improve the security on roads. The only test reference about the evaluation of environmental impact in a field test is the design for a new transportation centre in the independence National Historic Park where they evaluate the influence of buses in the National Park and they proposed design alternatives (Spiller & Mickela, 2000).

Next part of this chapter, a brief summary of the each study will be presented.

2.1. Evaluation of an Automotive Rear-End Collision Avoidance System

This FOT was focused on the ACAS performance, capability and safety benefits. Moreover, it was interesting to analyze the driver acceptance of the systems. A sample of 66 drivers participated in this study (March 2003-November 2004). In the experimental design, participants driver without ACAS (first week, baseline) and next 3 weeks they drove with ACAS. Driving behaviour was evaluated through indicators such as travel speed, time headway or distraction.

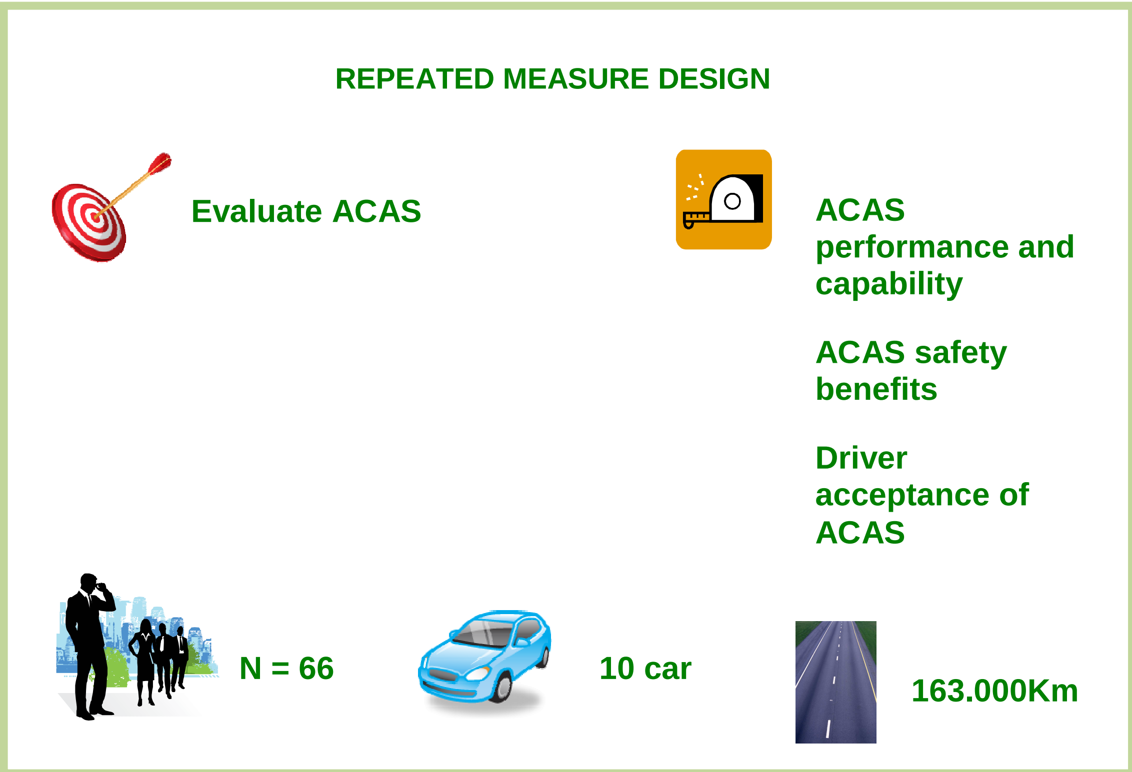

Figure 1 Main characteristics of "Evaluation of an Automotive Rear-End Collision Avoidance System" FOT.

2.2. Overall Field Trial Results

This study is focused on a behavioural and attitudinal analysis of field trials with twenty cars with ISA (Intelligent Speed Adaptation). The experimental design was composed by three different phases. The first one (for one month) was the baseline and the participant drive without ISA system. Next four months subjects drove with the ISA system active and finally, the last month they drove with the ISA inactive (Design ABA).

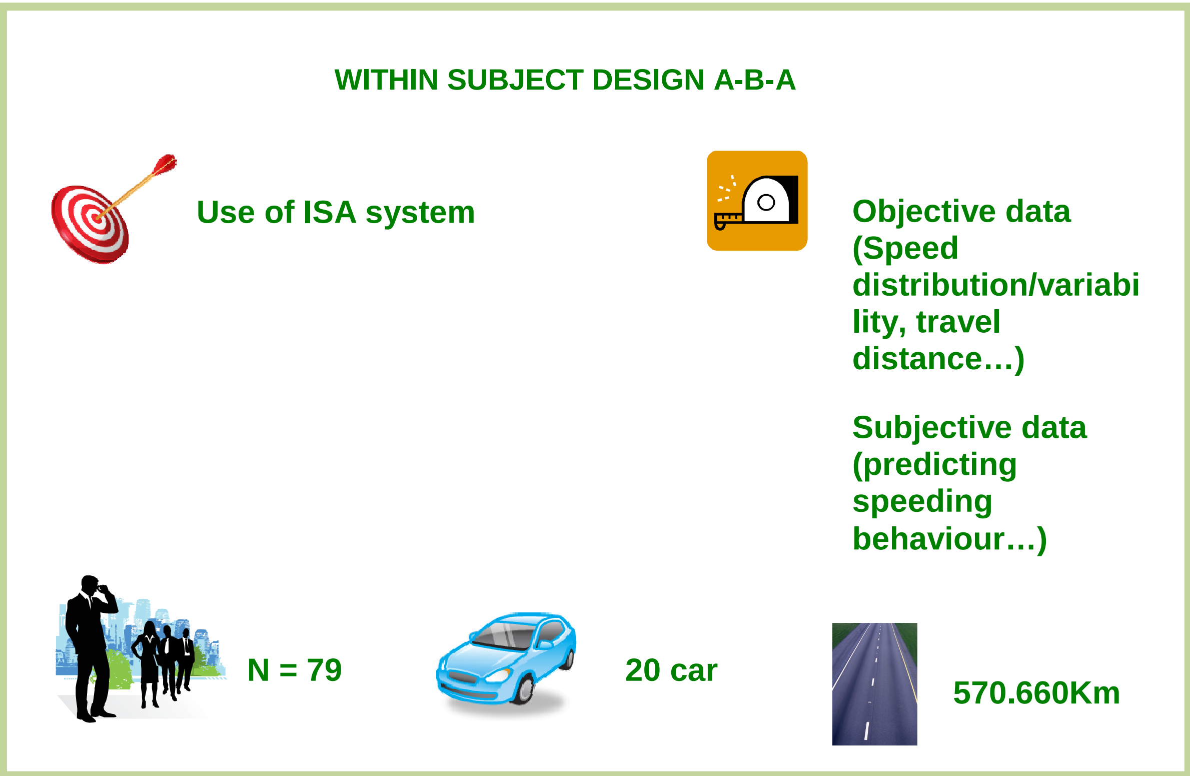

Figure 2 Main characteristics of "Overall Field Trial Results" FOT.

2.3. Road Departure Crash Warning System Field Operational Test: Methodology and Results

The main objective of this project was to evaluate the suitability of road departure crash warning systems looking for safety-related impacts within the driving data, determining driver acceptance of the system and making observations of system performance. The sample was comprised of 87 drivers. The experimental design was a within-subject where each driver's baseline (6 days) was compared with the treatment condition (20 days). Driver behaviour was evaluated through indicators as means speed or percentage eyes off road time and subjective opinions where related with usefulness, satisfaction, or perceived behavioural control.

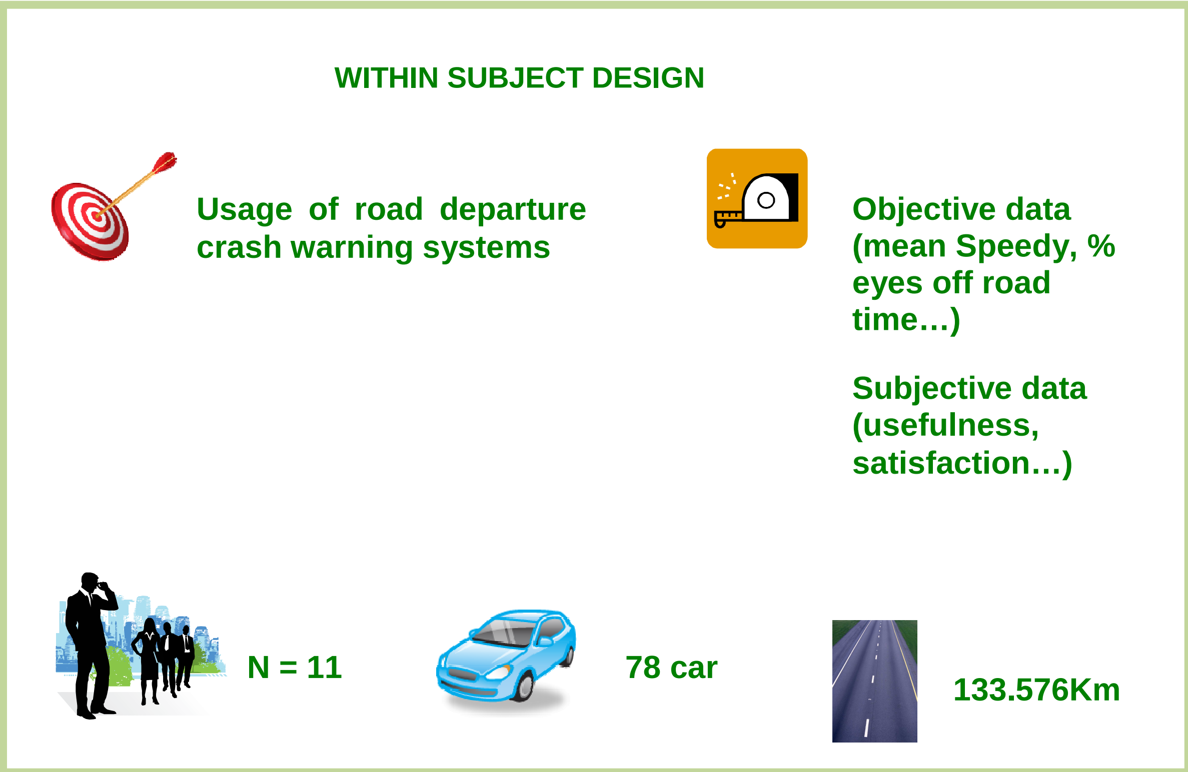

Figure 3 Main characteristics of "Road Departure Crash Warning System Field Operational Test: Methodology and Results" FOT.

2.4. Intelligent Speed Adaptation

The main objective of the "Intelligent Speed Adaptation" study was to investigate the car driver behaviour when using the ISA systems. This project tried to resolve questions about the acceptance of ISA, if the ISA system reduced the amount of speeding, how behaviour changes over the long term when driving with ISA, when and where drivers choose to override the voluntary ISA or how assess the impact of ISA on the quality of their driving. Participants were private motorist and for the fleet trials they were recruited from local organizations. Some driver characteristics were take into account such as gender, aged and if they were intender/non intender (based on prior intention to speed). A fleet of twenty cars was equipped with the ISA system. The first month they drove without system, the next months they drove with the system, and finally the last month participants they drove with the ISA system switched off.

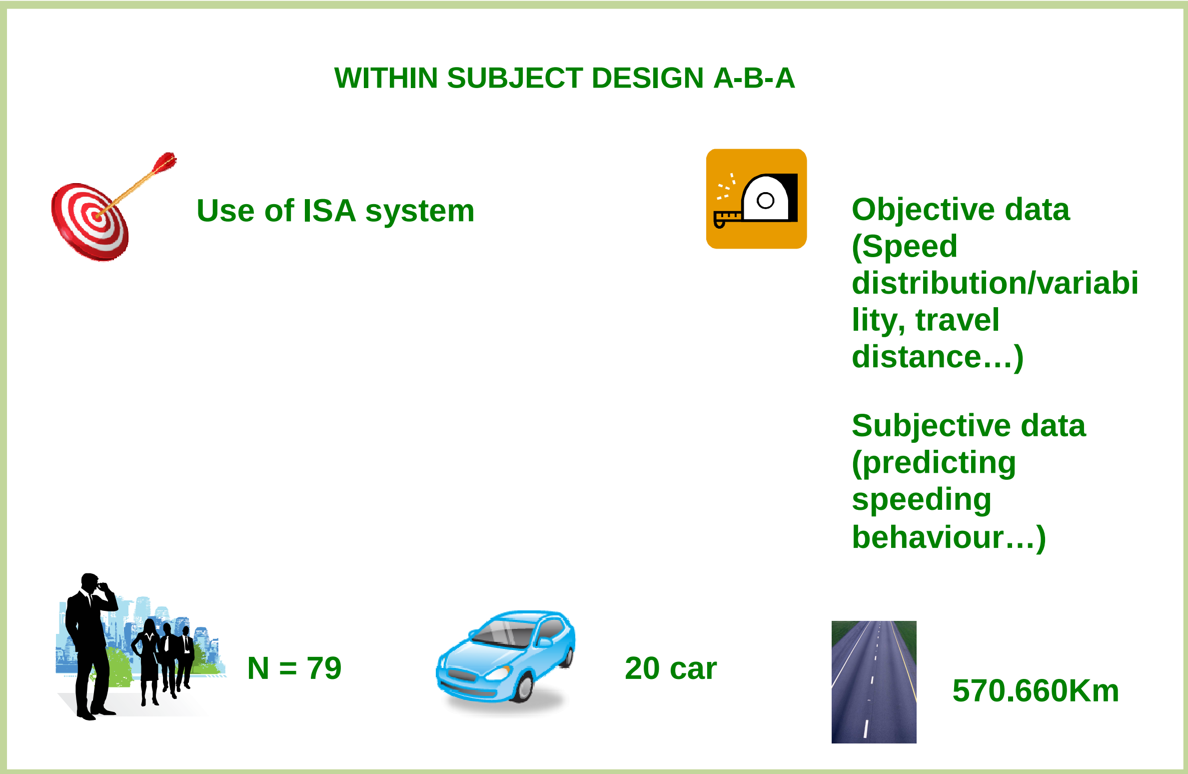

Figure 4 Main characteristics of "Intelligent Speed Adaptation" FOT.

2.5. An Overview of the 100-car Naturalistic Study and Findings

The main objective of this study was to provide information about driver performance, behaviour, environment, and other factors related to critical incidents, near crashes and crashes. The sample was comprised of 109 drivers (60% male, 40% female). In this Naturalistic study a total of 43.000 hours of data was registered during 12-13 months with experimental conditions.

Figure 5 Main characteristics of "An Overview of the 100-car Naturalistic Study and Findings" FOT.

2.6. Evaluation of the Mack Intelligent Vehicle Initiative Field Operational Test

This study was focused on the testing of a Lane Departure Warning System (LDWS) in order to achieve an in-depth understanding of the system benefits, ascertain the performance and capability potential of the system and assess the user acceptance. The study also assessed the product maturity for deployment and addressed the institutional a legal issues that might impact deployment. The sample was composed by 31 drivers. The study was divided in three phases during 12 months (March 2004-March 2005): baseline period (without system), active period (with system) and post-active period (without system). During each phase on-board data were collected. The total number of km. done by the trucks were 43.000 Km.

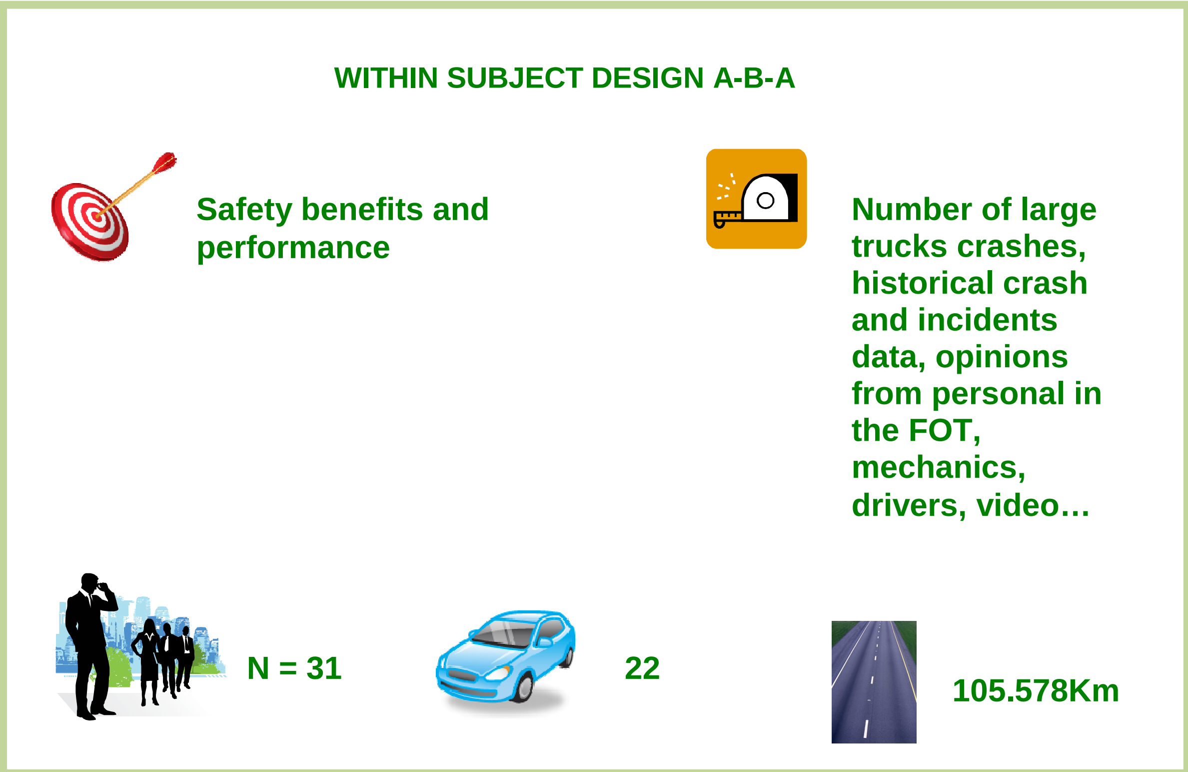

Figure 6 Main characteristics of "Evaluation of the Mack Intelligent Vehicle Initiative Field Operational Test" FOT.

2.7. Evaluation of the Freightliner Intelligent Vehicle Initiative Field Operational Test

The main objective of this FOT was to achieve an in-depth understanding of safety, mobility, efficiency, productivity benefits, and environmental quality benefits and assess the user acceptance and human factors. Furthermore, evaluate IVSS performance and capability potential, the product maturity for deployment and address institutional and legal issues that might affect deployment. The study used a repeated-measures design and the FOT plan was conducted over a 15 month period. Driver behaviour was evaluated through e.g. speed time history, average speed, lateral accelerations and subjective opinions where gathered about usability, acceptance, trust or workload driver perceptions.

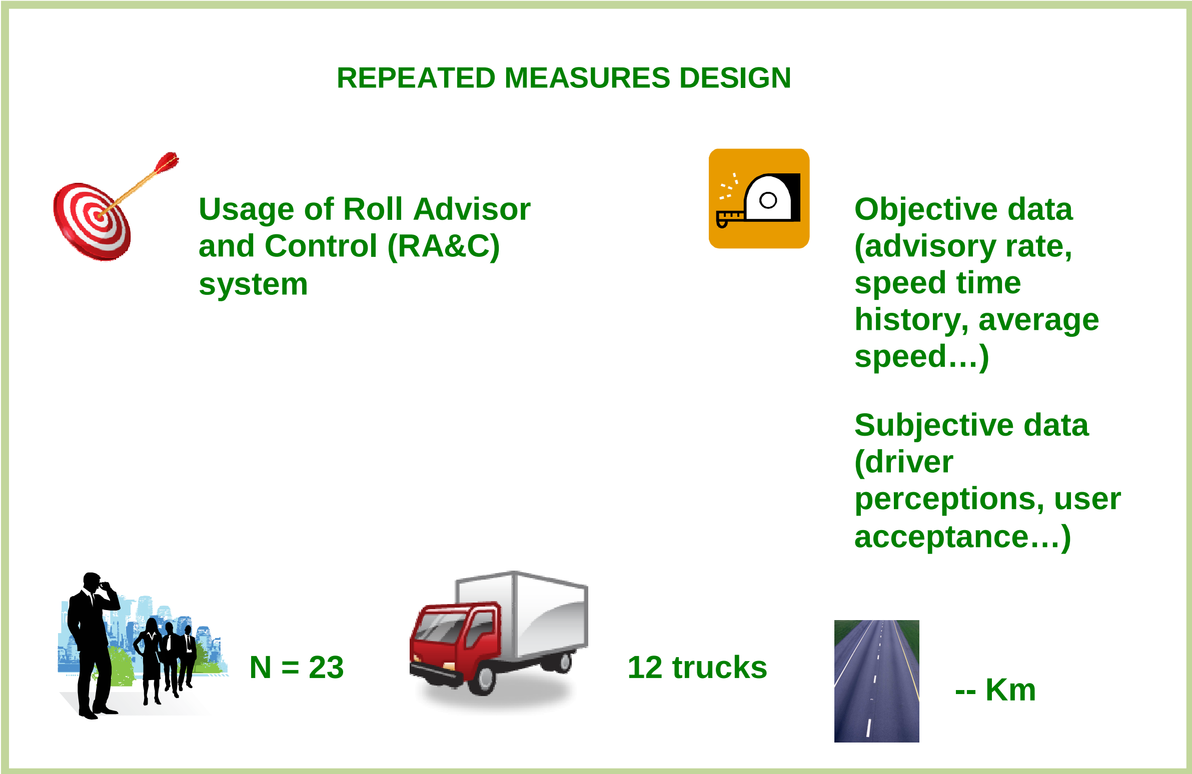

Figure 7 Main characteristics of "Evaluation of the Freightliner Intelligent Vehicle Initiative Field Operational Test" FOT.

2.8. Volvo Truck North Field Operational Test: Evaluation of Advanced Safety Systems for Heavy Truck Tractors

This FOT aimed to evaluate the performance in a real world environment of the following Advanced Safety Systems: Collision Warning system (CWS), Adaptive Cruise Control (ACC), disc brakes and an electronically controlled system (ECBS). Secondary objectives of the FOT were the acceleration of the deployment of the Advanced Safety Systems, help forge strategic partnerships in the transport industry and assess the state-of-the-art in safety benefits analysis for these systems.

The 3-year data collection involved 100 new tractors consisting of 50 (Control) vehicles equipped with **US Xpress** normal specifications (including CWS), and 50 (Test) vehicles equipped with the Advanced Safety Systems. Baseline vehicles (a 20-vehicle subset of the 50 Control vehicles) were operated for part of the FOT with their CWS driver displays disconnected. All of the FOT vehicles were equipped with onboard data acquisition systems. Beginning in January 2001, the vehicles were placed into service with US Xpress, and were operated in normal revenue generating service throughout the 48 contiguous United States.

For the evaluation both subjective and objective data were collected. The subjective data were collected through surveys and driver interviews, while for recording objective data (e.g. time to collision, speed, acceleration, etc.) a data recording system (DAS) based in a computer on board was used. The DAS system record data of the vehicle and the Advanced Safety Systems and download the data to a central computer by remote wireless. Video information was also recorded during the FOTs. The large amount of data recorded during the 3 years of FOT implied the use of data reduction techniques before the analyses.

