FESTA

D5: Common vision regarding nomadic systems FOTs

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Glossary

Subject	Definition	Source/ Reference
function	implementation of a set of rules to achieve a specified goal Unambiguously defined partial behaviour of one or more electronic control units.	combination of AIDE and FESTA ISO TC 22/SC 3 N xxx/BL10
system	a combination of hardware and software enabling one or more functions Set of elements (at least sensor, controller, and actuator) in relation with each other according to design. An element of a system can be another system at the same time. Then, it is called subsystem which can be a controlling or controlled system or which can contain hardware, software and manual operations.	FESTA ISO TC 22/SC 3 N xxx/BL10
use case	target condition in which a system is expected to behave according to a specified function	AIDE, PReVAL
situation	a combination of certain characteristics of a use case. Situations can be derived from use cases compiling a reasonable permutation of the use cases characteristics	FESTA
scenario	a use case in a specific situation	FESTA
research question	general question to be answered by compiling and testing related specific hypotheses	generic
hypothesis	specific question which can be tested with statistical means by analysing measures and performance indicators.	generic
baseline	scenario with system under evaluation "turned off".	generic
performance indicator	Performance 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 to one or more criteria.	generic (combination of different www sources and own)
event	"Singularities" based on a combination of measures and/or pre-processed measures. Can extend over time. One or several preconditions must be fulfilled.	generic
trigger	"Marker" in the data, indicating instances that can be of interest for research.	generic
measure	A measure can either be direct or pre-processed. A direct measure is logged directly from a sensor, while a pre-processed measure is a combination of different direct or other pre-processed measures. A measure does not have a “denominator” which makes it comparable to other instances of the same measure or to external criteria.	generic
FOT aka Field Operational Test	fleet of vehicles vehicles DO have some kind of data acquisition system onboard (consequence: pure questionnaire based analysis without online data acqu. System is NOT an FOT)	

Subject	Definition	Source/ Reference
on-vehicle sensors data	Data collected via on-vehicle sensors.	FESTA
subjective data	Data collected from the drivers/passengers.	FESTA
Situational Variable	Situational Variables are not necessarily directly relevant for Performance Indicators or Derived Measures, but they provide key background information that complements the driver behaviour data and is sometimes needed to derive the driver behaviour data.	FESTA
data acquisition	The process of sampling or recording data (real world data) for computer processing. Includes acquisition of pure sensor data, as well as acquisition of data from real-time and off-line services, and subjective data.	generic
latency	A latent period: the time between stimulus and response. In data acquisition generally the time between real world event (or stimulus) and the recording of that event.	Various sources (Merriam-Webster, etc.)
sensor	A device that responds to a physical stimulus (as heat, light, sound, pressure, magnetism, or a particular motion) and transmits a resulting impulse which can be read by an instrument/observer.	Various sources (Merriam-Webster, etc.)
Vehicle bus	An in-vehicle internal communications network that connects different components and modules.	generic
trip	Includes the sequence from the vehicle ignition key being turned on until it is turned off (even if the vehicle is not moving during this time frame).	generic
event data recorder	A logging device that, when triggered by an event such as a crash, stores the information about the few seconds leading up to the event (and throughout the event).	generic
upload	Transfer of data from client to a server.	generic
download	Transfer of data from server to a client.	generic

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Executive Summary

On the basis of systems & functions identified in WP5 nomadic devices, the Nomadic Device team in FESTA has focused its efforts to find a generic method to answer these following questions:

- What are the relevant nomadic devices services to be tested in an FOT?
- What are the relevant use cases lists that correspond to mature systems?
- How to identify & prepare the research & questions towards nomadic devices?
- How to link hypotheses to indicators and concrete measurements during the FOT?

In the annex, the reader will find a list answering partially these questions but most important the process was used to setup a methodology for the selection of the systems and functions and the identification of the research questions for future FOTs addressing Nomadic Devices. Therefore, this document provides a procedure on how to build a list of functions and hypotheses taking into account issues with a holistic point of view on safety, mobility, environment, business and implementation rather than providing an exhaustive list of functions or hypotheses which would need to be tested in an FOT.