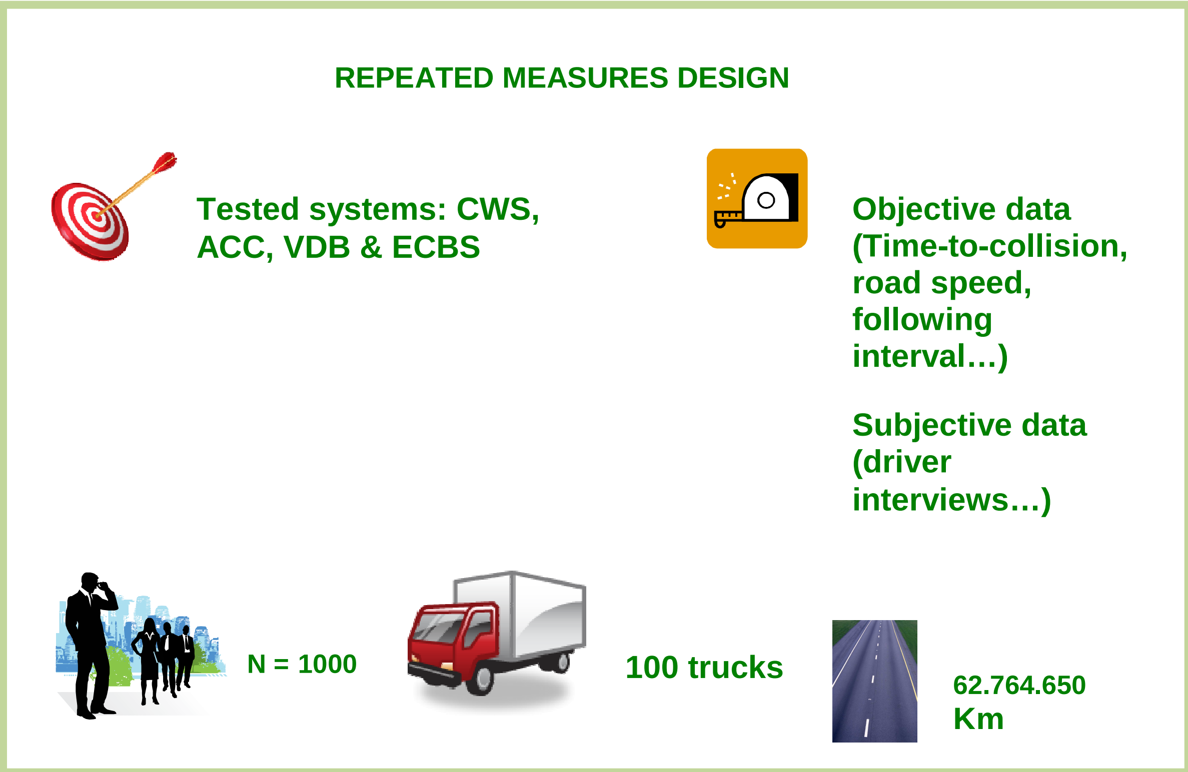

Figure 8 Main characteristics of "Volvo Truck North Field Operational Test: Evaluation of Advanced Safety Systems for Heavy Truck Tractors" FOT.

2.9. Automotive Collision Avoidance System Field Operational Test Report: Methodology and Results

The objective of this FOT is to analyze the effects of ACAS on driving behaviour. To reach this aim 96 drivers participated in this study. The design proposed was a mixed-factor design: between –subjects' variables made reference to driver age and driver age while the within-subjects variables were related with ACAS disabled (baseline) versus ACAS enabled. The period of the test was of twelve months. Driver behaviour was evaluated through the time headway, the systems usage, the overtaking manoeuvres, and the selection of freeway lane…etc. Moreover subjective aspects such as usability, acceptance, trust or workload were analyzed.

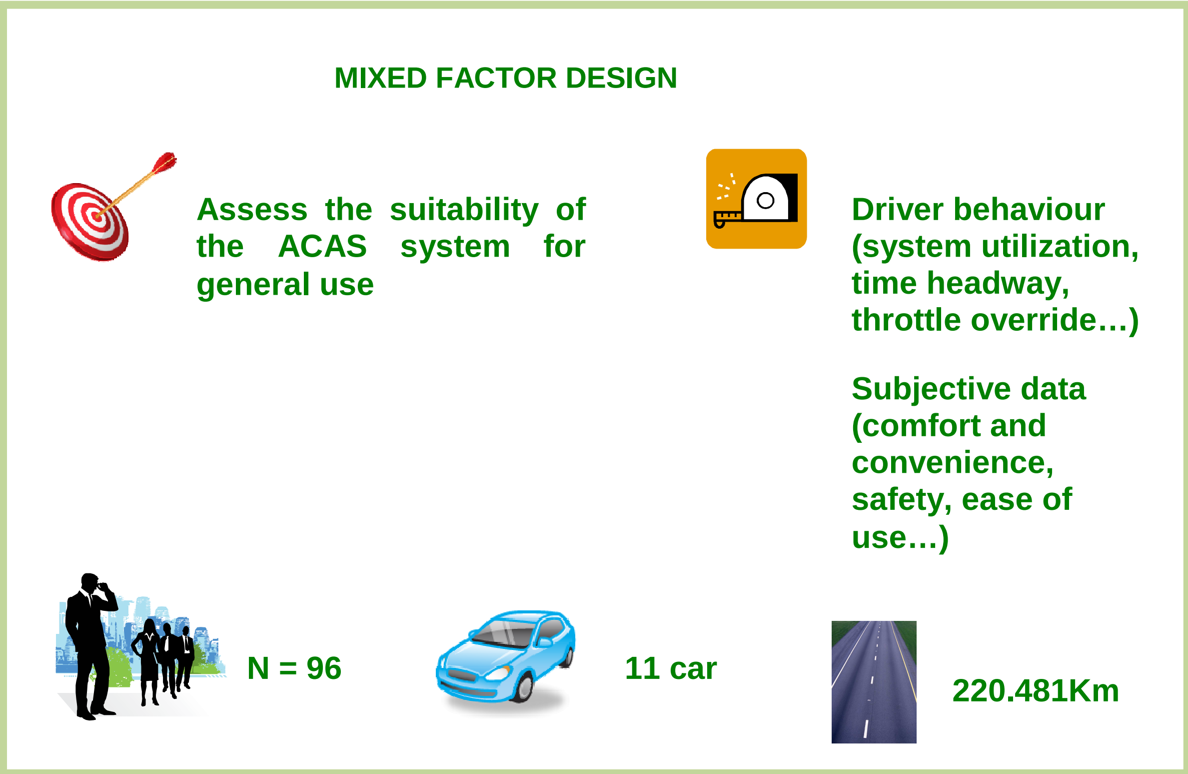

Figure 9 Main characteristics of "Automotive Collision Avoid System Field Operational Test Report: Methodology and Results" FOT.

2.10. Intelligent Cruise Control Field Operational Test

The target of this FOT was to characterize safety and comfort issues. The main device analyzed in this study was the ACC system. Ten field-vehicles were used in this project. The results presented the driving experience of 108 volunteer participants who used an ACC-equipped car. The experimental design was a naturalistic one without constraining where or when the participants were driving. The independent variables associated with driver characteristic were age, conventional-cruise-control usage, and duration of exposure to ACC. Performance indicators such as velocity, frequency of cut-in, time to impact…were analyzed. Moreover, subjective indicators such as usefulness, satisfaction or willingness to purchase were evaluated too.

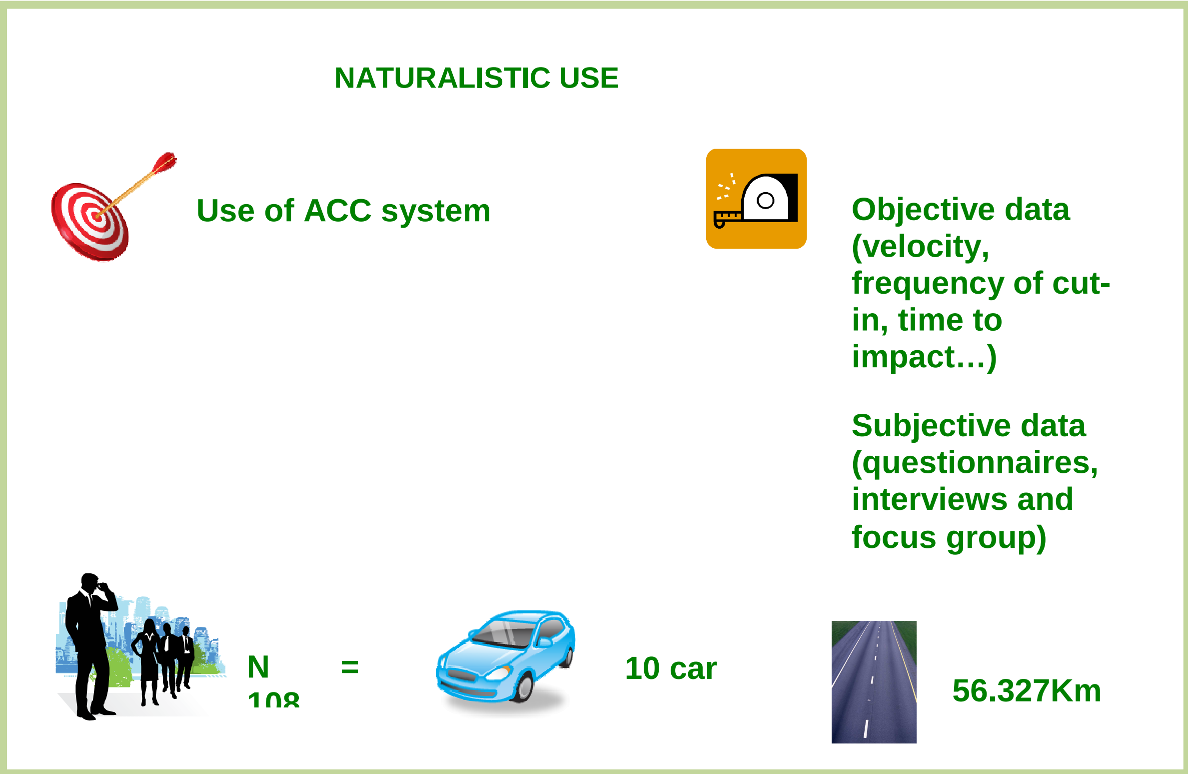

Figure 10 Main characteristics of "Intelligent Cruise Control Field Operational Test" FOT.

2.11. *Integrated Vehicle-Based Safety Systems Heavy-Truck On-Road Test Report*

The main objective of this study was carried out a series of on-road verification tests to assess the performance of an integrated safety system for light vehicles. The study was part of the Integrated Vehicle-Based Safety Systems (IVBSS) initiative in the Intelligent Transportation Systems (ITS) program of the U.S. Department of Transportation and addresses the prevention of rear-end, lane change, and road departure crashes. The goal of the IVBSS program is to accelerate the deployment of integrated crash warning systems for light vehicles1 and heavy commercial trucks that help prevent rear-end, lane change, and road departure crashes.

For the study a prototype integrated system provides FCW (Forward Crash Warning), Lane Departure Warning (LDW), and LCM (Lane Change Merge). This system was integrated in an International 8600 heavy truck for the road tests that was driven in an uncontrolled driving environment on public roads.

Test objectives were to measure the system's susceptibility to nuisance alerts, assess alerts in perceived crash situations, and evaluate system availability over a wide range of driving conditions. On-road tests were conducted three times between September 2007 and March 2008. Data collected during the tests was analyzed and used to evaluate system readiness for a field operational test planned for 2009 and to identify areas of system performance that could be improved prior to the start of the field test.

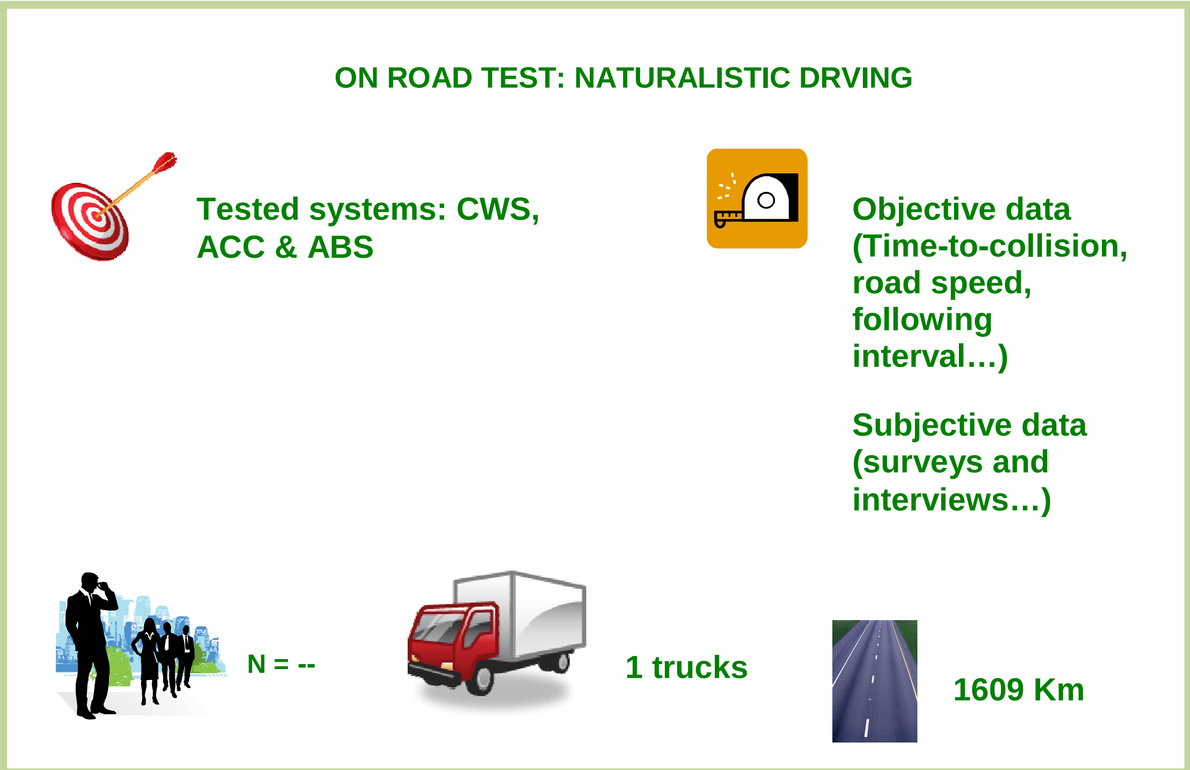

Figure 11 Main characteristics of "Integrated Vehicle-Based Safety Systems Heavy-Truck On-Road Test Report" FOT.

2.12. Evaluation of the Volvo Intelligent Vehicle Initiative Field Operational Test.

The IVI program was focused in the evaluation of the effectiveness of IVSS and stimation of the social benefits and costs, taking as reference the deployment in the FOTs and in case the IVSS were deployed across the entire heavy vehicles national fleet.

Three primary goals are presented in this study: Achieve an in-depth understanding of the safety benefits of intelligent vehicle safety systems (IVSS), assess user (driver) acceptance and human factors, and analyze the ratio of life-cycle benefits to costs for deploying the IVSS on a societal level.

Three systems were tested: Collision Warning System (CWS), Adaptive Cruise Control (ACC) and Advanced Braking System (ABS). And they were designed to assist commercial vehicle drivers in order to reduce the occurrence and severity of rear-end crashes as well as lane change / merge crashes.

For this study, new Volvo tractors were equipped with IVSS technologies and instrumented for data collection before being leased and laced in normal service operations. Depending on the safety systems installed on the tractors, they were divided into three groups: 50 "test" vehicles, equipped with the three safety technologies (CWS, ACC and AdvBS); 30 "control" vehicles, equipped with CWS; and 20 "Baseline" vehicles, equipped with a disabled CWS for the first 18 months of the FOT, and then with enabled CWS for the remaining time of the FOT. When the CWS was disabled, data were collected, but the driver display was not active and alerts were not communicated to the drivers.

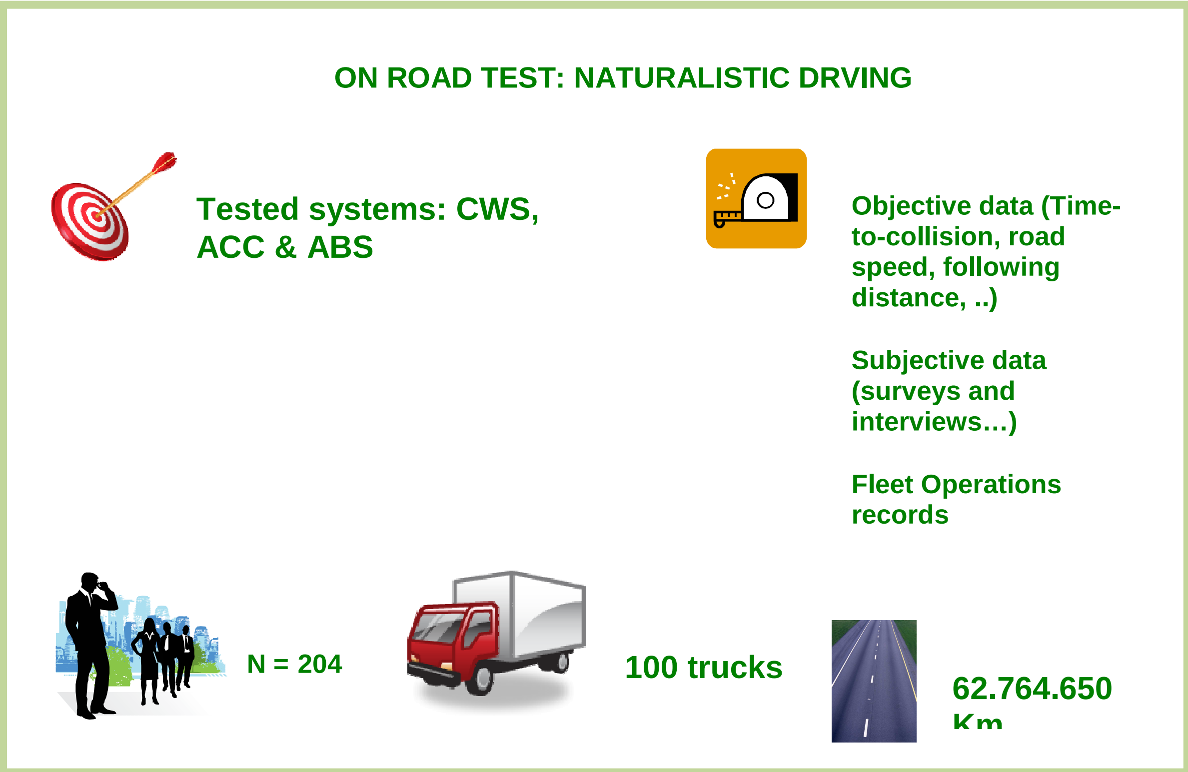

Figure 12 Main characteristics of "Evaluation of the Volvo Intelligent Vehicle Initiative Field Operational Test Version 1.3" FOT.

3. FESTA methodology description

3.1. Introduction

FESTA was created under the 7th Framework Programme as the action to support Field Operational Test. Although the FREILOT project is a pilot, the FESTA methodology could be a reference to draw up an evaluation plan and to identify which behavioural measures should be took into account.

The FESTA methodology has been developed because there was a need to offer guidelines and a common methodology for the conduction of FOTs in Europe (FESTA Handbook). This methodology provides aspects as for example the needs of analysis or the integration the acquired data.

The final aim of a FOT is to evaluate different in-vehicle systems in order to address specific research questions related to different topics (environment, traffic efficiency or acceptance). To achieve this general objective the first step is to identify functions. After this, it is necessary to define statistically testable hypotheses and to find measurements to test these hypotheses.

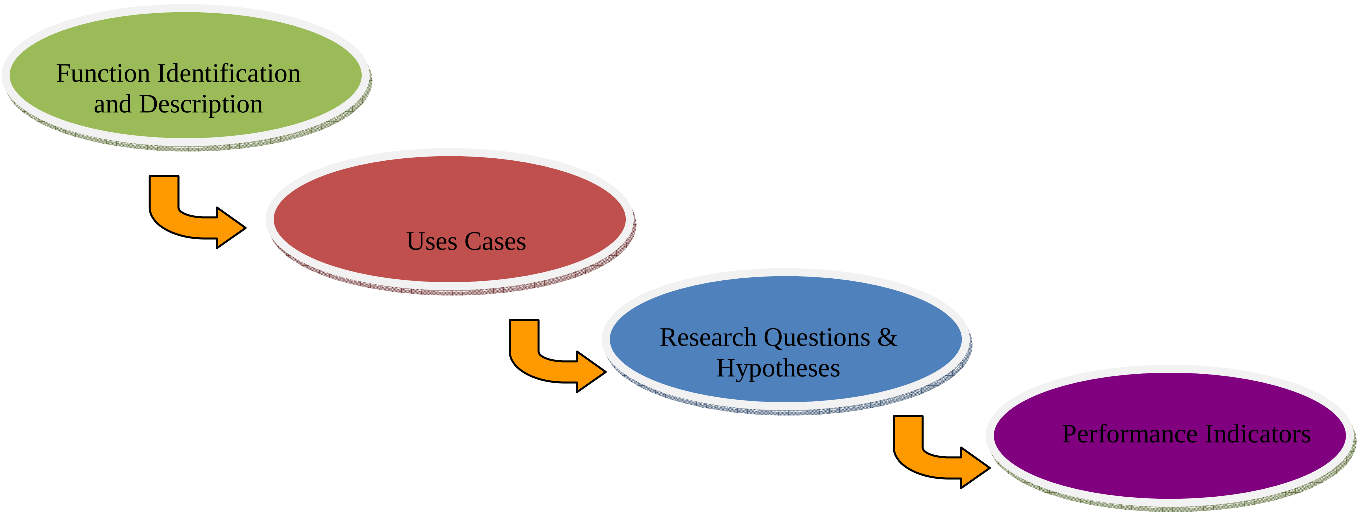

Figure 13 First steps considered to follow an FOT (based on FESTA Handbook)

3.2. Function Identification and Description

It's necessary to have a complete description of the selected functions. This information can to be divided into two parts:

- Functional Classification: it contains all relevant specifications of the system, provided by the vendor.
- Descriptions of limitations, boundary circumstances and extra information that will be useful for us with the purpose of understand how the function works. When it's mentions boundary circumstances, it's refers when and under wich circumstances the function will operate, what type of data will be needed to record during the FOT, where the FOT will be developed…etc. (Infrastructure requirements, driver requirements, road context, traffic context, environmental restrictions and other limitations.)

3.3. Use Cases

The use cases are putting the systems and functions at a suitable level of abstraction in order to group technology-independent functionalities and answer more holistic research questions described later.

The definition of use case is a target condition in which a system is expected to behave according to a specified function. A specific use case is a system and driver state, where “system” includes the road and traffic environment. Use cases are very general descriptions, and provide a tool for people with different background.

After, the situations are defined as a combination of characteristics of a use case. Situations can be derived from use cases compiling a reasonable permutation of the use cases characteristics.

3.4. Research Question & Hypotheses

A research question (RQ) is a statement that identifies the event to be studied; therefore the RQ is the question that you are trying to answer when you do research on a topic, in this case, about a FOT. The Research Questions (RQ) should focus mainly on impacts although there are other questions than can be asked.

Once the research questions are proposed, hypotheses can be derived from them. In this process the general research questions are expressed as more specific and statistically testable hypotheses. Hypotheses are more detailed predictions about the nature and direction of the relationship between two variables, for example, between intersection control and delivery time. These hypotheses are statements that can be proved or disproved.

Finally, the hypotheses are linked with measurements and indicators for quantitative analyses. Sometimes, the hypotheses include an indicator which needs to be measured, e.g. a concrete hypothesis likes “The intersection control will decrease the delivery time”. In this case, it is obvious that delivery time is a direct measurement. In other cases, it will be important to identify surrogate measurements or indicators.

3.5. Performance Indicators

Regarding the data logging systems, FESTA proposes guidelines and recommendations for selecting the more adequate data logging system and how to handle data in a FOT study. In general it covers aspects such as data acquisition, data storage, and data analyses tools.

Performance indicators (PIs) are quantitative or qualitative measurements, agreed on beforehand, expressed as a percentage, index, rate or other value, which is monitored at regular or irregular intervals and can be compared with one or more criteria.

For PI measured via rating scales and questionnaires, focus groups, interviews, etc., the “denominator” would be the time and circumstances of administrating the measuring instruments, for example before the test, after having experienced the system, and so on.

PIs are very diverse in nature. There are global PIs as well as detailed PI, there are observed and self-reported PIs, there are PIs calculated from continuous and from discrete data, and so on. An example for a rather global PI based on continuous log data would be the mean speed on motorways, whereas an example for a PI based on discrete, self-reported data would be the level of perceived usability of a function.

Some PIs can be based on either self-reported, discrete measures or on log data, like for example the rate of use of a system. The participants can be asked how often they use a function, but the actual function activation and the different settings chosen by the driver can also be logged from the system.

All PIs are based on measures, which are combined and/or aggregated in certain ways, and which are normalised in order to allow comparisons

4. Description of Services

The chapter describes the services that will be evaluated in the four pilot sites, a brief description of their functionality and the uses cases for each of them. More detailed information can be found in the D.FL.2.1 Implementation plan.

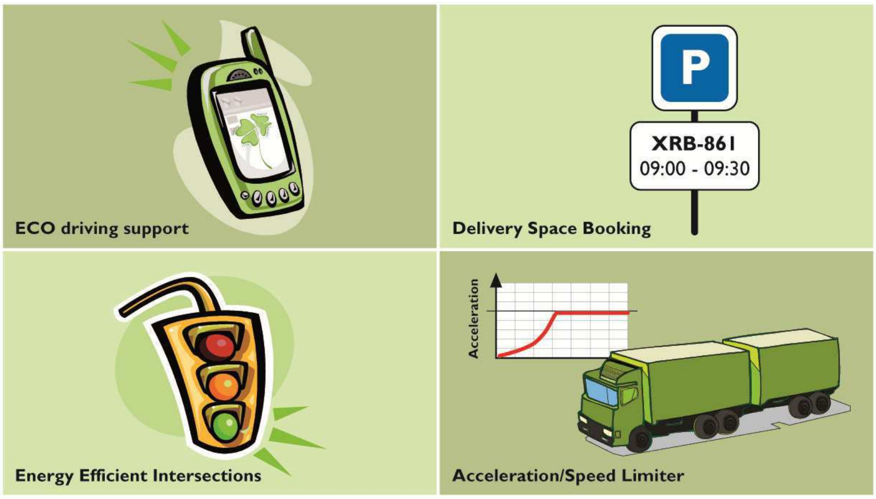

Figure 14 FREILOT services

4.1. Intersection Control

4.1.1. Functionality

The Intersection Control application provides priority to Heavy Goods Vehicles (HGV) at controlled intersections. If possible the traffic light towards which the vehicle is driving will become green sooner, or the current green phase will be extended to allow the vehicle to pass without stopping. Depending on the detection mechanism priority is provided to all HVGs or to the FREILOT vehicles only.

4.1.2. Use Cases

The following use cases will be implemented:

- Intersection Control with passive detection
  - **Request priority**: a vehicle requests priority at an intersection
  - **Speed Advice**: a speed advice is presented to a oncoming vehicle
  - **Retrieve Logging**: logging information is retrieved for further processing
- Intersection Control with coordination system (Lyon).
  - **Coordination for green wave:** A common time base for all intersection controllers of an area is necessary in order to build a green wave. The controllers shall be coordinate
  - **Retrieve Logging**: logging information is retrieved for further processing
  - **FREILOT Embedded System** : All embedded systems which can log data for evaluation
- Use cases zone speed limiter
  - **Define Speed Limitation Zones**: The Volvo expert defines the speed limitation zones for a set of trucks in the back office system. This is done thanks to inputs from the fleet operator and from the city operator. Each zone is defined by a polygon (GPS points) and the associated speed limit.

  - **Upload Speed Limitation Zones**: The identified zones are uploaded by the back office system to the vehicles, using GPRS communication..
  - **Zone detection**: The onboard system detects if the truck enters/exits a zone by comparing the defined zones with the current GPS position.
  - **Acceptation of speed limitation:** The driver then has the choice to accept or reject the speed limitation. If the driver accepts, the speed limit of the zone is applied by speed limiter function of the truck.

These use cases are described in more detail in the D.FL.2.1 Implementation plan.

4.2. Speed Limiter

4.2.1. Functionality

The Speed Limiter service limits the vehicle speed in certain predefined zones in a city. Vehicle position is determined by GPS. When the vehicle enters a speed zone a message is sent to the driver asking him to accept the predefined speed limitation.

4.2.2. Use Cases

The main use cases identified are the following ones:

- **Define Speed Limitation Zones**: The Volvo expert defines the speed limitation zones for a set of trucks in the back office system. This is done thanks to inputs from the fleet operator and from the city operator. Each zone is defined by a polygon (GPS points) and the associated speed limit.
- **Upload Speed Limitation Zones**: The identified zones are uploaded by the back office system to the vehicles, using GPRS communication..
- **Zone detection**: The onboard system detects if the truck enters/exits a zone by comparing the defined zones with the current GPS position.
- **Acceptation of speed limitation**: The driver then has the choice to accept or reject the speed limitation. If the driver accepts, the speed limit of the zone is applied by speed limiter function of the truck.

These use cases are described in more detail in the D.FL.2.1 Implementation plan.

4.3. Acceleration Limiter

4.3.1. Functionality

The acceleration Limiter service limits the engine acceleration to a certain level in order to optimize the fuel consumption in relation to a mobility trade-off. The function is made to optimize a route profile to be travelled by a specific truck type.

An acceleration limitation map and related parameters are adjusted using an off-board tool which automatically calculates the optimized set-up of parameters; the acceleration map is then downloaded to the vehicle engine management system and thus the service is activated.

4.3.2. Use Cases

The main use cases identified are the following ones:

- **Define Mission:** The Volvo expert defines together with the fleet operator which route, truck and load that will be used for a specific mission.

- **Calculate optimal acceleration map**: The Volvo expert calculates the optimal acceleration map for the defined route or type of route. This is done with a Volvo in-house simulation tool that combines advanced vehicle models and actual route data
- **Update vehicle acceleration map:** The Volvo expert downloads the new acceleration map to the vehicle. This is done with a dedicated and physical connection to the vehicle.
- **Limit acceleration:** The EMS limit the acceleration according to the defined map. The driver doesn't need to interact at all.

These use cases are described in more detail in the D.FL.2.1 Implementation plan.

4.4. Eco Driver Support

4.4.1. Functionality

The Eco Driving Support service aims to help the driver to improve his driving style to minimize the fuel consumption by giving real-time advices during the trip; the service gives continuous feedback to the driver on how to improve:

- Engine speed at shift up in start and acceleration section
- Accelerator position in start and acceleration section
- Engine speed in cruise section
- Max vehicle speed in start-stop section
- The percentage of coasting in deceleration section

The system also gives the fleet operator the possibility to evaluate the truck driver's performance though an off-board analysis tool.

4.4.2. Use Cases

The main use cases identified are the following ones:

- **Set configuration**: The driver can define if the advices are displayed or not.
- **Get real-time advice**: The driver coaching system gives advices depending on driver performance. The following advices can be given:
- **Late shift up in start and acceleration section**
- **Accelerator pedal pushed too far**
- **Late shift up in steady running section**
- **Low percentage of coasting in deceleration section**
- **Parking brake set but engine still running**
- **Upload trip result**: The result from each trip is uploaded to the fleet management system
- **Get trip evaluation**: The driver can get an evaluation of the trip that was performed.

These use cases are described in more detail in the D.FL.2.1 Implementation plan.

4.5. Delivery Space Booking

4.5.1. Functionality

The Delivery Space Booking feature allows an operator or / and his drivers to book a delivery space in advance, in order to make sure that the driver can benefit from a free public space once he arrives to an unloading or loading point.

Two different approaches will be tested in the project: in Lyon, the driver will be able to manage the system (booking, cancellations, rescheduling) using onboard equipment, in Bilbao, no action will be possible from within the truck. Nevertheless, a specific device places next to each space will allow drivers to book those in real time, if they are not booked yet.

4.5.2. Use Cases

The main use cases for the delivery space booking will be:

- Request a reservation
- Confirm a reservation
- Cancel a reservation
- Check an existing reservation
- Send alerts to enforcement personnel
- Get reservation status
- Send arrival / departure notification

Additionally, in Lyon, these use case will be tested:

- All previous use cases, from within the truck
- Update Estimated Time of Arrival

5. Pilot sites conditions

This chapter summarizes the pilot sites conditions (see D.FL.2.1 Implementation plan): services to be tested, number of trucks and characteristics, intersections proposed for Intersection Control, Parking Booking areas to be used during the project.

The FREILOT pilots will run in four test sites in Europe: Krakow – Poland; Bilbao – Spain; Helmond – Netherlands; Lyon – France. Five applications will be tested in the different test sites: Intersection control, Speed and acceleration limiter, Eco driving support and Delivery Space Booking.

Below a table summarizing the applications to be tested in each test site is included:

Applications	Bilbao	Helmond	Krakow	Lyon
Intersection control		✓	✓	✓
Speed and acceleration limiter	✓	✓		✓
Eco driving support	✓	✓	✓	✓
Delivery space booking	✓			✓

Table 1 Pilot Site Setup

These services are implemented in a set of trucks provided for different fleet operators who normally have delivery routes in the cities selected. The list of trucks per test site is constantly evolving (an updated version of the number of trucks can be found on the project's share point). Next table summarizes the number of trucks per test site and per service at the moment this document is prepared:

Applications	Bilbao	Helmond	Krakow	Lyon
Intersection Control (IC)	x	20 trucks	?	?
Speed Limiter (SL)	3 truck	2 trucks	?	?
Acceleration Limiter (AL)	3 truck	2 trucks	?	5 trucks
Eco Driving Support (EDS)	1 truck	14 trucks	?	3 trucks
Delivery Space Booking (DSB)	40 trucks	x	x	?

Table 2 Number of trucks per system and test site

The services installed in each truck are summarized in the next table:

HELMOND	
FREILOT Services Combination	Truck ID
AL	H15
SL	H14
IC	Waiting
AL + SL	H16
EDS + IC	H11, H12, H13, H17, H18, H19, H20
LYON	
FREILOT Services Combination	Truck ID
AL	L09, L10, L11, L12, L13
EDS	L16, L18, L19
IC+SL+AL+EDS+DSB	R1
BILBAO	
FREILOT Services Combination	Truck ID
AL	B04
SL	B03
EDS	B07
DSB	Final number of trucks? 40?
SL+AL	B05
AL+SL+EDS	B06
KRAKOW	
FREILOT Services Combination	FREILOT Services Combination
No data	No data

Table 3 Number of trucks per system and test site

A wide description of each pilot site configuration is included in the D.FL.2.1 Implementation plan.

6. Research Questions

This section describes the main research questions that guide the evaluation of FREILOT Services. The research questions are presented according to:

- The different impacts of FREILOT services usage.
- The driver acceptance.
- The implications of measured impacts.

6.1. Impacts of FREILOT services usage

Three different evaluation goals are suggested about the impacts of FREILOT services usage: impacts on the environment and fuel consumption, impacts on driving behaviour and impacts on traffic efficiency. The research questions are summarized as follows:

6.1.1. Impacts on the environment and fuel consumption

FREILOT services are expected to increase energy efficiency in road goods transport in urban areas with a reduction of 25% of fuel consumption, CO2 emissions and other pollutants.

RQ1: Achieve an in-depth understanding of the effect the FREILOT services have on energy efficiency (fuel consumption and fuel economy).

RQ2: Establish if the FREILOT services have a positive influence on the CO_2 emissions.

RQ3: Establish if the FREILOT services have a positive influence on other pollutants.

6.1.2. Impacts on driving behaviour

These research questions focus on extrapolating the results observed in the study to predict how FREILOT services influence driver behaviour.

RQ4: Determine if the driver changes his driving after the FREILOT services/systems usage.

RQ5: Determinate if the driver changes his behaviour after stopping to use FREILOT services.

RQ6: Determinate how the FREILOT services promote a more eco-friendly driving through the driver acceleration, braking and gear changing behaviour.

6.1.3. Impacts on traffic efficiency

Of particular interest is to collect information on the traffic efficiency impacts when FREILOT services are used. Three general questions are included:

RQ7: Determinate if the use of the FREILOT services will optimise the driver delivery time and promote travel time benefits for specific fleets (traffic efficiency).

RQ8: Determinate how the FREILOT services have influence on the traffic flow.

RQ9: Determine the impact of FREILOT services on noise levels.

6.2. Driver acceptance/perceptions of FREILOT services

Driver's acceptance of the FREILOT services and human factors are very important in the overall benefits of the FREILOT project.

RQ10: Assess driver acceptance and perceptions about the FREILOT services.

6.3. Implications of measured impacts

This section defines the research questions about the implications for policy and the identification of missing legislation or if it is necessary to establish new changes in the actual legislation.

- Laws, directives & enforcements
- Public authority implications

RQ11: The FREILOT services have an impact on legislation and they are accepted by Public authorities because these services have direct effects on performances, pollutants and noise.

6.4. Impacts of FREILOT by service

The FREILOT services under test are expected to reduce the fuel consumptions and CO_2 emissions. Furthermore the usage of these services is expected to change perceptions and lead to acceptance of the FREILOT services as well as to improve the traffic flow compared to the current situation. In this case, it is possible to include different research questions by service:

Function/Impact	Intersection Control	Acceleration limiter & Speed limiter	Eco-driving support	Delivery Space Booking
Effect on energy efficiency	RQ1_1	RQ1_2	RQ1_3	RQ1_4
Reduction of CO2	RQ2_1	RQ2_2	RQ2_3	RQ2_4
Reduction of other pollutants	RQ3_1	RQ3_2	RQ3_3	RQ3_4
Changes in the driving behaviour after FREILOT services/systems usages	RQ4_1	RQ4_2	RQ4_3	RQ4_4
Changes in the	RQ5_1	RQ5_2	--	--

driving behaviour after stopping to use FREILOT services/systems				
Promotion a more eco-friendly driving	RQ6_1	RQ6_2	RQ6_3	--
Improvement of traffic efficiency	RQ7_1	--	--	RQ7_4
Positive impact on traffic flow	RQ8_1	--	--	RQ8_4
Positive impact on noise level	--	--	--	--
Positive acceptance and perceptions on FREILOT services/systems by drivers	RQ10_1	RQ10_2	RQ10_3	RQ10_4
Positive impact on legislation and acceptation by Public authority	RQ11_1	RQ11_2	RQ11_3	RQ11_4
Possitive acceptance of customer & drivers of a modified journey duration / fuel consumption trade-off	--	RQ12_2	--	--

Table 4 Research Questions by service.

6.4.1. Energy Efficient Intersection Control (INC)

RQ1_1: Achieve an in-depth understanding of the benefits of the Energy Efficient Intersection Control on energy efficiency (fuel consumption and fuel economy).

RQ2_1: Establish if the Energy Efficient Intersection Control has a positive influence on the CO2 emissions.

RQ3_1: Establish if the Energy Efficient Intersection Control has a positive influence on other pollutants.

RQ4_1: Determine if the driver changes his driving after the Energy Efficient Intersection Control usage.

RQ5_1: Determinate if the driver changes his behaviour after stopping to use Energy Efficient Intersection Control.

RQ6_1: Determinate how the Energy Efficient Intersection Control promotes a more eco-friendly driving through the driver acceleration, braking and gear changing behaviour.

RQ7_1: Determinate if the use of the Energy Efficient Intersection Control will optimise the driver delivery time and promote travel time benefits for specific fleets (traffic efficiency).

RQ8_1: Determinate how the Energy Efficient Intersection Control influences the traffic flow.

RQ10_1: Assess driver acceptance and perceptions about the Energy Efficient Intersection Control service.

RQ11_1: The FREILOT services have an impact on legislation and they are accepted by Public authority because these services have direct effects on performances, pollutants and noise.

6.4.2. Acceleration / Speed Limiter (AL) & (SL)

RQ1_2: Achieve an in-depth understanding of the benefits of the Acceleration / Speed Limiter has an effect on energy efficiency (fuel consumption and fuel economy).

RQ2_2: Establish if the Acceleration / Speed Limiter has a positive influence on the CO_2 emissions.

RQ3_2: Establish if the Acceleration / Speed Limiter have a positive influence on other pollutants.

RQ4_2: Determine if the driver changes his driving after the Acceleration / Speed Limiter usage.

RQ5_2: Determinate if the driver changes his behaviour after stopping to use Acceleration / Speed Limiter.

RQ6_2: Determinate how the Acceleration / Speed Limiter promote a more eco-friendly driving through the driver acceleration, braking and gear changing behaviour.

RQ8_2: Determinate how the Acceleration / Speed Limiter services have influence on the traffic flow.

RQ10_2: Assess driver acceptance and perceptions about the Acceleration / Speed Limiter service.

RQ11_2: The FREILOT services have an impact on legislation and they are accepted by Public authority because these services have direct effects on performances, pollutants and noise..

RQ12_2: Determinate the acceptance of customer & drivers of a modified journey duration/fuel consumption trade-off.

6.4.3. Eco-driving Support (EDS)

RQ1_3: Achieve an in-depth understanding of the effects the Eco-driving Support has on energy efficiency (fuel consumption and fuel economy).

RQ2_3: Establish if the Eco-driving Support has a positive influence on the CO2 emissions

RQ3_3: Establish if the FREILOT services have a positive influence on other pollutants.

RQ4_3: Determine if the driver changes his driving after the Eco-driving Support usage.

RQ6_3: Determinate how the Eco-driving Support promotes a more eco-friendly driving through the driver acceleration, braking and gear changing behaviour.

RQ10_3: Assess driver acceptance and perceptions about the Eco-driving Support service.

RQ11_3: The FREILOT services have an impact on legislation and they are accepted by Public authority because these services have direct effects on performances, pollutants and noise.

6.4.4. Real time loading / Delivery Space Booking (DSB)

RQ1_4: Achieve an in-depth understanding of the benefits of the Delivery Space Booking has an effect on energy efficiency (fuel consumption and fuel economy).

RQ2_4: Establish if the Delivery Space Booking has a positive influence on the CO2 emissions.

RQ3_4: Establish if the FREILOT services have a positive influence on other pollutants.

RQ4_4: Determine if the driver changes his driving after the Delivery Space Booking usage.

RQ7_4: Determinate if the use of the Delivery Space Booking will optimise the driver delivery time and promote travel time benefits for specific fleets (traffic efficiency).

RQ8_4: Determinate how the Delivery Space Booking has influence on the traffic flow.

RQ9_1: Determine the impact of Delivery Space Booking on noise levels.

RQ10_4: Assess driver acceptance and perceptions about the Delivery Space Booking service.

RQ11_4: The FREILOT services have an impact on legislation and they are accepted by Public authority because these services have direct effects on performances, pollutants and noise.

7. Hypotheses

Taking into account the above presented research questions several hypotheses are established for each FREILOT service. These hypotheses try to find the answer for the research questions that has been proposed in the section 6. Research Questions

- RQ1, RQ2 & RQ3: Research questions about the impacts on environment and fuel consumption benefits
- RQ4, RQ5 & RQ6: Research questions about impacts on driving behaviour
- RQ7, RQ8 & RQ9: Research questions about impacts on traffic efficiency, traffic flow and noise levels.
- RQ10: Research questions about driver acceptance or perceptions of FREILOT services
- RQ11: Implications of measured impacts.

For each service, a table summarized the research question, the area and the measure proposed. The area is identified with the next abbreviations: E&FC for Environment & Fuel Consumption, DB for Driving Behaviour, TE for Traffic Efficiency and DA for Driver Acceptance. Moreover every hypothesis is identified by two letters and a number.

7.1. Intersection Control Hypotheses

Thirty-eight hypotheses are proposed for Intersection Control Service. Most of then are related to the reduction of fuel consumption or the possibility that the usage of Intersection Control disturb the surrounding traffic. Other questions that could be assessed with the hypotheses are related with the acceptance and perception of the drivers about the system.

These hypotheses are proposed taking into account each possible use case of the service. So, before presented the table summarizing all the statements, below a table identifying each use case is presented.