The main chapter of this document describes 5 steps to go from the definition of the relevant functions and systems to the hypotheses to be tested during an FOT. Eventually, the hypotheses will lead to a list of indicators and measures which will help the study design of your FOT. The five steps are:

- Step 1: Selection and description of Functions
- Step 2: Definition of use cases and situations
- Step 3: Identification of the Research Questions
- Step 4: Creation of Hypotheses
- Step 5: Link Hypotheses with indicators for quantitative analyses

Building the right list of functions and their hypotheses will be the basis of a good FOT. Understanding the political, societal and technical benefit of the FOT as a whole before it has even started is a key to its successful outcome. It is therefore strongly advised to put considerable effort and time on this preliminary work which might seems more paper-like before starting the exciting implementation of the devices and functions for large-scale testing.

1 Introduction

The objective of an FOT is to evaluate in-vehicle functions based on Information and Communication Technology (ICT) in order to address specific research questions. These research questions can be related to safety, environment, mobility, traffic efficiency, usage, and acceptance. By addressing the research questions, FOTs promise to furnish the major stakeholders (customers, public authorities, OEMs, suppliers, and the scientific community) with valuable information able to improve their policy-making and market strategies. Individuating the most relevant functions and connected hypothesis to successfully address the above-mentioned research questions is one of the major challenges in an FOT. In this deliverable, the process of individuating the nomadic device based vehicle functions to be tested in an FOT and the relevant connected hypotheses will be elucidated. Specifically, the reader will be guided in the process of 1) selecting the nomadic device based vehicle functions to be tested, 2) defining the connected use cases to test these nomadic device based vehicle functions, 3) identifying the research questions related to these use cases, 4) formulating the hypothesis associated to these research questions, and 5) linking these hypothesis to the correspondent performance indicators. The FOT chain shows specifically the steps reported above (see Figure 1.1**Errore. L'origine riferimento non è stata trovata.**). The three first boxes reflect the process described in this document i.e. the steps needed to go from systems and functions to research questions and hypotheses and eventually the definition of the necessary set of indicators.

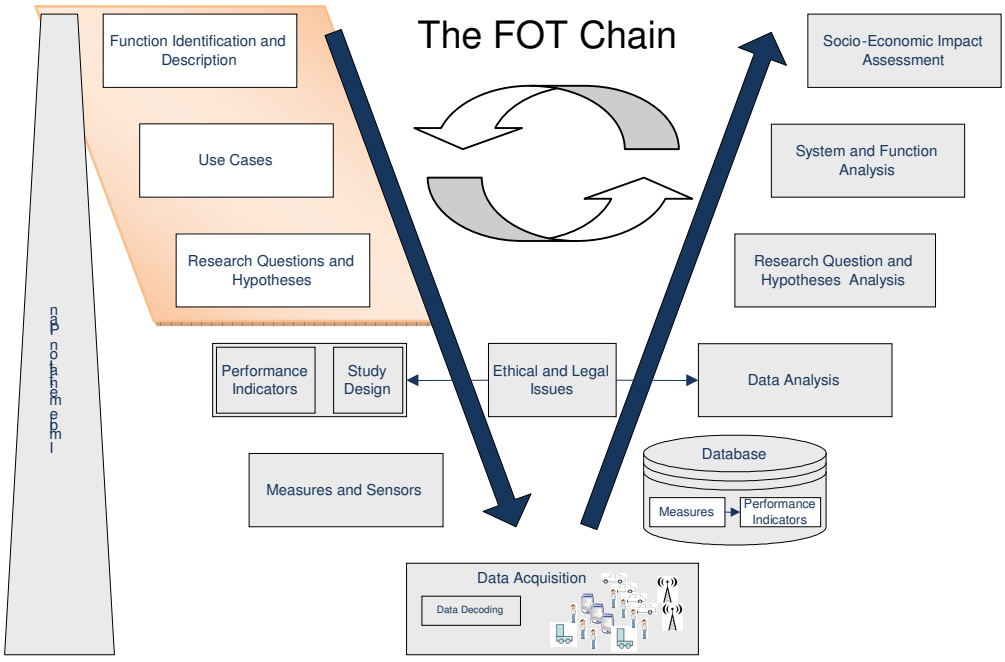


Figure 1.1: The FOT chain and the relevant steps from function identification to hypotheses covered by this deliverable.