IC_SF	Isolated control, priority for specific identified fleets Isolated control is on an intersection by intersection basis (no coordination). Control strategies are determined by local (loop) detectors. The priority in this use case is for specifically actively detected vehicles.
IC_HGV	Isolated control, priority for all vehicles over a specified length As the previous use case, but now there is priority for all long vehicles.
GW_SF	Green wave, optimised for specific identified fleets Green wave systems use coordination on a corridor. The coordination is fixed for a measured (by a limited number of (loop) detectors) traffic situation.
GW_HGV	Green wave, optimised for all vehicles over a specified length
AC_SF	Adaptive control, optimised for specific indentified fleets Adaptive control is a form of flexible network control, where coordination depends on the actual traffic demand. With higher volumes on the main corridor, coordination will occur as an emergent phenomenon.
AC_HGV	Adaptive control, optimised for all vehicles over a specified length

Table 5 Use cases Intersection Control

Intersection Control				
Hypotheses	RQ	Area	ID	Measure
Overall estimated fuel consumption in use case IC_SF will be lower than reference (default non-prioritised control)	RQ1_1	E&FC	IC1	Direct
Measured fuel consumption in the specific fleet in use case IC_SF will be 10% lower than reference (default non-prioritised control)	RQ1_1	E&FC	IC2	Direct
Overall estimated fuel consumption in use case GW_SF will be lower than reference (default non-prioritised control)	RQ1_1	E&FC	IC3	Direct
Measured fuel consumption in the specific fleet in use case GW_SF will be 10% lower than reference (default non-prioritised control)	RQ1_1	E&FC	IC4	Direct
Overall estimated fuel consumption in use case AC_SF will be lower than reference (default non-prioritised control)	RQ1_1	E&FC	IC5	Direct
Measured fuel consumption in the specific fleet in use case NC_AC_SF will be 12% lower than reference (default non-prioritised control)	RQ1_1	E&FC	IC6	Direct
Overall estimated fuel consumption in use case IC_HGV will be 5% lower than reference case (default non-prioritised control)	RQ1_1	E&FC	IC7	Direct
Overall estimated fuel consumption in use case GW_HGV will be 5% lower than reference case (default non-prioritised control)	RQ1_1	E&FC	IC8	Direct
Overall estimated fuel consumption in use caseAC_HGV will be 5% lower than reference case (default non-prioritised control)	RQ1_1	E&FC	IC9	Direct
Estimated fuel consumption of HGV's in use case IC_HGV will be 9% lower than reference case (default non-prioritised control)	RQ1_1	E&FC	IC10	Direct
Estimated fuel consumption of HGV's in use case GW_HGV will be 7% lower than reference case (default non-prioritised control)	RQ1_1	E&FC	IC11	Direct
Estimated fuel consumption of HGV's in use case AC_HGV will be 8% lower than reference case (default non-prioritised control)	RQ1_1	E&FC	IC12	Direct
Average cycle times on the intersections will increase nu more than 12% in use case IC_SF	RQ8_1	TE	IC13	Direct
Average cycle times on the intersections will increase no more than 15% in use case GW_SF	RQ8_1	TE	IC14	Direct
Average cycle times on the intersections will increase no more than 10% in use case AC_SF	RQ8_1	TE	IC15	Direct
Average cycle times on the intersections will increase no more than 20% in use case IC_HGV	RQ8_1	TE	IC16	Direct
Average cycle times on the intersections will increase no	RQ8_1	TE	IC17	Direct

more than 15% in use case GW_HGV				
Average cycle times on the intersections will increase no more than 18% in use case AC_HGV	RQ8_1	TE	IC18	Direct
Overall ravel times on main routes will remain unchanged in use case NC_IC_SF	RQ8_1	TE	IC19	Direct
Overall travel times on main routes will remain unchanged in use case GW_SF	RQ8_1	TE	IC20	Direct
Overall travel times on main routes will remain unchanged in use case AC_SF	RQ8_1	TE	IC21	Direct
Increase in travel times on crossing routes will be lower than 5% in use case IC_SF	RQ8_1	TE	IC22	Direct
Increase in travel times on crossing routes will be lower than 5% in use case GW_SF	RQ8_1	TE	IC23	Direct
Increase in travel times on crossing routes will be lower than 5% in use case AC_SF	RQ8_1	TE	IC24	Direct
Travel times on main routes will improve by 5% in use case IC_HGV	RQ8_1	TE	IC25	Direct
Travel times on main routes will improve by 5% in use case GW_HGV	RQ8_1	TE	IC26	Direct
Travel times on main routes will improve by 8% in use case AC_HGV	RQ8_1	TE	IC27	Direct
Increase in travel times on crossing routes will be lower than 20% in use case IC_HGV	RQ8_1	TE	IC28	Direct
Increase in travel times on crossing routes will be lower than 8% in use case GW_HGV	RQ8_1	TE	IC29	Direct
Increase in travel times on crossing routes will be lower than 10% in use case AC_HGV	RQ8_1	TE	IC30	Direct
Intersection Control service is appreciated by drivers	RQ10_1	DA	IC31	Questionnaire
Drivers will perceive that Intersection Control service is reliable	RQ10_1	DA	IC32	Questionnaire
Drivers will find the Intersection Control service is useful when driving	RQ10_1	DA	IC33	Questionnaire
Drivers will think the Intersection Control service is easy to use	RQ10_1	DA	IC34	Questionnaire
Drivers stress perception will decrease with the Intersection Control service usage	RQ10_1	DA	IC35	Questionnaire
Perceived risk of accidents will decrease with the Intersection Control service usage	RQ10_1	DA	IC36	Questionnaire
According to the driver perception the Intersection Control service will improve of freight transport image in urban areas	RQ10_1	DA	IC37	Questionnaire
Drivers will trust the Intersection Control service	RQ10_1	DA	IC38	Questionnaire

Table 6 Hypotheses Intersection Control

7.2. Speed Limiter Hypotheses

Sixteen hypotheses are proposed for the Speed Limiter Service. Again most of them are related with the acceptance and perception of the drivers about the system. Furthermore some measures could determinate if the speed limiter system will increase the time of delivery or the average speed of the truck. Other questions that could be assessed with the hypotheses are related to the reduction of fuel consumption or the possibility that the usage of Speed Limiter disturb the surrounding traffic.

Speed Limiter				
Hypotheses	RQ	Area	ID	Measure
Using the Speed Limiter service, the time of delivery will increase	RQ8_2	TE	SL1	Direct
Using the Speed Limiter service reduces fuel consumption	RQ1_2	E&FC	SL2	Direct
A truck using the the Speed Limiter service will not disturb surrounding traffic	RQ9_2	TE	SL3	Direct
Average speed of the truck will decrease with the usage of the speed limiter	RQ4_2	DB	SL4	Direct
Driver braking behaviour will change after stopping to use speed limiter	RQ5_2	DB	SL5	Direct
Driver braking behaviour will change with the usage of speed limiter	RQ6_2	DB	SL6	Direct
Using the Speed Limiter service, the driver will accept/acknowledge speed limit recommendations from the system	RQ10_2	DA	SL7	Questionnaire
Using the Speed Limiter service, the driver will be not be disturbed in his driving task	RQ10_2	DA	SL8	Questionnaire
The Speed Limiter service is appreciated by drivers	RQ10_2	DA	SL9	Questionnaire
Drivers will perceive that speed limiter service is reliable	RQ10_2	DA	SL10	Questionnaire
Drivers will find the speed limiter is useful when driving	RQ10_2	DA	SL11	Questionnaire
Drivers will think the speed limiter is easy to use	RQ10_2	DA	SL12	Questionnaire
Drivers' stress perception will decrease with the speed limiter usage	RQ10_2	DA	SL13	Questionnaire
Perceived risk of accidents will decrease with the speed limiter usage	RQ10_2	DA	SL14	Questionnaire
According to the driver perception, the speed limiter system will improve the freight transport image in urban areas	RQ10_2	DA	SL15	Questionnaire
Drivers will trust the speed limiter system	RQ10_2	DA	SL16	Questionnaire

Table 7 Hypotheses Speed Limiter

7.3. Acceleration Limiter Hypotheses

Seventeen hypotheses are proposed for the Acceleration Limiter System. Most of them are related to the acceptance and perception of the drivers about the system (e.g. risk perceptions). Although the primary questionnaire seeks to evaluate the perceptions and opinions of drivers, also a questionnaire for fleet owners will be designed. Some measures could determinate if Acceleration Limiter service will reduce the fuel consumption or capacity of acceleration on flat road. It could be possible to evaluate if driver accelerates less with the usage of the system.

Acceleration Limiter				
Hypotheses	RQ	Area	ID	Measure
Using the Acceleration Limiter service, fuel consumption will decrease	RQ1_2	E&FC	AL1	Direct
Using the Acceleration Limiter service load, capacity will not change	RQ8_2	TE	AL2	Direct
Using the Acceleration Limiter service, the driver will notice decreased capacity of acceleration on flat road	RQ6_2	DB	AL3	Direct
Using the Acceleration Limiter service, the exterior noise level will decrease	RQ2?	E&FC	AL4	??
Acceleration Limiter usage will decrease CO2 emissions	RQ2_2	E&FC	AL5	Direct
Acceleration Limiter usage will decrease emissions of other pollutants	RQ3_2	E&FC	AL6	Direct
The driver will accelerate less with the usage of the acceleration system	RQ4_2	DB	AL7	Direct
Using the Acceleration Limiter service, the driver will note decreased capacity of acceleration on flat road	RQ4_2	DB	AL8	Questionnaire
The Acceleration Limiter service is appreciated by drivers	RQ10_2	DA	AL9	Questionnaire
Drivers will perceive that the Acceleration Limiter service is reliable	RQ10_2	DA	AL10	Questionnaire
Drivers will find the Acceleration Limiter is useful when driving	RQ10_2	DA	AL11	Questionnaire
Drivers will think the Acceleration Limiter is easy to use	RQ10_2	DA	AL12	Questionnaire
Drivers' stress perception will decrease with the acceleration limiter usage	RQ10_2	DA	AL13	Questionnaire
Perceived risk of accidents will decrease with the acceleration limiter usage	RQ10_2	DA	AL14	Questionnaire
According to the driver perception the acceleration limiter system will improve of freight transport image in urban areas	RQ10_2	DA	AL15	Questionnaire
Drivers will trust the acceleration limiter system	RQ10_2	DA	AL16	Questionnaire
The drivers will accept increase on journey duration as a trade off to decreased fuel consumption	RQ12_2	DA	AL17	Questionnaire

Table 8 Hypotheses Acceleration Limiter

7.4. Eco Driving Support Hypotheses

Thirteen hypotheses are proposed for Eco Driving Support. The majority are related to the acceptance and perception of the drivers about the service. Furthermore some measures could determine if the speed limiter system will increase the time of delivery or the average speed of the truck. Other questions that are assessed with the hypotheses are related with the reduction of fuel consumption or the possibility that the usage of Eco Driving Support disturb the surrounding traffic.

Eco Driving Support				
Hypotheses	RQ	Area	ID	Measure
Following the advice from the Eco-Driving Support service will lead to decreased fuel consumption	RQ1_3	E&FC	EDS1	Direct
Following the advice from the Eco-Driving Support service CO2 emissions will decrease	RQ2_3	E&FC	EDS2	Direct
Following the advice from the Eco-Driving Support service emission of other pollutants will decrease	RQ2_3	E&FC	EDS3	Direct
Following the advice from the Eco-Driving Support service harsh acceleration and braking will reduce	RQ4_3 RQ6_3	DB	EDS4	Direct
In stressful situations drivers will have difficulties to follow the instructions	RQ3_3	DB	EDS5	Questionnaire
Eco-Driving Support service is appreciated by drivers	RQ10_3	DA	EDS6	Questionnaire
Drivers will perceive that Eco driving support is reliable	RQ10_3	DA	EDS7	Questionnaire
Drivers will find the Eco driving support useful when driving	RQ10_3	DA	EDS8	Questionnaire
Drivers will think the Eco driving support is easy to use	RQ10_3	DA	EDS9	Questionnaire
Drivers’ stress perception will increase with the Eco driving support usage	RQ10_3	DA	EDS10	Questionnaire
Perceived risk of accidents will decrease with the Eco driving support usage	RQ10_3	DA	EDS11	Questionnaire
According to the driver perception the Eco driving support system will improve of freight transport image in urban areas	RQ10_3	DA	EDS12	Questionnaire
Drivers will trust the Eco driving support system to give good advice	RQ10_3	DA	EDS13	Questionnaire

Table 9 Hypotheses Eco Driving Support

7.5. Delivery Space Booking Hypotheses

Seventeen/ Eighteen hypotheses are proposed for Delivery Space Booking service. Most of them are related with the acceptance and perception of the drivers about the service. Moreover some measures could determinate if the delivery space book reduces the lengths and time of delivery journeys or if the service decreases the fuel consumption or the CO2 emissions. Assess the state about double lane stops is another objective to assess with the hypotheses for this service.

Delivery Space Booking				
Hypotheses	RQ	Area	ID	Measure
Delivery space booking reduces the lengths of delivery journeys	RQ8_4,	E&FC, TE	DSB1	Direct
Delivery space booking reduces the time of delivery	RQ7_4,	E&FC,	DSB2	Direct

journeys	RQ8_4	TE		
Delivery Space Booking service decreases the fuel consumption	RQ1_4	E&FC	DSB3	Direct
Delivery Space Booking decreases the CO_2 emissions	RQ2_4	E&FC	DSB4	Direct
Delivery Space Booking decreases the emission of other pollutants	RQ2_4	E&FC	DSB5	Direct
Drivers decreases the double lane stops with the Delivery Space Booking usage	RQ3_4, RQ8_4	DB,TE	DSB6	Direct
Delivery space booking avoids the need of searching for free spaces	RQ10_4	DA	DSB7	Questionnaire
Drivers will perceive delivery conditions safer while delivery operations in a dedicated delivery space	RQ10_4	DA	DSB8	Questionnaire
Drivers will perceive that delivery space booking facilitate their delivery operations	RQ10_4	DA	DSB9	Questionnaire
Delivery space booking service is appreciated by drivers	RQ10_4	DA	DSB10	Questionnaire
Drivers will perceive that delivery space booking service is reliable	RQ10_4	DA	DSB11	Questionnaire
Delivery space booking service will not disturb driver in his driving task	RQ10_4	DA	DSB12	Questionnaire
Drivers will find the delivery space booking system easy to use	RQ10_4	DA	DSB13	Questionnaire
Drivers' stress perception will decrease with the delivery space booking usage	RQ10_4	DA	DSB14	Questionnaire
Perceived risk of accidents will decrease with the delivery space booking usage	RQ10_4	DA	DSB15	Questionnaire
According to the driver perception the delivery space booking system will improve of freight transport image in urban areas	RQ10_4	DA	DSB16	Questionnaire
Drivers will trust the delivery space booking service	RQ10_4	DA	DSB17	Questionnaire
Drivers consider that there are more availability space with the delivery space booking usage	RQ10_4	DA	DSB18	Questionnaire
The rest of the drivers will appreciate the delivery space booking system because they will find easier to drive in the city without double lines and trucks parked on the pavement , less stress	RQ10_4	TE, DA	DSB19	Questionnaire
The traffic flow gets benefits with the delivery space booking (the rest of the drivers do not hold up because of double lines, less congestions)	RQ8_4	E&FC, TE	DSB20	Questionnaire & Direct observation
Less tickets (fines) because of double lines	RQ_4	DB	DSB21	Direct (ask data to the police o to the companies)

Table 10 Hypotheses Delivery Space Booking

8. Indicators & Measurements.

Indicators are quantitative or qualitative measurements, agreed on beforehand, expressed as a percentage, index, rate or other value, which is monitored at regular or irregular intervals and can be compared with one or more criteria (FESTA Handbook). The indicators will allow answering the hypothesis.

In the previous chapter, the hypothesis for each system was identified and for each hypothesis the method for testing it was indicated (direct/questionnaire). Some indicators/measurements are defined for each FREILOT service and for each hypothesis. These indicators will be used for testing (true/false) each hypothesis for each service. In this section we are going to present the measurements for testing each hypothesis of each system.

For each service, the information needed for evaluating them are presented classified in three groups:

- General information.
- Direct measurements.
- Subjective measurements.

8.1. Intersection Control.

8.1.1. General information

The general data to be collected are following:

- Characteristics of each truck
    - Manufacturer.
    - Model.
    - Year of manufacturing.
    - Maximum load of the vehicle.
- Data from driver:
    - Nationality.
    - Age.
    - Male/female.
    - Driver experience (- at start of pilot: Less than one year, 1-2- years, 3-5 years, 5-10 years, 10-15 years, etc.)
- Characteristics of journey.
    - Origin.
    - Destination.
    - Total distance.
    - Total distance in urban areas.
- Use of Intersection Control:
    - Number of trucks using the Intersection Control.
    - Number of times that a truck in the project passes through the Intersection Control diary.

8.1.2. Direct measurements

The original list of measures needed per hypothesis (presented in previous versions of this deliverable) is kept after analyzing the data that can be provided by the DAS (see chapter 9). In blue we note the measures that are not available directly from dataloggers devices, but can be obtained with pos-processing methods.

RQ1_1 Hypo IC1, IC3, IC5	**Overall estimated fuel consumption in use case X will be lower than reference (default non-prioritised control)**
TRUCK	[Truck ID] [Fuel Consumption] [Distance drive by the truck] [GPS position]
SYSTEM	[Intersection ID] [Mode of operation] [Priority state][Time until green][Advised Speed] [State of traffic lights]
ENVIRONMENT	[Traffic Intensity]
DRIVER	[Driver ID]
RQ1_1 Hypo IC2, IC4, IC6, IC7, IC8, IC9	**Measured fuel consumption in the specific fleet in use case X will be Y% lower than reference (default non-prioritised control)**
TRUCK	[Truck ID] [Fuel Consumption] [Distance drive by the truck] [GPS position]
SYSTEM	[Intersection ID] [Mode of operation] [Priority state][Time until green][Advised Speed] [State of traffic lights]
ENVIRONMENT	[Traffic Intensity]
DRIVER	[Driver ID]
RQ1_1 Hypo IC10, IC11, IC12	**Estimated fuel consumption of HGV's in use case X will be Y% lower than reference case (default non-prioritised control)**
TRUCK	[Truck ID] [Fuel Consumption] [Distance drive by the truck] [GPS position]
SYSTEM	[Intersection ID] [Mode of operation] [Priority state][Time until green][Advised Speed] [State of traffic lights]
ENVIRONMENT	[Traffic Intensity]
DRIVER	[Driver ID]
RQ8_1 Hypo IC13, IC14, IC15, IC16, IC 17, IC18	**Average cycle times on the intersections will increase nu more than Y% in use case X**
TRUCK	
SYSTEM	[Intersection ID] [Mode of operation] [Priority state][Time until green][Advised Speed] [State of traffic lights]
ENVIRONMENT	[Traffic Intensity]
DRIVER	
RQ8_1 Hypo IC19, IC20, IC21	**Overall travel times on main routes will remain unchanged in use case X**
TRUCK	[Truck ID] [Fuel Consumption] [Distance drive by the truck]
SYSTEM	[Intersection ID] [Mode of operation] [Priority state][Time until green][Advised Speed] [State of traffic lights]
ENVIRONMENT	[Traffic Intensity]
DRIVER	[Driver ID]
RQ8_1	**Increase in travel times on crossing routes will be lower than Y% in use**

Hypo IC22, IC23, IC24	**case X**
TRUCK	[Truck ID] [Fuel Consumption] [Distance drive by the truck] [GPS position]
SYSTEM	[Intersection ID] [Mode of operation] [Priority state][Time until green][Advised Speed] [State of traffic lights]
ENVIRONMENT	[Traffic Intensity]
DRIVER	[Driver ID]
RQ8_1 Hypo IC25, IC26, IC27	**Travel times on main routes will improve by Y% in use case X**
TRUCK	[Truck ID] [Fuel Consumption] [Distance drive by the truck] [GPS position]
SYSTEM	[Intersection ID] [Mode of operation] [Priority state][Time until green][Advised Speed] [State of traffic lights]
ENVIRONMENT	[Traffic Intensity]
DRIVER	[Driver ID]
RQ8_1 Hypo IC28, IC29, IC30	**Increase in travel times on crossing routes will be lower than Y% in use case X**
TRUCK	[Truck ID] [Fuel Consumption] [Distance drive by the truck] [GPS position]
SYSTEM	[Intersection ID] [Mode of operation] [Priority state][Time until green][Advised Speed] [State of traffic lights]
ENVIRONMENT	[Traffic Intensity]
DRIVER	[Driver ID]

Table 11 Direct measurements Intersection Control

8.1.3. Subjective data.

The subjective data for evaluating the intersection control service will be collected through questionnaires prepared for the drivers of the truck.

The hypotheses that will be tested with questionnaires are the following ones:

Hypothesis	RQ ID.	Hypo ID
Intersection Control service is appreciated by drivers	RQ10_1	IC31
Drivers will perceive that Intersection Control service is reliable	RQ10_1	IC32
Drivers will find the Intersection Control service is useful when driving	RQ10_1	IC33
Drivers will think the Intersection Control service is easy to use	RQ10_1	IC34
Drivers stress perception will decrease with the Intersection Control service usage	RQ10_1	IC35
Perceived risk of accidents will decrease with the Intersection Control service usage	RQ10_1	IC36
According to the driver perception the Intersection Control service will improve of freight transport image in urban areas	RQ10_1	IC37

Drivers will trust the Intersection Control service	RQ10_1	IC38

Table 12 Subjective data Intersection Control

A proposal of items to analyze the different hypotheses is provide in the following table:

IC31	**Intersection Control service is appreciated by drivers**	**RQ10_1**	**Questionnaire**
▪ “I really appreciate the Intersection Control service” ▪ “After using Intersection Control I like the service” ▪ “I think that using the Intersection Control service increases my productivity” ▪ “I think that using the Intersection Control service decreases the travel times” ▪ “I think that using the Intersection Control service increases the efficacy of my work”			
IC32	**Drivers will perceive that Intersection Control service is reliable**	**RQ10_1**	**Questionnaire**
▪ “I perceive Intersection Control is a reliable service” ▪ “I think the Intersection Control is effective to manage the traffic in the road intersections” ▪ “I believe the Intersection Control service works properly”			
IC33	**Drivers will find the Intersection Control service is useful when driving**	**RQ10_1**	**Questionnaire**
▪ “I find the Intersection Control service is useful when driving” ▪ “I consider Intersection Control makes easier my urban driving”” ▪ “The use of Intersection Control services makes urban driving easier” ▪ “I believe I have the indispensable knowledge to utilize the Intersection Control service”			
IC34	**Drivers will think the Intersection Control service is easy to use**	**RQ10_1**	**Questionnaire**
▪ “I find the Intersection Control service is easy to use” ▪ “I think it easy to understand how the Intersection Control service works” ▪ “It is easy to understand how the Intersection Control service works” ▪ “I have difficulties to understand the Intersection Control service” ▪ “It is hard to comprehend the Intersection Control service working” ▪ “It is easy to indentify the functions of the Intersection Control service”			
IC35	**Drivers stress perception will decrease with the Intersection Control service usage**	**RQ10_1**	**Questionnaire**
▪ “More I use the Intersection Control service, I find the urban driving is easier” ▪ “I perceive less stressed when I use the Intersection Control” ▪ “More I use the Intersection Control service, I feel less stressed” ▪ “More I use the Intersection Control service, I feel more stressed”			

<table>
<tr><td colspan="4">▪ "I feel calmer with the use of Intersection Control service"
▪ "More I use the Intersection Control service, I feel more apprehensive about it"</td></tr>
<tr><td>IC36</td><td>Perceived risk of accidents will decrease with the Intersection Control service usage</td><td>RQ10_1</td><td>Questionnaire</td></tr>
<tr><td colspan="4">▪ "I perceive the risk of accidents is lower since I use the Intersection Control service"
▪ "Using the Intersection Control service, I consider my driving is more safety"
▪ "My perceived risk of accidents is lower since I use the Intersection Control service"
▪ "The number of incidents and near crashes has decreased with the use of Intersection Control service"
▪ "The number of accidents has decreased with the use of Intersection Control service"
▪ "I think I have had less number of accidents with the use of Intersection Control service"
▪ "I think the number of incidents and near crashes is independent of the use of the Intersection Control service"
▪ "I think the number of accidents is independent of the use of the Intersection Control service"
▪ "I am confident in my ability to drive the truck safely with the Intersection Control service"</td></tr>
<tr><td>IC37</td><td>According to the driver perception the Intersection Control service will improve of freight transport image in urban areas</td><td>RQ10_1</td><td>Questionnaire</td></tr>
<tr><td colspan="4">▪ "According my perception, the Intersection Control service improves the freight transport image in urban areas"
▪ "The freight transport image in urban areas is improved with the usage of Intersection Control service"
▪ "I believe the urban congestion has decreased with the usage of the Intersection Control service"
▪ "I consider the length of traffic queues in road intersections are smaller with the usage of Intersection Control service"</td></tr>
<tr><td>IC38</td><td>Drivers will trust the Intersection Control service</td><td>RQ10_1</td><td>Questionnaire</td></tr>
<tr><td colspan="4">▪ "I trust the Intersection Control service"
▪ "I am confident of using Intersection Control service"</td></tr>
</table>

In next version of this document, these questionnaires will be included in the annexes.

8.2. Speed Limiter

8.2.1. General information

- Number of trucks with Speed Limiter.
- Characteristics of each truck
  - Manufacturer.

  - Model.
  - Year of manufacturing.
  - Maximum load of the vehicle.
- Characteristics of journey.
  - o Origin.
  - o Destination.
  - o Time of delivery.
  - o Total distance.
  - o Total distance in urban areas.
- Data from driver:
  - Nationality.
  - Age.
  - Male/female.
  - Driver experience (- at start of pilot: Less than one year, 1-2- years, 3-5 years, 5-10 years, 10-15 years, etc.)

- How many times and for how long time truck enters speed limited zones

8.2.2. Direct measurements

The original list of measures needed per hypothesis (presented in previous versions of this deliverable) is kept after analyzing the data that can be provided by the DAS (see chapter 9). In blue we note the measures that are not available directly from dataloggers devices, but can be obtained with pos-processing methods. In red the data that is not available.

RQ8_2 Hypo SL1	**Using Speed Limiter service, the time of delivery will increase**
TRUCK	[Truck ID] [Distance drive by the truck] [Speed] [GPS position]
SYSTEM	[Activation of system (ON/OFF)] [Speed limit value] [Number of times the system is activated during a trip]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ1_2 Hypo SL2	**Using Speed Limiter service reduces fuel consumption**
TRUCK	[Truck ID] [Distance drive by the truck] [Speed] [Fuel Consumption] [GPS position]
SYSTEM	[Activation of system (ON/OFF)] [Speed limit value] [Number of times the system is activated during a trip] [Number of times the system prevents the driver from over-speeding during the trip] [Number of times the driver overruns the Speed Limit]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ9_2	**A truck using the Speed Limiter service will not disturb surrounding**

Hypo SL3	traffic
TRUCK	[Truck ID] [Distance drive by the truck] [Speed] [GPS position]
SYSTEM	[Activation of system (ON/OFF)] [Speed limit value] [Number of times the system is activated during a trip]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions] [Traffic Intensity]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ4_2 Hypo SL4	**Average speed of the truck will be decrease with the usage of the speed limiter**
TRUCK	[Truck ID] [Distance drive by the truck] [Speed] [GPS position]
SYSTEM	[Activation of system (ON/OFF)] [Speed limit value] [Number of times the system is activated during a trip]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ5_2 Hypo SL5	**Driver braking behaviour will change with the usage of speed limiter**
TRUCK	[Truck ID] [Distance drive by the truck] [Speed] [Use of brake (On/Off)] [Brake Pressure] [GPS position]
SYSTEM	[Activation of system (ON/OFF)] [Speed limit value] [Number of times the system is activated during a trip]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]

Table 13 Direct measurements Speed Limiter

8.2.3. Subjective data.

The subjective data for evaluating the Speed Limiter service will be collected through questionnaires for the drivers of the truck.

The hypotheses that will be tested with questionnaires are the following ones:

Hypothesis	RQ ID.	Hypo ID
Using Speed Limiter service, driver will accept/acknowledge speed limit recommendations from the system	RQ10_2	SL7
Using Speed Limiter service, driver will be not disturb in his driving task	RQ10_2	SL8
Speed Limiter service is appreciated by drivers	RQ10_2	SL9
Drivers will perceive that speed limiter service is reliable	RQ10_2	SL10
Drivers will find the speed limiter is useful when driving	RQ10_2	SL11

Drivers will think the speed limiter is easy to use	RQ10_2	SL12
Drivers' stress perception will decrease with the speed limiter usage	RQ10_2	SL13
Perceived risk of accidents will decrease with the speed limiter usage	RQ10_2	SL14
According to the driver perception the speed limiter system will improve of freight transport image in urban areas	RQ10_2	SL15
Drivers will trust the speed limiter system	RQ10_2	SL16

Table 14 Subjective data Speed Limiter

A proposal of items to analyze the different hypotheses is provide in the following table:

<table>
<tr><td>SL7</td><td>Using the Speed Limiter service, the driver will accept/acknowledge speed limit recommendations from the system</td><td>RQ10_2</td><td>Questionnaire</td></tr>
<tr><td colspan="4">"Using the Speed Limiter service, I accept/acknowledge speed limit recommendations from the system"
"I think the speed limitation provide by the Speed Limiter service is acceptable"
"I accept/acknowledge speed limit recommendations from the Speed Limiter service"</td></tr>
<tr><td>SL8</td><td>Using the Speed Limiter service, the driver will be not be disturbed in his driving task</td><td>RQ10_2</td><td>Questionnaire</td></tr>
<tr><td colspan="4">"Using the Speed Limiter service, I am not disturbed in my driving task"
"The use of the Speed Limiter service annoys me to drive"
"The use of the Speed Limiter makes me difficult to drive"
"Speed Limiter service disturbs me when I drive"
"The use of The Speed Limiter service helps me in the driving task"
"The use of the Speed Limiter makes me easy to drive"</td></tr>
<tr><td>SL9</td><td>The Speed Limiter service is appreciated by drivers</td><td>RQ10_2</td><td>Questionnaire</td></tr>
<tr><td colspan="4">"I really appreciate the Speed Limiter service"
"After using Speed Limiter I like the service"
"I think that using the Speed Limiter increases my productivity"
"I think that using the Speed Limiter service decreases the travel times"
"I think that using the Speed Limiter service increases the efficacy of my work"</td></tr>
<tr><td>SL10</td><td>Drivers will perceive that speed limiter service is reliable</td><td>RQ10_2</td><td>Questionnaire</td></tr>
<tr><td colspan="4">"I perceive Speed Limiter is a reliable service"
"I think the Speed Limiter is effective to not exceed the speed limitations"
"I believe the Speed Limiter service works properly"</td></tr>
<tr><td>SL11</td><td>Drivers will find the speed limiter is useful when driving</td><td>RQ10_2</td><td>Questionnaire</td></tr>
</table>

• "I find the Speed Limiter service is useful when driving" • "I consider Speed Limiter makes easier my urban driving"" • "The use of Speed Limiter services makes urban driving easier" • "I believe I have the indispensable knowledge to utilize the Speed Limiter service"			
SL12	**Drivers will think the speed limiter is easy to use**	**RQ10_2**	**Questionnaire**
• "I find the Speed Limiter service is easy to use" • "I think it easy to understand how the Speed Limiter service works" • "It is easy to understand how the Speed Limiter service works" • "I have difficulties to understand the Speed Limiter service" • "It is hard to comprehend the Speed Limiter service working" • "It is easy to indentify the functions of the Speed Limiter service"			
SL13	**Drivers' stress perception will decrease with the speed limiter usage**	**RQ10_2**	**Questionnaire**
• "More I use the Speed Limiter service, I find the urban driving is easier" • "I perceive less stressed when I use the Speed Limiter" • "More I use the Speed Limiter service, I feel less stressed" • "More I use the Speed Limiter service, I feel more stressed" • "I feel calmer with the use of Speed Limiter service" • "More I use the Speed Limiter service, I feel more apprehensive about it"			
SL14	**Perceived risk of accidents will decrease with the speed limiter usage**	**RQ10_2**	**Questionnaire**
• "I perceive the risk of accidents is lower since I use the Speed Limiter service" • "Using the Speed Limiter service, I consider my driving is more safety" • "My perceived risk of accidents is lower since I use the Speed Limiter service" • "The number of incidents and near crashes has decreased with the use of Speed Limiter service" • "The number of accidents has decreased with the use of Speed Limiter service" • "I think I have had less number of accidents with the use of Speed Limiter service" • "I think the number of incidents and near crashes is independent of the use of the Speed Limiter service" • "I think the number of accidents is independent of the use of the Speed Limiter service" • "I am confident in my ability to drive the truck safely with the Speed Limiter service"			
SL15	**According to the driver perception, the speed limiter system will improve the freight transport image in urban areas**	**RQ10_2**	**Questionnaire**
• "According my perception, the Speed Limiter service improves the freight transport image in urban areas" • "The freight transport image in urban areas is improved with the usage of Speed Limiter service" • "I believe the urban congestion has increased with the usage of the Speed Limiter			

service”			
SL16	**Drivers will trust the speed limiter system**	**RQ10_2**	**Questionnaire**
• “I trust the Speed Limiter service” • “I am confident of using Speed Limiter service”			

In next version of this document, these questionnaires will be included in the annexes.

8.3. Acceleration Limiter

8.3.1. General information

- Number of trucks with Acceleration Limiter.
- Characteristics of each truck
  - Manufacturer.
  - Model.
  - Year of manufacturing.
  - Maximum load of the vehicle.
- Data from driver:
  - Nationality.
  - Age.
  - Male/female.
  - Driver experience (- at start of pilot: Less than one year, 1-2- years, 3-5 years, 5-10 years, 10-15 years, etc.)
- Characteristics of journey.
  - Origin.
  - Destination.
  - Total distance.
  - Total distance in urban areas.

8.3.2. Direct measurements

The original list of measures needed per hypothesis (presented in previous versions of this deliverable) is kept after analyzing the data that can be provided by the DAS (see chapter 9). In blue we note the measures that are not available directly from dataloggers devices, but can be obtained with pos-processing methods. In red the data that is not available.

RQ1_2 Hypo AL1	**Using Acceleration Limiter service fuel consumption will decrease**
TRUCK	[Truck ID] [Distance drive by the truck] [Acceleration] [Fuel Consumption] [GPS position]
SYSTEM	[Activation of system (ON/OFF)] [Acceleration limit value] [Number of times the system is activated during a trip]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ8_2 Hypo AL2	**Using Acceleration Limiter service load capacity will not change**
TRUCK	[Truck ID] [Distance drive by the truck] [Acceleration] [Load capacity] [GPS position]
SYSTEM	[Activation of system (ON/OFF)] [Acceleration limit value] [Number of times the system is activated during a trip]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ6_2 Hypo AL3	**Using Acceleration Limiter service driver will decreased capacity of acceleration on flat road**
TRUCK	[Truck ID] [Distance drive by the truck] [Acceleration] [GPS position]
SYSTEM	[Activation of system (ON/OFF)] [Acceleration limit value] [Number of times the system is activated during a trip]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ2_2 Hypo AL5	**Acceleration Limiter usage will decrease the CO_2 emissions and other pollutants**
TRUCK	[Truck ID] [Distance drive by the truck] [Acceleration] [Emissions] [GPS position]
SYSTEM	[Activation of system (ON/OFF)] [Acceleration limit value] [Number of times the system is activated during a trip]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ3_2 Hypo AL6	**Acceleration Limiter usage will decrease emissions of other pollutants.**
TRUCK	[Truck ID] [Distance drive by the truck] [Acceleration] [Emissions] [GPS position]
SYSTEM	[Activation of system (ON/OFF)] [Acceleration limit value] [Number of times the system is activated during a trip]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ4_2 Hypo AL8	**Driver will accelerate less with the usage of the acceleration system**

TRUCK	[Truck ID] [Distance drive by the truck] [Acceleration] [Accelerator Use (ON/OFF)] [GPS position]
SYSTEM	[Activation of system (ON/OFF)] [Acceleration limit value] [Number of times the system is activated during a trip]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]

Table 15 Direct measurements Acceleration Limiter

8.3.3. Subjective data.

The subjective data for evaluating the Acceleration Limiter service will be collected through questionnaires prepared for the drivers of the truck.

The hypotheses that will be tested with questionnaires are the following ones:

Hypothesis	RQ ID.	Hypo ID
Using Acceleration Limiter service driver will note decreased capacity of acceleration on flat road	RQ4_2	AL8
Acceleration Limiter service is appreciated by drivers	RQ10_2	AL9
Drivers will perceive that acceleration limiter service is reliable	RQ10_2	AL10
Drivers will find the acceleration limiter is useful when driving	RQ10_2	AL11
Drivers will think the acceleration limiter is easy to use	RQ10_2	AL12
Drivers' stress perception will decrease with the acceleration limiter usage	RQ10_2	AL13
Perceived risk of accidents will decrease with the acceleration limiter usage	RQ10_2	AL14
According to the driver perception the acceleration limiter system will improve of freight transport image in urban areas	RQ10_2	AL15
Drivers will trust the acceleration limiter system	RQ10_2	AL16
The drivers will accept increase on journey duration as a trade off to decreased fuel consumption	RQ12_2	AL17

Table 16 Subjective data Acceleration Limiter

A proposal of items to analyze the different hypotheses is provide in the following table:

AL8	**Using the Acceleration Limiter service, the driver will note decreased capacity of acceleration on flat road**	**RQ4_2**	**Questionnaire**
• "Using the Acceleration Limiter service, I decrease capacity of acceleration on flat road"			
AL9	**The Acceleration Limiter service is appreciated by drivers**	**RQ10_2**	**Questionnaire**

• "I really appreciate the Acceleration Limiter service" • "After using Acceleration Limiter I like the service" • "I think that using the Acceleration Limiter increases my productivity" • "I think that using the Acceleration Limiter service decreases the travel times" • "I think that using the Acceleration Limiter service increases the efficacy of my work"			
AL10	**Drivers will perceive that the Acceleration Limiter service is reliable**	**RQ10_2**	**Questionnaire**
• "I perceive Acceleration Limiter is a reliable service" • "I think the Speed Limiter is effective to not exceed the speed limitations" • "I believe the Acceleration Limiter service works properly"			
AL11	**Drivers will find the Acceleration Limiter is useful when driving**	**RQ10_2**	**Questionnaire**
• "I find the Acceleration Limiter service is useful when driving" • "I consider Acceleration Limiter makes easier my urban driving"" • "The use of Acceleration Limiter services makes urban driving easier" • "I believe I have the indispensable knowledge to utilize the Acceleration Limiter service"			
AL12	**Drivers will think the Acceleration Limiter is easy to use**	**RQ10_2**	**Questionnaire**
• "I find the Acceleration Limiter service is easy to use" • "I think it easy to understand how the Acceleration Limiter service works" • "It is easy to understand how the Acceleration Limiter service works" • "I have difficulties to understand the Acceleration Limiter service" • "It is hard to comprehend the Acceleration Limiter service working" • "It is easy to indentify the functions of the Acceleration Limiter service"			
AL13	**Drivers' stress perception will decrease with the acceleration limiter usage**	**RQ10_2**	**Questionnaire**
• "More I use the Acceleration Limiter service, I find the urban driving is easier" • "I perceive less stressed when I use the Acceleration Limiter" • "More I use the Acceleration Limiter service, I feel less stressed" • "More I use the Acceleration Limiter service, I feel more stressed" • "I feel calmer with the use of Acceleration Limiter service" • "More I use the Acceleration Limiter service, I feel more apprehensive about it"			
AL14	**Perceived risk of accidents will decrease with the acceleration limiter usage**	**RQ10_2**	**Questionnaire**
• "I perceive the risk of accidents is lower since I use the Acceleration Limiter service" • "Using the Acceleration Limiter service, I consider my driving is more safety" • "My perceived risk of accidents is lower since I use the Acceleration Limiter service" • "The number of incidents and near crashes has decreased with the use of Acceleration Limiter service" • "The number of accidents has decreased with the use of Acceleration Limiter service" • "I think I have had less number of accidents with the use of Acceleration Limiter service" • "I think the number of incidents and near crashes is independent of the use of the Acceleration Limiter service"			

• “I think the number of accidents is independent of the use of the Acceleration Limiter service” • “I am confident in my ability to drive the truck safely with the Acceleration Limiter service”			
AL15	**According to the driver perception the acceleration limiter system will improve of freight transport image in urban areas**	**RQ10_2**	**Questionnaire**
• “According my perception, the Acceleration Limiter service improves the freight transport image in urban areas” • “The freight transport image in urban areas is improved with the usage of Acceleration Limiter service” • “I believe the urban congestion has increased with the usage of the Acceleration Limiter service”			
AL16	**Drivers will trust the acceleration limiter system**	**RQ10_2**	**Questionnaire**
• “I trust the Acceleration Limiter service” • “I am confident of using Acceleration Limiter service”			
AL17	**The drivers will accept increase on journey duration as a trade off to decreased fuel consumption**	**RQ12_2**	**Questionnaire**
• “I accept increase on journey duration as a trade off to decreased fuel consumption”			

In next version of this document, these questionnaires will be included in the annexes.

8.4. Eco Driver Support.

8.4.1. General information.

- Number of trucks with Eco Driver Support.
- Characteristics of each truck
  - Manufacturer.
  - Model.
  - Year of manufacturing.
  - Maximum load of the vehicle.
- Data from driver:
  - Nationality.
  - Age.
  - Male/female.
  - Driver experience (- at start of pilot: Less than one year, 1-2- years, 3-5 years, 5-10 years, 10-15 years, etc.)
- Characteristics of journey.
  - Origin.

- Destination.
- Total distance.
- Total distance in urban areas.

8.4.2. Direct measurements.

The original list of measures needed per hypothesis (presented in previous versions of this deliverable) is kept after analyzing the data that can be provided by the DAS (see chapter 9). In blue we note the measures that are not available directly from dataloggers devices, but can be obtained with pos-processing methods. In red the data that is not available.

RQ1_3 Hypo EDS1	**Using Eco-Driving will support the driver to drive in a way that reduces fuel consumption.**
TRUCK	[Truck ID] [Distance drive by the truck] [Fuel Consumption] [GPS position]
SYSTEM	[When the system gives an advice (ON/OFF)] [Advice given by the system] [Number of advices given per route]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ2_3 Hypo EDS2	**Following the advice from the Eco-Driving support service fuel consumption will decrease.**
TRUCK	[Truck ID] [Distance drive by the truck] [Fuel Consumption] [GPS position]
SYSTEM	[When the system gives an advice (ON/OFF)] [Advice given by the system] [Number of advices given per route]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ2_3 Hypo EDS3	**Following the advice from the Eco-Driving Support service CO_2 emissions will decrease.**
TRUCK	[Truck ID] [Distance drive by the truck] [Emissions] [GPS position]
SYSTEM	[When the system gives an advice (ON/OFF)] [Advice given by the system] [Number of advices given per route]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]
RQ4_3, RQ6_3 Hypo EDS4	**Following the advice from the Eco-Driving Support service harsh acceleration and braking will reduce.**
TRUCK	[Truck ID] [Distance drive by the truck] [Speed] [Acceleration] [Brake Use (ON/OFF)] [Accelerator Use (ON/OFF)] [GPS position]
SYSTEM	[When the system gives an advice (ON/OFF)] [Advice given by the system] [Number of advices given per route]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID] [Driver use of the system (accept/no accept limitation)]

Table 17 Direct measurements Eco Driving Support

8.4.3. Subjective data.

The subjective data for evaluating the Eco Driver Support service will be collected through questionnaires for the drivers of the truck.

The hypotheses that will be tested with questionnaires are the following ones:

Hypothesis	RQ ID.	Hypo ID
In stressful situations drivers will have difficulties to follow the instructions	RQ3_3	EDS5
Eco-Driving Support service is appreciated by drivers	RQ10_3	EDS6
Drivers will perceive that Eco driving support is reliable	RQ10_3	EDS7
Drivers will find the Eco driving support useful when driving	RQ10_3	EDS8
Drivers will think the Eco driving support is easy to use	RQ10_3	EDS9
Drivers' stress perception will increase with the Eco driving support usage	RQ10_3	EDS10
Perceived risk of accidents will decrease with the Eco driving support usage	RQ10_3	EDS11
According to the driver perception the Eco driving support system will improve of freight transport image in urban areas	RQ10_3	EDS12
Drivers will trust the Eco driving support system to give good advice	RQ10_3	EDS13

Table 18 Subjective data Eco-Driving Support

A proposal of items to analyze the different hypotheses is provide in the following table:

<table>
<tr><th>EDS5</th><th>In stressful situations drivers will have difficulties to follow the instructions</th><th>RQ3_3</th><th>Questionnaire</th></tr>
<tr><td colspan="4">• "I have difficulties to follow the instructions of Eco-driving support in stressful situations"</td></tr>
<tr><td>EDS6</td><td>Eco-Driving Support service is appreciated by drivers</td><td>RQ10_3</td><td>Questionnaire</td></tr>
<tr><td colspan="4">• "I really appreciate the Eco-driving support service"
• "After using Eco-driving support I like the service"
• "I think that using the Eco-driving support increases my productivity"
• "I think that using the Eco-driving support service optimizes the travel times"
• "I think that using the Eco-driving support service increases the efficacy of my work"
• "I appreciate Eco-driving support service because it helps me to reduce fuel consumption"
• "The main advantage of Eco-driving support I think is that this service helps to reduce fuel consumption"
• "I don't like the Eco-driving support because it makes the driving task more difficult"</td></tr>
<tr><td>EDS7</td><td>Drivers will perceive that Eco-driving support is reliable</td><td>RQ10_3</td><td>Questionnaire</td></tr>
</table>

<table>
<tr><td colspan="4">• “I perceive Eco-driving support is a reliable service”
• “I think the Eco-driving is effective to reduce the fuel consumption and the pollutants”
• “I believe that the advices provide by the Eco-driving support are adequate”
• “I believe the Eco-driving support service works properly”</td></tr>
<tr><td>EDS8</td><td>Drivers will find the Eco-driving support useful when driving</td><td>RQ10_3</td><td>Questionnaire</td></tr>
<tr><td colspan="4">• “I find the Eco-driving support is useful when driving”
• “I consider Eco-driving support makes easier my urban driving”
• “The use of Eco-driving support services makes urban driving easier”
• “I believe I have the indispensable knowledge to utilize the Eco-driving support service”
• “Using the Eco-driving support, I consider my driving is more efficiency”</td></tr>
<tr><td>EDS9</td><td>Drivers will think the Eco-driving support is easy to use</td><td>RQ10_3</td><td>Questionnaire</td></tr>
<tr><td colspan="4">• “I find the Eco-driving support is easy to use”
• “I think it easy to understand how the Eco-driving support works”
• “It is easy to understand how the Eco-driving support works”
• “I have difficulties to understand the Eco-driving support”
• “It is hard to comprehend the Eco-driving support working”
• “It is easy to indentify the functions of the Eco-driving support”</td></tr>
<tr><td>EDS10</td><td>Drivers’ stress perception will increase with the Eco-driving support usage</td><td>RQ10_3</td><td>Questionnaire</td></tr>
<tr><td colspan="4">• “More I use the Eco-driving support, I find the urban driving is easier”
• “I perceive less stressed when I use the Eco-driving support”
• “More I use the Eco-driving support, I feel less stressed”
• “More I use the Eco-driving support, I feel more stressed”
• “More I use the Eco-driving support service, I feel more apprehensive about it”
• “I feel calmer with the use of Eco-driving support service”</td></tr>
<tr><td>EDS11</td><td>Perceived risk of accidents will decrease with the Eco-driving support usage</td><td>RQ10_3</td><td>Questionnaire</td></tr>
<tr><td colspan="4">• “I perceive the risk of accidents is lower since I use the Eco-driving support”
• “Using the Eco-driving support, I consider my driving is more safety”
• “My perceived risk of accidents is lower since I use the Eco-driving support”
• “The number of incidents and near crashes has decreased with the use of Eco-driving support”
• “The number of accidents has decreased with the use of Eco-driving support”
• “I think I have had less number of accidents with the use of Eco-driving support”
• “I think the number of incidents and near crashes is independent of the use of the Eco-driving support”
• “I think the number of accidents is independent of the use of the Eco-driving support”
• “I am confident in my ability to drive the truck safely with the Eco-driving support”</td></tr>
<tr><td>EDS12</td><td>According to the driver perception the Eco-driving support system will improve of freight transport image in urban areas</td><td>RQ10_3</td><td>Questionnaire</td></tr>
</table>

• "According my perception, the Eco-driving support improves the freight transport image in urban areas" • "The freight transport image in urban areas is improved with the usage of Eco-driving support" • "I believe the urban congestion has increased with the usage of the Eco-driving support" • "I think the Eco-driving support improves the freight transport image in urban areas taking into account that its use reduce the CO2 emissions and other pollutants			
EDS13	**Drivers will trust the Eco-driving support system to give good advice**	**RQ10_3**	**Questionnaire**
• "I trust the Eco-driving support service" • "I am confident of using Eco-driving support"			

In next version of this document, these questionnaires will be included in the annexes.

8.5. Delivery Space Booking.

8.5.1. General information.

The general information identified for evaluating Delivery Space Booking are the following:

- Characteristics of each truck
  - Manufacturer.
  - Model.
  - Year of manufacturing.
  - Maximum load of the vehicle.
- Data from driver:
  - Nationality.
  - Age.
  - Male/female.
  - Driver experience (- at start of pilot: Less than one year, 1-2- years, 3-5 years, 5-10 years, 10-15 years, etc.)
- Characteristics of journey.
  - Origin.
  - Destination.
  - Total distance.
  - Total distance in urban areas.
  - Travel time.
- Use of DSB:
  - Number of trucks using the DSB.
  - Number of reservations per day.
  - Number of stops per day.

- Duration of each stop.
- Number of times space was occupied by unauthorized vehicle

8.5.2. Direct measurements.

The original list of measures needed per hypothesis (presented in previous versions of this deliverable) is kept after analyzing the data that can be provided by the DAS (see chapter 9). In blue we note the measures that are not available directly from dataloggers devices, but can be obtained with pos-processing methods. In red the data that is not available.

RQ8_4 Hypo DSB1	**Delivery space booking reduces the lengths of delivery journeys**
TRUCK	[Truck ID] [Distance drive by the truck] [Speed] [GPS position]
SYSTEM	[Mode of operation of the system] [ID of DSB stop]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID]
RQ7_4, RQ8_4 Hypo DSB2	**Delivery space booking reduces the time of delivery journeys**
TRUCK	[Truck ID] [Distance drive by the truck] [Speed] [GPS position]
SYSTEM	[Mode of operation of the system] [ID of DSB stop] [Date]
ENVIRONMENT	[Number of stops in intersections] [Stops/slow speed in congestions]
DRIVER	[Driver ID]
RQ1_4 Hypo DSB3	**Delivery Space Booking service decreases the fuel consumption**
TRUCK	[Truck ID] [Fuel Consumption] [Distance drive by the truck] [GPS position]
SYSTEM	[Mode of operation of the system] [ID of DSB stop]
ENVIRONMENT	[Traffic intensity] [Congestion]
DRIVER	[Driver ID]
RQ2_4 Hypo DSB4	**Delivery Space Booking decreases the CO_2 emissions.**

TRUCK	[Truck ID] [Fuel Consumption] [Emissions] [Distance drive by the truck] [GPS position]
SYSTEM	[Mode of operation of the system] [ID of DSB stop]
ENVIRONMENT	[Traffic intensity] [Congestion]
DRIVER	[Driver ID]
RQ2_4 **Hypo DSB5**	**Delivery Space Booking decreases the emission of other pollutants**
TRUCK	[Truck ID] [Fuel Consumption] [Emissions] [Distance drive by the truck] [GPS position]
SYSTEM	[Mode of operation of the system] [ID of DSB stop]
ENVIRONMENT	[Traffic intensity] [Congestion]
DRIVER	[Driver ID]
RQ3_4, RQ8_4 **Hypo DSB6**	**Drivers decreases the double lane stops with the Delivery Space Booking usage.**
TRUCK	[Truck ID] [GPS position]
SYSTEM	[Mode of operation of the system] [ID of DSB stop] [Number of double lane stops in the DSB stop of other vehicles per day]
ENVIRONMENT	[Traffic intensity]
DRIVER	[Driver ID]

Table 19 Direct measurements Delivery Space Booking

8.5.3. Subjective data.

The subjective data for evaluating the Delivery Space Booking service will be collected through questionnaires prepared for the drivers of the truck and the fleet managers.

The hypotheses that will be tested with questionnaires are the following ones:

Hypothesis	RQ ID.	Hypo ID
Delivery space booking avoids the need of searching for free spaces	RQ10_4	DSB7
Drivers will perceive delivery conditions safer while delivery operations in a dedicated delivery space	RQ10_4	DSB8
Drivers will perceive that delivery space booking facilitate their delivery operations	RQ10_4	DSB9
Delivery space booking service is appreciated by drivers	RQ10_4	DSB10
Drivers will perceive that delivery space booking service is reliable	RQ10_4	DSB11
Delivery space booking service will not disturb driver in his driving task	RQ10_4	DSB12
Drivers will find the delivery space booking system easy to use	RQ10_4	DSB13
Drivers' stress perception will decrease with the delivery space booking usage	RQ10_4	DSB14
Perceived risk of accidents will decrease with the delivery space booking usage	RQ10_4	DSB15

According to the driver perception the delivery space booking system will improve of freight transport image in urban areas	RQ10_4	DSB16
Drivers will trust the delivery space booking service	RQ10_4	DSB17
Drivers consider that there are more availability space with the delivery space booking usage	RQ10_4	DSB18
The rest of the drivers will appreciate the delivery space booking system because they will find easier to drive in the city without double lines and trucks parked on the pavement , less stress	RQ10_4	DSB19
The traffic flow gets benefits with the delivery space booking (the rest of the drivers do not hold up because of double lines, less congestions)	RQ8_4	DSB20
Less tickets (fines) because of double lines	RQ_4	DSB21

Table 20 Subjective data Delivery Space Booking

A proposal of items to analyze the different hypotheses is provide in the following table:

DSB7	**Delivery space booking avoids the need of searching for free spaces**	**RQ10_4**	**Questionnaire**
• "I think the Delivery Space Booking service avoids the need of searching for free spaces" • "Since I use the Delivery Space Booking service is easier to me to find free spaces to the delivery/unloading task" • "The Delivery Space Booking service facilitates my delivery task because I don't need to look for free spaces"			
DSB8	**Drivers will perceive delivery conditions safer while delivery operations in a dedicated delivery space**	**RQ10_4**	**Questionnaire**
• "I perceive delivery conditions safer while delivery operations in a dedicated delivery space" • "I feel safe when I unload the goods using the space obtained by the Delivery Space Booking service" • "My safety has increased since I used the Delivery Space Booking service" • "Using the Delivery Space Booking service, I consider the unloading is more safety"			
DSB9	**Drivers will perceive that delivery space booking facilitates their delivery operations**	**RQ10_4**	**Questionnaire**
• "I think the Delivery Space Booking service facilitates my delivery operations"			
DSB10	**Delivery space booking service is appreciated by drivers**	**RQ10_4**	**Questionnaire**
• "I really appreciate the Delivery Space Booking service" • "After using Delivery Space Booking I like the service" • "I think that using the Delivery Space Booking service increases my productivity" • "I think that using the Delivery Space Booking service optimizes the travel times" • "I think that using the delivery Space Booking service optimizes the delivery times" • "I think that using the Delivery Space Booking service increases the efficacy of my work" • "I appreciate Delivery Space Booking service because it helps me to reduce fuel			

consumption"
- "The main advantage of Delivery Space Booking I think is that this service helps to reduce fuel consumption"
- "I like the Delivery Space Booking because it makes the driving task easier"

DSB11	**Drivers will perceive that delivery space booking service is reliable**	**RQ10_4**	**Questionnaire**

- "I perceive Delivery Space Booking service is a reliable service"
- "I think the Delivery Space Booking service is effective to reduce double lane stops"
- "I believe the Delivery Space Booking service is effective to reduce the delivery times"
- "I believe that the advices provide by the Delivery Space Booking service are adequate"
- "I believe the Delivery Space Booking service works properly"

DSB12	**Delivery space booking service will not disturb driver in his driving task**	**RQ10_4**	**Questionnaire**

- "I think the Delivery Space Booking service does not disturb me in my driving task "

DSB13	**Drivers will find the delivery space booking system easy to use**	**RQ10_4**	**Questionnaire**

- "I find the Delivery Space Booking service is easy to use"

DSB14	**Drivers' stress perception will decrease with the delivery space booking usage**	**RQ10_4**	**Questionnaire**

- "More I use the Delivery Space Booking service, I find the urban driving is easier"
- "I perceive less stressed when I use the Delivery Space Booking service"
- "More I use the Delivery Space Booking service, I feel less stressed"
- "More I use the Delivery Space Booking service, I feel more stressed"
- "More I use the Delivery Space Booking service, I feel more apprehensive about it"
- "I feel calmer with the use of Delivery Space Booking service"

DSB15	**Perceived risk of accidents will decrease with the delivery space booking usage**	**RQ10_4**	**Questionnaire**

- "I perceive the risk of accidents is lower since I use the Delivery Space Booking service"
- "Using the Delivery Space Booking service, I consider the driving is more safety"
- "My perceived risk of accidents is lower since I use the Delivery Space Booking service"
- "The number of incidents and near crashes has decreased with the use of Delivery Space Booking service"
- "The number of accidents has decreased with the use of Delivery Space Booking service"
- "I think I have had less number of accidents with the use of Delivery Space Booking service"
- "I think the number of incidents and near crashes is independent of the use of the Delivery Space Booking service"
- "I think the number of accidents is independent of the use of the Delivery Space Booking service"
- "I am confident in my ability to drive the truck safely with the Delivery Space Booking service"

DSB16	**According to the driver perception the delivery space booking system will improve of freight transport image in urban areas**	**RQ10_4**	**Questionnaire**

<table>
<tr><td colspan="4">

- "According my perception, the Delivery Space Booking service improves the freight transport image in urban areas"
- "The freight transport image in urban areas is improved with the usage of Delivery Space Booking service"
- "I believe the urban congestion has increased with the usage of the Delivery Space Booking service"
- "I consider the Delivery Space Booking service improves the freight image in urban areas because decrease the number of double lane stops"
- "I think the Delivery Space Booking service improves the freight transport image in urban areas taking into account that its use reduce the fuel consumption"

</td></tr>
<tr><td>DSB17</td><td>Drivers will trust the delivery space booking service</td><td>RQ10_4</td><td>Questionnaire</td></tr>
<tr><td colspan="4">

- "I trust the Delivery Space Booking service"
- "I am confident of using Delivery Space Booking service"

</td></tr>
<tr><td>DSB18</td><td>Drivers consider that there are more availability space with the delivery space booking usage</td><td>RQ10_4</td><td>Questionnaire</td></tr>
<tr><td colspan="4">

- "I consider that there are more availability space with the Delivery Space Booking service usage"
- "I think it is easier to find a free space since I used the Delivery Space Booking service"

</td></tr>
<tr><td>DSB19</td><td>The rest of the drivers will appreciate the delivery space booking system because they will find easier to drive in the city without double lines and trucks parked on the pavement , less stress</td><td>RQ10_4</td><td>Questionnaire</td></tr>
<tr><td colspan="4">

- "I believe the rest of the drivers appreciate the Delivery Space Booking service because they will find easier to drive in the city without double lines and trucks parked on the pavement, less stress…"

</td></tr>
<tr><td>DSB20</td><td>The traffic flow gets benefits with the delivery space booking (the rest of the drivers do not hold up because of double lines, less congestions)</td><td>RQ8_4</td><td>Questionnaire & Direct observation</td></tr>
<tr><td colspan="4">

- "I think the traffic flow gets benefits with the Delivery Space Booking service (the rest of the drivers do not hold up because of double lines, less congestions…"

</td></tr>
<tr><td>DSB21</td><td>Less tickets (fines) because of double lines</td><td>RQ_4</td><td>Direct (ask data to the police o to the companies)</td></tr>
<tr><td colspan="4">

- "I have less tickets/fines because of double-parked since I used Delivery Space Booking service "

</td></tr>
</table>

9. Data Management.

This chapter describes the procedures of data management that are going to be followed in FREILOT, including the requirements and format of data. The first part describes the data collection schema, an overall description about the process that defines how the data is going to be retrieved from the different test sites and stored in the CTAG central database

Next, the different data acquisition scenarios where the data collection schema has to be adapted are introduced too. There are different data acquisition scenarios due to the combination of the different services and test sites working during the FREILOT experiment. It is important to note that each scenario has their own features (data list available, data files definition) and datalogging systems so the data acquisition processes may differ among them. In this section the data list registered and the data files generated including the measures per scenario are included.

Finally, regarding that some final adjustments are still to be done, a preliminary description about the global database located in CTAG is included.

9.1. Data collection schema

A common data collection schema is needed to retrieve and store all data coming from Bilbao, Lyon, Helmond and Krakow test sites to the CTAG central database. An overall vision of this schema is presented bellow:

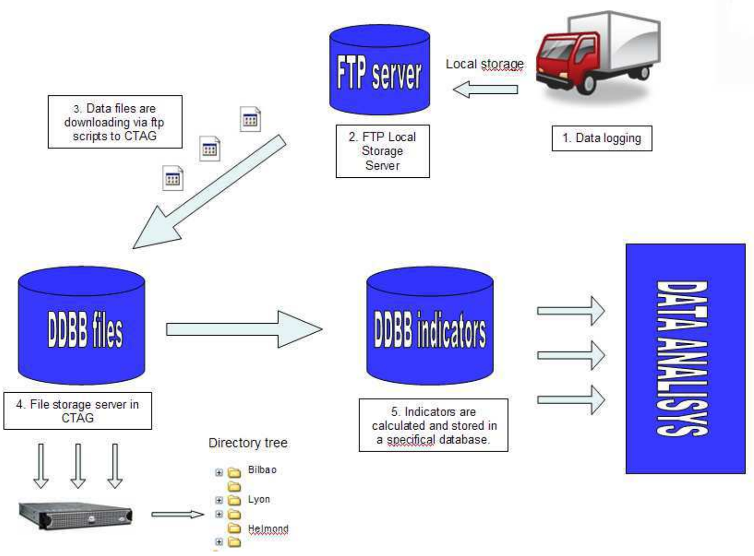

Figure 15 Data management scheme

The data is logged from the data logger devices during the 12 months of experiment and stored locally in the FTP servers managed and supervised by the test site leaders. It's important to note that the work of the DAS systems is different depending on the test site and service so the data collection schema may differ in each location.

Periodically the data files are going to be downloaded and saved in the CTAG central database. This process has to be done automatically so the development of automated downloading scripts is needed to facilitate this task. After the files collection, the rest of the evaluation process will start:

- Data processing.
- Performance indicators calculation.
- Hypothesis testing.
- Global assessment.

9.2. Data acquisition scenarios

During the process for the definition of the data acquisition system, three main tasks were carried out:

1. Preparation of the data list with the measures that can be provided for each datalogger system. Different dataloggers will be used in function of the scenario (see Implementation plan).
2. Definition of the different file formats where the logs are saved. Main issues in this task are the name of the files (to avoid duplicate names), file format (text files) and data arrangement inside these files (this is an important point for the later evaluation tools development).
3. Data storage schema. This task is focused in the identification of the data servers that will store the files locally and the downloading scripts development to automate the data retrieval from the data sources (pilot sites) to CTAG database.

These tasks have to be sorted out with the partners in charge of the implementation work package and in the four pilot sites where the five FREILOT functionalities has to be installed. The 5 data acquisition scenarios identified are listed bellow:

1. **Acceleration Limiter**, **Speed Limiter**, **Eco Drive Support** in Bilbao, Lyon, Helmond and Krakow.
2. **Intersection Control** in Helmond and Krakow.
3. **Intersection Control** in Lyon.
4. **Delivery Space Booking** in Bilbao.
5. **Delivery Space Booking** in Lyon.

The next table summarizes the five existing scenarios per test site and system:

System / Test site	IC	SL	AL	EDS	DSB
Lyon	Scenario 3	Scenario 1	Scenario 1	Scenario 1	Scenario 5
Helmond	Scenario 2	Scenario 1	Scenario 1	Scenario 1	
Krakow	Scenario 2	Scenario 1	Scenario 1	Scenario 1	
Bilbao		Scenario 1	Scenario 1	Scenario 1	Scenario 4

Table 21 Summary of data acquisition scenarios

9.2.1. Scenario 1: SL ,AL, EDS in BILBAO, HELMOND, LYON and KRAKOW

This section involves the measures logged in trucks in which the Volvo systems are implemented. The files definition, naming, and file store server issues are also described.

9.2.1.1. List of measures logged.

The Volvo systems have their own data adquisition system, the system takes snapshot of the data when an event ocurrs directly from the truck network. The first task was the selection of measures and events needed to perform the Speed Limiter, Acceleration limiter and Eco Drive Support evaluation and performance indicators calculation.

In the tables below we decribe the common measures (registered for all the four in-vehicle systems), and then separately the measures belonging to each system in particular. The data features, units and events which trigger the measures logging, are also recopilated in the tables:

Common measures	RANGE	UNITS	Trigger
TruckID	1-100	numerical code	driver login/logout zone entry/exit
DriverID	-	alphanumerical code	driver login/logout zone entry/exit
VehicleTotalWeight	0,0 to 119713,243245	kg	periodic(2 min) zone entry/exit
LOV.Vehicle.Distance	0-500.000	m	periodic(2 min) zone entry/exit driver login/logout
LOV.Vehicle.Fuel	0.00 - 10 000 000	l	periodic(2 min) zone entry/exit driver login/logout
BrakeCounter	-	numerical register	periodic(2 min)
VehicleStopCounter	-	numerical register	periodic(2 min)
LOV.vehicle.moving.time	1 - 4294967295	s	zone entry/exit driver login/logout
LOV.Vehicle.Moving.fuel	0.00 – 10 000 000	l	zone entry/exit driver login/logout
Speed	-	Km/h	periodic(2 min)
Tracking		**UNITS**	**Trigger**
Position	-	GPS coordinates, ex: 43.262217; -2.929084; 2.97	periodic (2min)
DateTime	-	YYYY-MM-DD HH:MM:SS	periodic (2min)

Table 22 Common measure list registered in all Volvo systems.

Next tables sumarize the characteristics of the measures registered per system:

Speed Limiter	RANGE	UNITS	Trigger
SL.Counter	0-10.000	numerical register	driver logout
SL.Value	0-100 m/s	m/s	zone entry
SL.Active.Time	1 - 4.294.967.295	s	zone exit
SL.Active.Fuel	0.00 – 10.000.000	l	zone exit
SL.Active.Distance	0-500.000	m	zone exit
SL.Limiting.Time	1 - 4.294.967.295	s	zone exit
SL.Limiting.Fuel	0.00 – 10.000.000	l	zone exit
SL.Limiting.Distance	0-500.000	m	zone exit
SL.Overriding.Counter	0-10.000	numerical register	zone exit
SL.Overriding.Time	1 - 4.294.967.295	s	zone exit
SL.Overriding.Fuel	0.00 – 10.000.000	l	zone exit
SL.Overriding.Distance	0-500.000	m	zone exit

Table 23 Measure list registered in Speed Limiter system.

Acceleration Limiter	RANGE	UNITS	Trigger
AL.Map0.Active.Count	0-10.000	numerical register	driver logout
AL.Map0.Active.Fuel	0.00 - 10.000.000	l	driver logout
AL.Map0.Active.distance	0-500.000	m	driver logout
AL.Map0.Overriding.Count	0-10.000	numerical register	driver logout
AL.Map1.Active.Count	0-10.000	numerical register	zone exit
AL.Map1.Active.Fuel	0.00 - 10.000.000	l	zone exit
AL.Map1.Active.distance	0-500.000	m	zone exit
AL.Map1.Overriding.Count	0-10.000	numerical register	zone exit
AL.Map2.Active.Count	0-10.000	numerical register	zone exit
AL.Map2.Active.Fuel	0.00 - 10.000.000	l	zone exit
AL.Map2.Active.distance	0-500.000	m	zone exit
AL.Map2.Overriding.Count	0-10.000	numerical register	zone exit

Table 24 Measure list registered in Accelerator Limiter system.

Eco Drive Support	RANGE	UNITS	Trigger
EDS.AccPedDrv	0-100	%	driver logout
EDS.AccSftDrv	0-100	%	driver logout
EDS.StdSftDrv	0-100	%	driver logout
EDS.CstRatDrv	0-100	%	driver logout
EDS.GlobalDrv	0-100	numerical register	driver logout
EDS.FuelConso	0.00 - 10.000.000	l	driver logout
EDS.AverageSpeed		Km/h	driver logout
EDS.TotalDistance	0-500.000	m	driver logout

Table 25 Measure list registered in Eco drive support system.

9.2.1.2. Files definition

All the logs generated during the experiment have to be collected in data files periodically. For Volvo systems it has been decided that the files were generated daily for truck and system. To avoid duplicate names, a common file name pattern has been defined too. This standard name is proposed for all the services involved in FREILOT (to get an easier development of the data management tool). The proposal of file name is the following:

- "yyyy-mm-dd hh_mm_ss_IDCity_x_IDSystem_y_IDTruck_platenumber_IDDriver_driverid_IDCompany_company.txt"

Where:

- "yyyy-mm-dd hh_mm_ss" : references the date and hour.
- "x" references to the city: 2→Bilbao, 3→Lyon,4→Helmond,5→Krakow.
- "y" references to the system being tested: 1→Intersection Control, 2→Speed Limiter, 3→Acceleration Limiter, 4→Eco Drive Support, 5→Delivery Space Booking.

Depending on the data logging system selected for each system and the info available per test sites, some fields won't be present in the file name. In case of the Volvo systems the pattern name will be as follows:

- "yyyy-mm-dd_IDCity_x_IDSystem_y_IDTruck_platenumber_ IDCompany_companyname.txt"

For example at Lyon, on 2010-09-28 testing the EDS on a truck belonging to the company NANUK:

- "2010-09-28_IDCity_3_IDSystem_4_IDTruck_9800CDF_IDCompany_NANUK.txt"

An example of text file logged from Volvo systems (values are dummy) is presented below:

```
date: 2010-05-14 15:23:08
truckId: H4D4685FDHUCHJXW45
driverId: SERGE_DUPONT
trigger: ZONE_EXIT
zoneId: 68

SL.Value: 50
SL.Active.Time: 16584695
SL.Active.Fuel: 0.896425
SL.Active.Distance: 589
SL.Limiting.Time: 49563258
SL.Limiting.Fuel: 0.58564
...
```

Figure 16 Example of data file from Volvo data logger.

9.2.1.3. Local Data Server

In order to share and retrieve the data files generated in all test sites a definition of the servers which will store all the amount of data collected is needed. The desirable solution is using FTP servers in all test sites. In the next figure the schema of the Volvo local data management is showed:

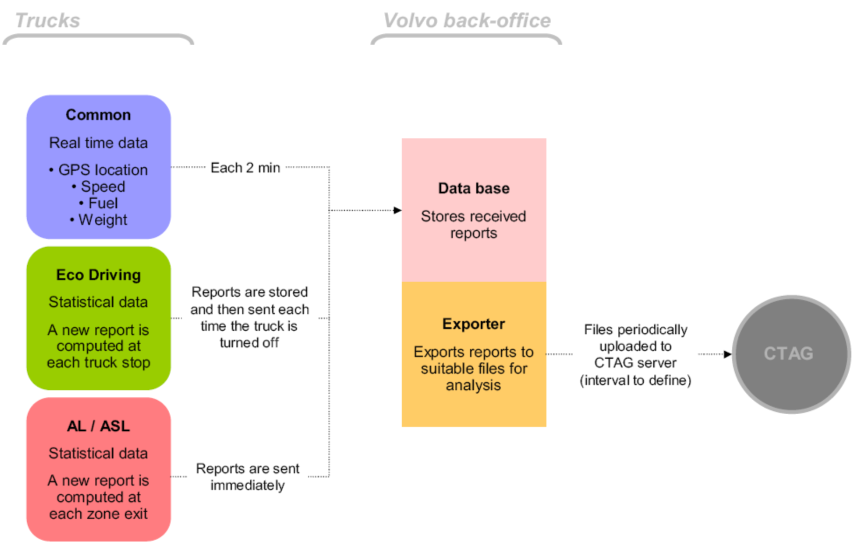

Figure 17 Data logging schema and data retrieval with Volvo systems.

The data reports from trucks are uploaded to the Volvo back office where are exported to suitable files for analysis. Later the data files can be retrieved from Volvo server periodically. This period can be variable and has to be supported by the downloading scripts.

9.2.2. Scenario 2: Intersection Control in HELMOND and KRAKOW

Intersection Control has two DAS which will register data: a vehicle unit collecting GPS data and sending it to the road unit when the vehicle is on radio range of an intersection, and a road side unit collecting data related with the traffic light controller status on intersections. The road side unit stores the truck and intersection logs and compresses the data into one file. These files are retrieved to the Peek headquarter where CTAG will be able to download them later.

9.2.2.1. List of measures logged.

In the tables below the measures registered in this case are presented. The first table gathers the info coming from the truck logs and the second table contains the logs from the intersection infrastructure.

Intersection Control Truck Logs	RANGE	UNITS	Logging Frequency
GPS date and time	-	YYYY-MM-DD HH:MM:SS	1 Hz
GPS position	-	GPS coordinates	1 Hz
GPS heading	-	degrees	1 Hz
GPS Speedy	-	Km/h	1 Hz
Priority message received:	-		1 Hz
intersection id	-	numerical register	1 Hz
priority state	-	numerical register	1 Hz
distance to the stop line	-	m	1 Hz
time until green (if applicable)	-	s	1 Hz
advised speed (if any)	-	km/h	1 Hz

Table 26 List of truck logs registered in Intersection Control system.

Intersection control Road side Logs	RANGE	UNITS	Logging Frequency
state of traffic lights for all directions (including pedestrians)	-	-	1 Hz
state of any pending priority requests	-	-	1 Hz

Table 27 List of road side logs registered in Intersection Control system.

9.2.2.2. Files definition

We will have two files containing the data logged with the intersection control system. The file name pattern is the same commented in the previous scenario with Volvo systems (see section 9.2.1.2). Some variations depending on the particularities of each DAS were introduced. In this case, there are two files per intersection, one of them containing the data logs coming from all the trucks which have been crossing the intersection during the day and the other with info about the traffic controller state per day. Then these two files are compressed into another one. The name proposed for these three files are the followings:

- “yyyy-mm-dd_IDCity_x_IDSystem_y_IDIntersection_xx.gz”. For the compressed file being:
  - “yyyy-mm-dd” the date where the file is created.
  - “x” city ID: 2→Bilbao, 3→Lyon,4→Helmond,5→Krakow.
  - “y” system : 1→Intersection Control, 2→Speed Limiter, 3→Acceleration Limiter, 4→Eco Drive Support, 5→Delivery Space Booking.
  - “xx” is the intersection ID. It could be an alphanumerical code, not defined yet.

Example of name for Lyon: “2010-10-15_IDCity_3_IDSystem_1_IDIntersection_A1.gz”

- “yyyy-mm-dd_IDCity_x_IDSystem_y_IDIntersection_xx_TruckLogs.txt”. For the file containing the truck logs. An example of file name in Lyon could be:

  “2010-10-15_IDCity_3_IDSystem_1_IDIntersection_A1_TruckLogs.txt”

- “yyyy-mm-dd_IDCity_x_IDSystem_y_IDIntersection_xx_IntersectionLogs.txt”. Containing the infrastructure logs.

  For example: “2010-10-15_IDCity_3_IDSystem_1_IDIntersection_A1_IntersectionLogs.txt”.

9.2.2.3. Local Data Server

As in the 9.2.1.3 section the desirable solution to store and share data in/from the test sites (Helmond and Krakow) is a FTP server. The development of the downloading scripts can be adapted easily if we have this solution in all the pilot sites. The data retrieval has to be done periodically to store the files in CTAG database.

9.2.3. Scenario 3: Intersection Control in Lyon

In Lyon test site the data provided by the Intersection control data loggers is recorded on trucks per day. There are two different test sites which their proper priority mode of operation:

1. Green wave
2. Priority control with cooperative system

In both test sites the trucks will register the data logs only when they enter in the test area. For the green wave test site, FREILOT trucks will detect that they are entering in the test zone using GPS positioning.

9.2.4. Data list recorded

The data recorded depends on the intersection where the data has been logged. In the intersection with the green wave mode operative the data list is composed of the GPS measures recorded each second, this list is referenced in the following table:

Intersection Control Green Wave mode	RANGE	UNITS	Logging Frequency
GPS date and time	-	YYYY-MM-DD HH:MM:SS	1 Hz
GPS position	-	GPS coordinates	1 Hz
GPS heading	-	degrees	1 Hz
GPS Speedy	-	Km/h	1 Hz
Priority message received:	-		1 Hz
town id	-	numerical register	
intersection id	-	numerical register	1 Hz
priority state	0 no priority 1 intersection priority -1unknown	numerical register	1 Hz
distance to the stop line	-1 if distance unknown	m	1 Hz
time until green (if applicable)	-1 if time unknown	s	1 Hz
advised speed (if any)	-1 if no advised speed	km/h	1 Hz

Table 28 List of data registered with Intersection Control Green Wave mode in Lyon.

The list of data for cooperative priority intersection will contain GPS position and specific information sent by the cooperative system, see the next tables:

Intersection Control priority control mode	RANGE	UNITS	Logging Frequency
GPS date and time	-	YYYY-MM-DD HH:MM:SS	1 Hz
GPS position	-	GPS coordinates	1 Hz
GPS heading	-	degrees	1 Hz
GPS speed	-	Km/h	1 Hz
Priority message received:	-		1 Hz
city id		numerical register	
intersection id	-	numerical register	1 Hz
priority state	0 no priority 1 intersection priority -1unknown	numerical register	1 Hz
distance to the stop line	-1 if distance unknown	m	1 Hz
time until green (if applicable)	-1 if time unknown	s	1 Hz
advised speed (if any)	-1 if no advised speed	km/h	1 Hz

When crossing the traffic light:	Description	UNITS	LoggingFrequency
tag HIST	tag to identify specific intersection data	-	Event
Trajet Id	ID diaser of route (0..7)	numerical code	Event
Itinary Id	Database ID of the vane	numerical code	Event
First announce timestamp	Date and time of the first exchange of data between truck and intersection	YYYY-MM-DD HH:MM:SS	Event
Crossing timestamp	Date and time when truck cross intersection	YYYY-MM-DD HH:MM:SS	Event
Lost time	Time where truck speed < 5km/h	s	Event

Table 29 List of data registered in Intersection control with Cooperative System in Lyon.

9.2.4.1. Files definition

For both intersections (priority control mode/green wave mode), there will be one file per truck and day (if trucks cross the test areas) containing the data described in the previous section. There will be another file containing data registered by the traffic density sensors installed in the test sites.

The name of the files follows the same pattern we have defined previously:

- “yyyy-mm-dd_IDCity_x1_IDZone_x2_IDSystem_y_IDTruck_z_IDCompany_w.txt“
  Where :
  - “yyyy-mm-dd“ is the date where the data contained is logged .
  - “x1“ : Id of city : Lyon 3.

- “x2“ : Id of area, Route de lyon (cooperative priority) = 0, Gerland (green wave) = 1.
- “y“ : Id of system , for the Intersection Control is 1.
- “z“ : Id of truck (ex. truck 1 : 2001, truck 2 : 2002, truck 3 : 2003)
- “w“ : ID of company.

The files have a header which contains line beginning by "#" and describing:

1. Id of the truck which the file comes from.
2. Description of the data fields.

An example of file logged for truck identified as “2001“ that is approaching to the intersection controller “VN052” looks as follows :

```
#################################################
# File for statistic of the day for FREILOT Lyon#
#Truck Id : 2001
# Line format :
# Date,GPSLong,GPSLat,GPSHeading,GPSSpeed,IdTown,IdCarref,PriorityState,DistancePF,TimeBeforeGreen,MaxSpeedAdvised
#################################################
2010/09/13 14:9:57;4.804850;45.781340;36;2;-1;-1;-1;-1;-1;-1
2010/09/13 14:9:58;4.804870;45.781350;37;2;139;52;-1;-1;-1;-1
2010/09/13 14:9:59;4.804870;45.781350;37;4;139;52;-1;-1;-1;-1
2010/09/13 14:10:0;4.804870;45.781350;37;6;139;52;-1;-1;-1;-1
2010/09/13 14:10:1;4.804870;45.781350;38;12;139;52;-1;-1;-1;-1
2010/09/13 14:10:2;4.804870;45.781350;38;13;139;52;-1;-1;-1;-1
HIST ;0 ;0002 ; 21/09/2010 15 :52 :45 ; 21/09/2010 15 :53 :37 ;21
2010/09/13 14:10:3;4.804870;45.781350;38;11;139;52;1;292;7;-1
2010/09/13 14:10:4;4.804870;45.781350;39;15;139;52;1;290;6;-1
2010/09/13 14:10:5;4.804870;45.781350;39;18;139;52;1;285;5;-1
2010/09/13 14:10:6;4.804870;45.781350;40;20;139;52;1;283;4;-1
2010/09/13 14:10:7;4.804870;45.781350;41;23;139;52;1;278;3;-1
2010/09/13 14:10:8;4.804870;45.781350;42;25;139;52;1;275;2;-1
date: 2010-05-14 15:23:08
```

Figure 18 Example of file registered in Lyon with the Intersection control data logger.

9.2.4.2. Local Data Server

The files logged on trucks will be sent via GPRS and locally stored in a FTP server. Then the files will be retrieved from Lyon to the CTAG database.

9.2.5. Scenario 4: Delivery Space Booking in Bilbao

For the DSB in Bilbao the data is logged from each truck and day taking advantage of a Blackberry’s GPS system. The driver logins to the Blackberry’s system before starting the journey and then the GPS data is collected for the whole journey. Files are sent via GPRS to the Bilbao local FTP server.

9.2.6. Data list recorded

The data recorded per truck and day using the GPS data loggers is described in the next table:

Delivery Space Booking	RANGE	UNITS	Logging frequency
GPS date and time	-	YYYY-MM-DD HH:MM:SS	0.5 Hz
GPS position	-	GPS coordinates	0.5 Hz
GPS speed	-	Km/h	0.5 Hz
GPS number of satellites	-		0.5 Hz
GPS signal level	-	dB	0.5 Hz

Table 30 List of data registered by DSB system in Bilbao

9.2.6.1. Files definition

The data files in Bilbao will contain the data recorded per truck and delivery route (one truck can follow different routes per day). The names of the files are defined following the next pattern:

- "yyyy-mm-dd hh_mm_ss_IDCity_x_IDSystem_y_IDTruck_z_IDDriver_w_IDCompany_j_n_m.txt"

  Where:

  - "x" : city ID: Bilbao 2.
  - "y": system ID: DSB 5.
  - "z": truck ID: plate number of the truck.
  - "w": driver ID: login of the driver.
  - "j": company Id: name of the company which owns the truck.
  - "n" "m": files are fragmented because of size problems, "n" references the particular part from the total number of parts "m".

For example, in Bilbao using the DSB during a day, being the file the first part of a total of six, the name is as follows.

- "2010-07-22 07_49_08_IDCity_2_IDSystem_5_IDTruck_0624BCN_IDDriver_perez_IDCompany_DHL_1_6.txt"

An example of data file recorded in Bilbao is presented in the next picture:

```
date and time;latitude;longitude;altitude;speed;sats_number;signal_level
22/07/2010-11:13:13;43.20555;-2.708956;2.75;143.0;3;-72;
22/07/2010-11:13:15;43.205524;-2.708979;0.00;143.0;3;-72;
22/07/2010-11:13:17;43.205524;-2.708979;0.00;143.0;3;-72;
22/07/2010-11:13:19;43.205524;-2.708979;0.00;143.0;3;-72;
22/07/2010-11:13:22;43.205591;-2.708988;0.00;128.0;4;-72;
22/07/2010-11:13:24;43.205607;-2.70898;0.00;122.0;5;-72;
22/07/2010-11:13:26;43.205618;-2.709;0.00;118.0;5;-72;
22/07/2010-11:13:28;43.205649;-2.708979;0.00;114.0;5;-72;
22/07/2010-11:13:30;43.205672;-2.708975;3.19;114.0;5;-75;
22/07/2010-11:13:32;43.205706;-2.708952;4.33;113.0;5;-72;
22/07/2010-11:13:34;43.205718;-2.708959;4.11;114.0;4;-71;
22/07/2010-11:13:36;43.205732;-2.708954;2.75;110.0;3;-71;
22/07/2010-11:13:39;43.205744;-2.708937;0.00;110.0;3;-71;
22/07/2010-11:13:41;43.205738;-2.708956;0.00;109.0;4;-71;
```

Figure 19 Example of file registered in Bilbao with the DSB data logger.

9.2.6.2. Local Data Server

The data file server selected in order to store the files locally and facilitate file sharing, is a FTP server. CTAG can retrieve weekly the files uploaded during the experiment.

9.2.7. Scenario 5: Delivery Space Booking in Lyon.

Delivery Space Booking in Lyon might have the same data collection schema for non Volvo trucks as we have considered in Bilbao, this is data logging based in GPS measures from mobile devices in non Volvo trucks. Data files will contain the data from each truck per day. The data list, data files definition and naming is not closed yet but it might be very similar to the considerations made in Bilbao too.

9.2.8. Data list recorded

As we have mentioned before data list features will be very similar to Bilbao, we described the possible measures we finally have in the next table:

.

Delivery Space Booking	RANGE	UNITS	Logging frequency
GPS date and time	-	YYYY-MM-DD HH:MM:SS	0.5 Hz
GPS position	-	GPS coordinates	0.5 Hz
GPS speed	-	Km/h	0.5 Hz
GPS nº of satellites	-		0.5 Hz
GPS signal level	-	dB	0.5 Hz

Table 31 List of data registered by DSB system in Lyon

9.2.8.1. Files definition

The file name pattern proposed for Lyon files regarding the DSB system is described bellow, depending on some considerations need to be taken it's possible that some information indicated could change.

- "yyyy-mm-dd hh_mm_ss_IDCity_x_IDSystem_y_IDTruck_z_IDDriver_w_IDCompany_j.txt"

Where the different fields will contain the same information commented in the previous sections. Files would be registered per truck and day.

9.2.8.2. Local Data Server

Local data server or the back office systems are not defined yet.

9.3. Database

This chapter describes the data management process from the data acquisition systems to the final results.

In this case we have different locations where the data is collected (Bilbao, Helmond, Lyon and Krakov). But for storing data is recommendable to have a centralized database. This implies that this database must be in a fix place and it should have enough capacity for storing all the data collected during the 12 months of pilot. For FREILOT, the proposal is to have the centralized database in CTAG (Vigo) where the first analyses will be carried out.

The data storage server has capacity enough to store the files coming from the different test sites during the experiment. With the global data base centralized in one location, the data files sharing between the evaluation partners will be more effective. Then rest of the process continues with the performance indicator calculation, hypothesis testing and data global assessments.

10. Evaluation Plan

In previous chapters, the Research Questions, the Hypothesis, the measurements and the process for collecting data are described. This section is focused in the description of the evaluation plan, specifying the periods for data collection for each truck in each test site, taking into account the combination of services.

As it has been described in chapter 5, one of the main aims of FREILOT is the evaluation of the services described in the four pilot sites (Bilbao, Helmond, Lyon and Krakov). Each pilot site has its own configuration of services implemented and number of trucks using them (see Chapter 5 and Implementation Plan). In order to provide a common evaluation framework in the four pilot sites and for all the services, general experimental designs were proposed taking into account the combination of services per truck, independently of the test site. In some specific cases (if it would be necessary), the experimental design will be adapted to the technical exigencies/needs.

Each experimental design is composed of a Baseline period and an experimental period. During the Baseline period, the data defined in previous sections will be recorded without any system active, while during the Experimental period the data will be registered with the systems activated. In this way, from the Baseline, data from the current situation in the cities (without the services) will be available in order to compare with the effect of the services. In this way, during the pilot, the same indicators will be checked with/without the services in order to show the benefits.

Regarding the combination of systems, different combinations are proposed:

- 1 service per truck.
- 2 services per truck.
- 3 services per truck.
- All services per truck.

In this way, it will be possible to check the effects of the services separately and the effects of the combination of services.

Below the general experimental designs taking into account the combination of services per truck were presented. These general experimental designs will be adjusted in each pilot site, taking into account the number of trucks and the combination of systems implemented and presenting in next sub-chapters.

10.1. General Experimental Designs

Taking into account the combination of systems installed in the trucks, different experimental designs are proposed. These are described in following paragraphs.

- **Trucks with 1 service.**

2 MONTHS	8 MONTHS	2 MONTHS
System / service OFF	FREILOT service/ system working	System / service OFF
Baseline	FREILOT SYSTEMS Active	Study of carry-over effects

Figure 20 Proposal of Experimental Design for trucks with one system implemented

- **Trucks with 2 services.**

In case of combination of the in-vehicle systems (Acceleration Limiter, Speed Limiter and Eco Driving Support), the following experimental design is proposed:

2 MONTHS	8 MONTHS	2 MONTHS
Systems / services OFF	Two FREILOT services/ systems working simultaneously	Systems / services OFF
Baseline	FREILOT SYSTEMS Active	Study of carry-over effects

Figure 21 Proposal of Experimental Design for trucks with two systems implemented

In case that the combination of systems includes at least one of the services that involve infrastructure (Intersection Control and/or Delivery Space Booking), the experimental design proposed is the following one:

- Intersection Control:

2 MONTHS	10 MONTHS
Intersection Control OFF	Intersection Control working
Baseline	FREILOT SERVICES Active

Figure 22 Proposal of Experimental Design for trucks with Intersection Control Service in combination with other system

- Delivery Space Booking:

In this case the experimental design depends on the performance of each service combinations in each pilot site. These specifications are contained in the specific section of each test site.

- **Trucks with 3 services**

In this case, the experimental design proposed is the following one. The proposal is prepared taking into account that the only combination of 3 systems at this moment is a combination of in-vehicle systems.

2 MONTHS	8 MONTHS	2 MONTHS
Systems / services OFF	Three FREILOT systems/ services working simultaneously	Systems / services OFF
Baseline	FREILOT SYSTEMS Active	Study of carry-over effects

Figure 23 Proposal of Experimental Design for trucks with three systems implemented

- **Trucks with all services**

2 MONTHS	8 MONTHS
Systems / services OFF	IC + EDS + SL + AL + DSB working simultaneously Systems / services OFF
Baseline	FREILOT SYSTEMS Active

Figure 24 Proposal of Experimental Design for trucks with all systems implemented

10.2. Experimental Designs per Test Site

10.2.1. Bilbao Pilot Site

The applications to be tested in Bilbao Pilot Site are: Acceleration/Speed Limiter, Eco Driving Support and Delivery Space Booking.

The combinations of systems per trucks are the following ones:

BILBAO	
FREILOT Services Combination	Truck ID
AL	B04
SL	B03
EDS	B07
DSB	Final number of trucks? 40?
SL+AL	B05
AL+SL+EDS	B06

Table 32 Combination of systems per truck in Bilbao.

10.2.1.1. Experimental design

In this case, the experimental design proposed is a **within subject or repeated-measures design** where each driver in FREILOT pilot will drive with and without the system or service.

Taking into account the type of systems (in-vehicle and infrastructure related systems), two different configurations are proposed:

- For studying effects of in-vehicle systems (Acceleration Limiter, Speed Limiter and Eco Driving Support) and its combinations.
- For studying effects of Delivery Space Booking service.

.

- **In-vehicle systems (Acceleration Limiter, Speed Limiter and Eco Driving Support) and its combinations.**

In this case information for drivers in the two conditions will be provided. In this case the design will be A-B-A design with a baseline (A) and an experimental condition where the systems are activated (B).

Next figures summarize the periods applied for each truck, following the general experimental designs proposed:

Trucks with only one system (Acceleration Limiter or Speed Limiter or Eco Driving Support):

2 MONTHS	8 MONTHS	2 MONTHS
Acceleration Limiter OFF	Acceleration Limiter/Speed Limiter/Eco Driving Support active	Acceleration Limiter / Speed Limiter / Eco Driving Support OFF
Baseline	FREILOT SYSTEM Active	Study of carry-over effects

Figure 25 Field trial phases for trucks with only one system in-vehicle (Bilbao)

The three phases during the pilot are the following ones:

- FIRST TRIAL: Two months without the Acceleration Limiter as the baseline
- SECOND TRIAL: Eight months with Acceleration Limiter working
- THIRD TRIAL: Two months with the system inactive for studying carry-over effects.

Truck with Acceleration Limiter + Speed Limiter:

2 MONTHS	8 MONTHS	2 MONTHS
Acceleration Limiter +Speed Limiter OFF	Acceleration Limiter and Speed Limiter working simultaneously	Without Acceleration Limiter and Speed Limiter OFF
Baseline	FREILOT SERVICES Active	Study of carry-over effects

Figure 26 Field trial phases for AL + SL (Bilbao)

The three phases during the pilot are the following ones:

- FIRST TRIAL: Two months without the Acceleration Limiter + Speed Limiter as the baseline
- SECOND TRIAL: Eight months with Acceleration Limiter + Speed Limiter working simultaneously
- THIRD TRIAL: Two months with the systems inactive for studying carry-over effects.

Truck with Acceleration Limiter + Speed Limiter + Eco Driving Support:

2 MONTHS	8 MONTHS	2 MONTHS
Without Acceleration/Speed Limiter+Eco Driving Support	Acceleration Limiter + Speed Limiter + Eco Driving Support working simultaneously	Without Acceleration/Speed Limiter+Eco Driving Support
Baseline	FREILOT SYSTEMS Active	Study of carry-over effects

Figure 27 Field trial phases for AL + SL + EDS (Bilbao)

The three phases during the pilot are the following ones:

- FIRST TRIAL: Two months without the Acceleration/Speed Limiter + Eco Driving Support as the baseline
- SECOND TRIAL: Eight months with Acceleration/Speed Limiter + Eco Driving Support
- THIRD TRIAL: Two months with the systems inactive for studying carry-over effects.

- **Delivery Space Booking service.**

1,5 MONTHS	9 MONTHS	1,5 MONTHS
Delivery Space Booking Service OFF	Delivery Space Booking Service Working	Without Delivery Space Booking Service OFF
1st Baseline	FREILOT SERVICES Active	2nd Baseline

Figure 28 Field trial phases to DSB (Bilbao)

The three phases during the pilot are the following ones:

- FIRST TRIAL: 1,5 months without the Delivery Space Booking service
- SECOND TRIAL: 9 months with the Delivery Space Booking service active
- THIRD TRIAL: 1,5 months with the Delivery Space Booking service active

10.2.2. Helmond Pilot Site

Several applications will be implemented in Helmond: Acceleration and speed limiter, Eco Driving Support and Intersection Control. These applications will be tested used different experimental designs.

The combinations of systems per trucks are the following ones:

HELMOND	
FREILOT Services Combination	Truck ID
AL	H15
SL	H14
IC	Waiting final number of trucks
AL + SL	H16
EDS + IC	H11, H12, H13, H17, H18, H19, H20

Table 33 Combination of systems per truck in Helmond

10.2.2.1. Experimental design

In this case, the experimental design proposed is a **within subject or repeated-measures design** where each driver in FREILOT pilot will drive with and without the system or service.

Taking into account the type of systems (in-vehicle and infrastructure related systems), two different configurations are proposed:

- For studying effects of in-vehicle systems (Acceleration Limiter, Speed Limiter and Eco Driving Support) and its combinations.
- For studying effects of Intersection Control service and its combination with Eco Driving Support.

- **In-vehicle systems (Acceleration Limiter, Speed Limiter and Eco Driving Support) and its combinations.**

Trucks with only one system (Acceleration Limiter or Speed Limiter):

2 MONTHS	8 MONTHS	2 MONTHS
Acceleration Limiter OFF	Acceleration Limiter / Speed Limiter	Acceleration Limiter / Speed Limiter OFF
Baseline	FREILOT SYSTEMS Active	Study of carry-over effects

Figure 29 Field trial phases for trucks with only one system (Helmond)

The three phases during the pilot are the following ones:

- FIRST TRIAL: Two months without the Acceleration Limiter as the baseline
- SECOND TRIAL: Eight months with Acceleration Limiter working

- THIRD TRIAL: Two months with the system inactive for studying carry-over effects.

Truck with Acceleration Limiter + Speed Limiter:

2 MONTHS	8 MONTHS	2 MONTHS
Acceleration Limiter +Speed Limiter OFF	Acceleration Limiter and Speed Limiter working simultaneously	Without Acceleration Limiter and Speed Limiter OFF
Baseline	FREILOT SERVICES Active	Study of carry-over effects

Figure 30 Field trial phases for AL + SL (Helmond)

The three phases during the pilot are the following ones:

- FIRST TRIAL: Two months without the Acceleration Limiter + Speed Limiter as the baseline
- SECOND TRIAL: Eight months with Acceleration Limiter + Speed Limiter working simultaneously
- THIRD TRIAL: Two months with the systems inactive for studying carry-over effects.

- **Intersection Control and its combination with Eco Driving Support.**

Trucks with Intersection Control:

In this case, an adaptation of the general experimental design proposed for all the systems is proposed in order to have baseline period from two different weather conditions periods.

1 MONTH	5 MONTHS	1 MONTH	5 MONTHS
Intersection Control OFF	Intersection Control working	Intersection Control OFF	Intersection Control working
Baseline	FREILOT SERVICES Active	Baseline	FREILOT SERVICES Active

Figure 31 Field trial phases for IC (Helmond)

The three phases during the pilot are the following ones:

- FIRST TRIAL: One month without the Intersection Control service as the baseline.
- SECOND TRIAL: Five months with Intersection Control service.
- THIRD TRIAL: One month with the systems inactive for taking baseline in different weather conditions.
- FOURTH TRIAL: Five months with Intersection Control service.

Trucks with Intersection Control + Eco Driving Support:

2 MONTHS	8 MONTHS	2 MONTHS
Intersection Control + Eco Driving Support OFF	Intersection Control + Eco Driving Support working simultaneously	Intersection Control + Eco Driving Support OFF
Baseline	FREILOT SERVICES Active	Study of carry-over effects

Figure 32 Field trial phases for IC + EDS (Helmond)

The three phases during the pilot are the following ones:

- FIRST TRIAL: Two months without the Intersection Control + Eco Driving Support as the baseline
- SECOND TRIAL: Eight months with Intersection Control + Eco Driving Support working simultaneously
- THIRD TRIAL: Two months with the systems inactive for studying carry-over effects.

10.2.3. Krakow Pilot Site

Similar characteristics of Helmond are founded in Krakow Pilot Site. The applications are the same in both places: Acceleration/speed limiter, Eco Driving Support and Intersection Control. Then a similar proposal to Helmond Pilot is planned for the experimental design.

The combinations of systems per trucks are the following ones:

KRAKOW	
FREILOT Services Combination	FREILOT Services Combination
No data	No data

Table 34 Combination of systems per truck in Krakov

10.2.4. Lyon Pilot Site

In Lyon all the FREILOT services will be tested: Acceleration and Speed limiter, Eco Driving Support, Intersection Control and Delivery Space Booking.

The combinations of systems per trucks are the following ones:

LYON	
FREILOT Services Combination	Truck ID
AL	L09, L10, L11, L12, L13
EDS	L16, L18, L19
IC+SL+AL+EDS+DSB	R1

Table 35 Combination of systems per truck in Lyon

10.2.4.1. Experimental design

The general scheme is similar to the preceding pilot sites. For the Acceleration Limiter, Speed Limiter and Eco Driving Support it is proposed a within subject design ABA. The first baseline will have duration of 2 months as the last baseline. The experimental condition will last 8 months to complete one year of pilot period.

The last baseline is ruled out in the Intersection Control and Delivery Space Booking Services, therefore a within subject design AB is suggested.

Taking into account the type of systems (in-vehicle and infrastructure related systems), two different configurations are proposed:

- For studying effects of in-vehicle systems (Acceleration Limiter, Speed Limiter and Eco Driving Support) and its combinations.
- For studying effects of the combination of all systems.

Trucks with only one system (Acceleration Limiter or Eco Driving Support systems):

2 MONTHS	8 MONTHS	2 MONTHS
Acceleration Limiter OFF	Acceleration Limiter / Eco Driving Support actives	Acceleration Limiter / Eco Driving Support OFF
Baseline	FREILOT SYSTEMS Active	Study of carry-over effects

Figure 33 Field trial phases for trucks with only one system (Lyon)

The three phases during the pilot are the following ones:

- FIRST TRIAL: Two months without the Acceleration Limiter as the baseline
- SECOND TRIAL: Eight months with Acceleration Limiter working
- THIRD TRIAL: Two months with the system inactive for studying carry-over effects.

Truck with all systems:

In this case, a within subject design is proposed with a baseline (2 months) and an experimental condition (10 months).

2 MONTHS	10 MONTHS
Services OFF	All services actived
Baseline	FREILOT SERVICES Active

Figure 34 Field trial phases for truck with all systems (Lyon)

The three phases during the pilot are the following ones:

- FIRST TRIAL: Two months without the services as the baseline.
- SECOND TRIAL: Ten months with all the

services working.

10.3. Summary of Evaluation Plan

In the next table it is possible to see for each truck in each test site which are the dates planned for the data collection during baseline and experimental periods:

11. Fuel Consumption and Emissions

In order to estimate fuel consumption and gas emissions, we propose a methodology that presents two variants taking into account the datalogger system:

- VOLVO trucks datalogger
- GPS based datalogger (used in non-VOLVO trucks)

After a brief survey on the main methods and software used for fuel consumption and environmental impact of freight transport, we identified two types of models. The first uses average values for speeds and accelerations, and is mainly used for overall greenhouse gas emissions for transport (cf ARTEMIS Projects Andre M and al, 2006). The methods belonging to this category use in general synthetic equations, often resumed on tables like those of COPERT and Impact ADEME software solutions. The second is able to estimate instantaneous fuel consumptions and emissions (cf CMEM User_Guide_v3.01d SCORA G and al.).

In next figure, the complete process for fuel consumption and CO2 emissions calculation is presented:

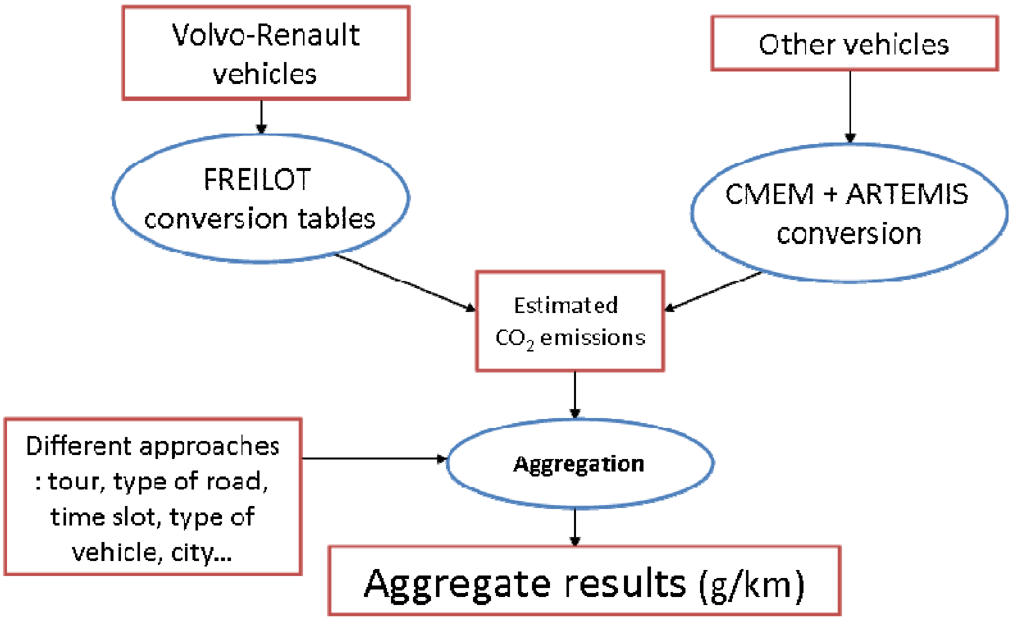

Figure 35 Evaluation of environmental impacts

For volvo trucks, instantaneous fuel consumption will be recorded directly from the vehicle. Then, by aggregating data, we can obtain the total fuel consumption.

For non-volvo trucks, the fuel consumption will be estimated using an instantaneous model as the CMEM software. The main input parameters are instantaneous speed, instantaneous acceleration, type of motor, weight of trucks and power of trucks. Before this estimation, the data recorded with this datalogger is going to be processed in order to identification the possible bugs, clean the GPS data and track the delivery stops. For this operation, specific software is going to be developed and adjusted. Next figure shows the process for estimation of the indicators from the GPS data:

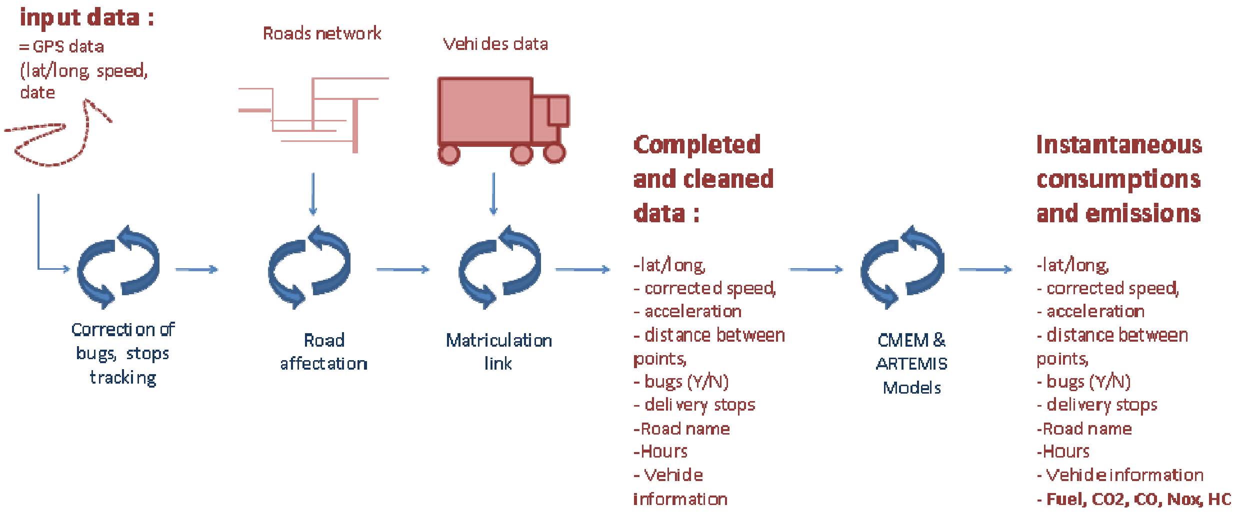

Figure 36 Calculation of fuel consumptions and pollutants emissions for non Volvo-Renault vehicles

According to many authors, fuel consumption and CO2 emissions are proportionally related (Shimizu and al.,1996) . Moreover, the CMEM software has been calibrated with similar hypothesis, then the relationship coefficient between fuel consumtion and CO2 emissions can be obtained.

Although CO2 are the main greenhouse gases emitted by freight transport vehicles, other pollutants, mainly hydorcarbures but also CO and NOx, contribute to greenhouse effect. In order to take it into account, we propose to estimate the greenhouse effect impacts taking into account these three gases into an integrated model. The model is based on COPERT tables that give the different weight of each gas to global warming impacts. Because the contribution of CO and NOx is less significant than that of CO2 and hydrocarbures, we will focus on these two components. The CMEM model is able to estimate both emissions, then, using the ponderation coefficients of COPERT 4, we can estimate the emissions of greenhouse gases, in CO2-equivalent units.

11.1. Evaluation

According to services tested, we will evaluate the impacts with/without the services. So, we present five categories of approaches to define and calculate fuel consumption and CO2 emissions, as well as other emissions:

Tour	This approach needs to make an early typology of tour according to the number of stops and stop times and the type of establishment served.
Zone (districts)	Traffic can depend on economic and demographic factors. Indeed, we need districts map (format GIS) and information about population and employment. Then, we can link districts and GPS data.
type of road	As districts, traffic can depend on type of road (motorway, main road, residential...) and building density (Routhier, 2002; Patier et al., 2007), we need a recent roads network (polylines format GIS) and building polygons.
Type of vehicle	Each vehicle have own equation of fuel consumption and pollutant emissions.
Time section	Traffic depends on time in a day. For each city, we must know approximately peak of activity. For example in Lyon, peak of activity are about 7:30-9am / 12am-1:30 pm. / 5:30 pm- 7 pm, but it is maybe different in Spain or Poland.

Moreover, we can analyze the data in order to make a combination of two or more approaches (for example, by type of road and time section).

12. Conclusions

To ensure a common and effective evaluation framework for all the pilot sites from the first phase of the project is a relevant issue for the correct development of a pilot. This is the main objective of this document: present the general framework for evaluation in the different test sites.

This document presents the basic evaluation methodology, including the data description, general specifications of data logging and data management process. Due to the early phase of development, there are some decisions to be taken in next months, depending on the final functionality of services, final number of trucks/drivers and other environmental conditions in each test site. This implies that this document will be reviewed and completed adding more details during this first year of the project.

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Annex I: FOT projects

Authors/ Year	Nº of participants	Nº Trucks	Nº Km (mileage)	Experimental Design	Parameters	Measures	Other characteristics
W. G. Najm, M. D. Stearns, H. Howarth, J. Koopmann, and J. Hitz. (2006). *Evaluation of an Automotive Rear-End Collision Avoidance System.*	N = 66	10 (car)	Total: 163.000 km. FCW: 64.000 km. ACC: 44.000 km.	Duration: March 2003 to November 2004. 1st week: collect baseline driving data, without ACAS. 2nd, 3rd, 4th weeks: With ACAS. 2 h of training(prior to starting the FOT)	- ACAS performance and capability. - ACAS safety benefits. - Driver acceptance of ACAS.	System capability: Sensor suite, alert logic, automatic controls, DVI (driver vehicle interface) Safety impact:3 areas - Exposure and response to driving conflicts at 4 different intensity levels. - Involvement in severe near crashes: Unintended consequences: Travel speed, time headway, distraction, and eyes-off-the-road.	Trigger: crash- imminent alerts Severe near crashes: minimum time-to-collision of less than 3 seconds Analysis of video episodes triggered Lead-vehicle-decelerating conflicts. Lead-vehicle-stopped conflicts
F. Lai, K. Chorlton and O. Carsten. (2007). Overall Field Trial Results.	N=79 (35 ♂;44 ♀)	20 (car)	Total: 570.660 km. ISA system: 352.109 km.	Within-subject design (A-B-A)	Use of ISA system	▪ Objective data (Speed distribution/variability, travel distance, comparison of vehicle speed across trial phases, jerks and effect of ISA on driver characteristics). ▪ Subjective data (predicting speeding behaviour, attitudes toward ISA: the impact of experience)	The questionnaires included different test as the Driver Behaviour Questionnaire, the NASA-RTLX, a scale to evaluate acceptability and some items to evaluate the driver perceived safety.

D.LeBlanc, J.Sayer, C. Winkler, R. Ervin, S. Bogard, J. Devonshire, M.Mefford, M.Hagan, Z. Bareket, R. Goodsell, and T. Gordon. (2006). Road Departure Crash Warning System Field Operational Test: Methodology and Results.	N = 11	78 (car)	Total: 133.576 km. (2500 h.)	Within-subject d esign, by comparing each driver's baseline data to their RDCW enabled data.	Road departure crash warning systems usage. RDCW: combination of a lateral drift warning (LDW) system and a curve-speed warning (CSW) system	▪ Objective data (Mean speed, percentage eyes off road time and rate of use of kickdown function with ISA system). ▪ Subjective data (usefulness, satisfaction, perceived behavioural control and mental workload).	Group of drivers is balanced for age and gender. A complete set of data was collected from 78 drivers distributed evenly by gender and within three age groups (ages 20-30, 40-50, and 60 and older).
O. Carsten, M. Fowkes, F. Lai, K. Chorlton, S. Jamson, F.Tate and B. Simpkin. (2008). Intelligent speed adaptation. Final Report.	N=79	--	Total: 570.660 km. ISA: 352.109 km.	Within-subject design (ABA)	Investigate car driver behaviour with ISA system Investigate the costs and benefits of ISA	▪ Objective data (Speed distribution/variability, travel distance, comparison of vehicle speed across trial phases, jerks and effect of ISA on driver characteristics…). ▪ Subjective data (predicting speeding behaviour, attitudes toward ISA: the impact of experience)	Car trials Truck trials Motorcycle trials. It's not clear the number of participants in Truck trials and the number of vehicles.

V.L. Neale, T.A. Dingus, S. G. Klauer, J. Sudweeks and M. Goodman. (2005). An overview of the 100-car naturalistic study and findings.	N = 109 (66 ♂;43 ♀)	100 (car)	Total: 3.218 km. (43.000 h)	Mixed-subject Design	Assess driver performance , behaviour, environment, driving context and other factors that were associated with critical incidents, near crashes and crashes To provide information about pre-crash data	▪ Objective data (Crashes, near crashes, incidents, vehicle dynamic and radar data, video including vehicle speed, vehicle headway, time-to-collision and driver reaction).	The study was divided in 2 experiments: a local/short haul truck driving study (N=42; 4 trucks; 1000 hours) and a long haul truck driving study (N=56; 2 trucks, 250h). The data set includes 3.218,7 vehicles miles, amost 43.000 hours of data, 241 primary and secondary drivers, 12 to 13 months of data collection for each vehicle.

J. Orban, J. Hadden, G. Stark, and V. Brown. (2006). Evaluation of the Mack Intelligent Vehicle Initiative Field Operational Test. Final Report.	N = 31	22	105.578 km.	Within-subject design 3 phases during 12 months: 1. Baseline period: without LDWS 2. Active period: with LDWS 3. Post-active period: after LDWS deactivated	Safety benefits User acceptance Human factors System performance Product maturity Institutional/ Legal issues Improvements in mobility efficiency, environmental quality Safety performance Prevention of crashes when a vehicle is in a driving conflict Driver acceptance	▪ Number of large trucks crashes that could be prevented ▪ Exposure of a vehicle to potential crash situations (driving conflicts) ▪ Historical crash and incidents data from the host operator and public databases (FARS & GES) ▪ Opinions from personal in the FOT, drivers, mechanics, corporate staff ▪ Video images of the lane to estimate the vehicle state (lateral position, speed, heading) ▪ Road alignment (lane width, road curvature.)	During each phase, on-board data were collected over a 12-month period (march 2004 -march 2005)

Batelle Final Report (2003). Evaluation of the Freightliner Intelligent Vehicle Initiative Field Operational Test.	N = 23	12	--	Repeated-measure design	Usage of Roll Advisor and Control (RA&C) system	▪ Objective data (advisory rate for each driver, speed time history, average speed, lateral accelerations, deceleration and RSC activated). ▪ Subjective data (driver perceptions about usability, workload, initial driver perceptions of the system, user acceptance, experience and expectations of the systems and perceived behavioural control).	The drivers in the FOT were not representative of the broad spectrum of attitudes and skills present in the general fleet-driver population. Personal interviews with the drivers allowed a much greater understanding than would have been possible had all the human factors been collected with pencil surveys. Even during the final interview, which was quite structured, the extra comments of the drivers revealed insights on how they interacted with the system, what they thought of its behaviour, and even how they drive their trucks.
Volvo Trucks North America. (2005). Volvo Trucks North Field Operational Test: Evaluation of Advanced Safety Sistems for Heavy Truck Tractors.	N = 1000	100 (truck)	Total: 62.764.650 km.	Repeated-measure design	Tested systems: ▪ Collision Warning System ▪ Adaptive Cruise Control ▪ Volvo Disk Brakes ▪ Electronically Controlled Brake System	▪ Objective data (Time to collision, road speed, following interval, longitudinal interval, longitudinal acceleration, engine brake usage, service brake usage, cruise control usage, brake pressure…) ▪ Subjective data (driver interviews: driver opinions regarding the Advanced Safety Systems).	The duration of the FOT was of 3-year data collection involved 100 new tractors consisting of 50 (Control) vehicles equipped with US Xpress normal specifications (including CWS), and 50 (Test) vehicles equipped with the Advanced Safety Systems. Baseline vehicles (a 20-vehicle subset of the 50 Control vehicles) were operated for part of the FOT with their CWS driver displays disconnected.

Batelle Final Report. (2007). Evaluation of the Volvo Intelligent Vehicle Initiative Field Operational Test Version 1.3.	N = 204	100 (truck)	Total:62.764.650 km.	Repeated-measure design	Tested 3 systems for commercial vehicles: ▪ Collision Warning System ▪ Adaptive Cruise Control ▪ Advanced Braking System These systems have developed to reduce the occurrence and severity of rear-end crashes	▪ Objective data (time-to-collision, road speed, following distance, following interval, acceleration, service brake duration, brake pressure, cruise control activation, steering position…). ▪ Subjective data (Surveys and interviews: expectation for the new safety technologies and driver experiences using the technologies). ▪ Fleet Operations records ▪ Historical Crash Data ▪ Special Test and Supplemental Data	▪ 50 "Test" vehicles: equipped with the 3 safety technologies: CWS, ACC and AdvBS. ▪ 30 "Control" vehicles: equipped with CWS ▪ 20 "Baseline" vehicles: equipped with a disabled CWS for the first 18 months of the FOT and with an enabled CWS for the remaining of the FOT

University of Michigan AND General Motors Transportation Research Institute. (2005).Automotive Collision Avoidance System Field Operational Test Report: Methodology and Results.	N = 96	11 (car)	Total: 220.481 km.	Mixed-factors design Between-subjects variables: driver age (20-30 years vs. 40-50 years vs. 60-70 years) and gender (male vs. female) Within-subjects variables: ACAS disabled (baseline) vs. ACAS enabled	Assess the suitability of the ACAS system	▪ Driver behaviour (system utilization, time headway, throttle override, reverse cut-ins, overtaking manoeuvre, selection of freeway lane, secondary task activity) ▪ Subjective data (comfort and convenience, safety, ease of use, willingness to purchase, willingness to rent FCW-equipped car, mean ratings of alert utility, awareness, responsive, amount of stress and distraction visual alerts.	Minimum-annual-mileage threshold: the value was determined using mean values reported in the year 2001 National Personal Transportation Survey, which reports average annual mileage by driver age and gender Public roads with traffic, unrestricted and unsupervised driving There were control of different variables as road type, traffic density, day/night illumination

P. Fancher, R. Ervin, J. Sayer, M. Hagan, S. Bogard, Z. Bareket, M. Mefford, J. Haugen. (1998). Intelligent Cruise Control Field Operational Test (Final Report).	N = 108	10 (car)	Total: 56.327 km.	Naturalist Use	Safety and comfort issues. ACC usage.	▪ Objective data (velocity, frequency of cut-in, Time to Impact and Maximum deceleration during ACC braking, Fraction of Brake with No Target/Max Decel (g's), Fraction of Brake Applications/Average Decel (g's), ACC Button Presses, Average Engagements Length, Engagements in Trip, Average Velocity of Engagement, Total utilization rate by road type: Percentages, Total utilization rate at low and high speed: Percentages and Total utilization rate: Percentages). ▪ Subjective data (questionnaires, interviews and focus Group): Usability, Acceptance, Trust and Workload.	The sample was composed by 108 randomly subjects. Manual driving behaviours as the baseline for interpreting ACC.

R. Harrington, A. Lam, E. Nodine, J. J. Ference, and W. G. Najm. (2008). Integrated Vehicle-Based Safety Systems Heavy-Truck On-Road Test Report.	--	1 truck	Each driver: 1609 km.	On-road test: Naturalistic driving	Assess the performance of a prototype integrated safety system developed for heavy commercial trucks: ▪ Forward crash warning ▪ Lane change/ merge ▪ Lane departure warning	Analysis of Alerts in different on-road test	Data collected during the tests was analyzed and used to evaluate system readiness for a field operational test planned for 2009 and to identify areas of system performance that could be improved prior to the start of the field test.