In the last few years, the number of ICT functions available on standard vehicles has been rapidly increasing. ICT functions are intrinsically designed to provide the driver with new, additional information, recommendations, advice and warnings. However, the extent to which this increased amount of information from these ICT functions

results in clear and positive effects on safety, environment, mobility, usage, and acceptance in real traffic situation is unknown. FOTs warrant to evaluate, for the first time, these ICT functions in real traffic as an unobtrusive driving situation (aka naturalistic driving). In the FESTA handbook we refer to 1) in-vehicle, 2) cooperative, and 3) nomadic systems intended as a combination of hardware and software enabling one or more ICT functions. Depending on the different systems implementing a specific function, different challenges may have to be faced during the FOT design.

1.1 The case of Nomadic Devices

Nomadic Devices have become very popular in the last two years by the introduction of so called Personal Navigation Devices (PND) and Smart Phones (SP). They both run more or less autonomously on their own hardware platform. They are actually present in nearly every second vehicle and have become a quasi-standard device bought by the end-user.

One of the PND and SP critical characteristics is unequivocally the mounting in the car. Mostly they are mounted with a suction disc directly to the windscreen and therefore limit the drivers' field of view increasing the risk for accidents. Nevertheless, the popularity of these devices has not been abated since Bluetooth voice commands or remote car's display control will be spread enough. To limit the risk increase connected with the increasing popularity of PND and SP, the European Automobile Manufacturers' Association (ACEA) as well as driver organisations (like ADAC in Germany) are trying to promote a safer integration of PNDs and SPs by means of the ESOP on HMI (ESOP 06).

The functionality of PNDs and SPs has been evolving over time. Initially, the PNDs objective has been limited to guide the driver from a geographic point A to a point B while, in the present time, the devices enable media player, media viewer, mobile phones, etc. and are in addition voice activated. Smartphones were coming right from the other side with its main emphasis on telephony, supported by additional functions like address book and message sender and receiver. Additional functions are now available Real time traffic information, Navigation, Speed Alert and new functions (photography, radio, media device centre etc.) are continuously added and the turn-over time is rapidly shortened.

Nomadic Devices are now available with telecommunication, Bluetooth, WiFi networks, assisted GPS, speech recognition and high-end operating systems with sufficient mass storage to host maps and related dynamic geo-referenced applications. Results regarding the Nomadic Device integration in the vehicle environment through projects like AIDE, GST, CVIS are already available. Furthermore, an upcoming FOT project (TeleFOT – with a focus on aftermarket and nomadic devices) will give perspectives and requests towards the methodological approach in FOTs to fulfil the user needs and safety considerations.

Usage aspects of Nomadic Devices related to the driver behaviour and acceptance, as well as environmental and traffic conditions need to be evaluated. The generation of indicators in the FESTA project aimed to compare on/off board solutions will, in the

longer term, help stakeholders to provide the drivers with the right nomadic services and the appropriate user interface.

In the light of the fast Nomadic Devices evolution, another main question that needs to be answered is how future integration of Nomadic Devices will look like. The end user is demanding more and more a seamless integration of external devices into the vehicle environment. For example, planning a route at home at the PC, downloading the data into the mobile device, approaching the vehicle and automatically loading the navigation system.

Due to the above-mentioned fast innovation cycle, the Nomadic Device FOTs will require a state of the art planning due to always new upcoming features and functions which are opportunities to car makers in contrast with the vehicle life cycle. This also includes a consideration of the surrounding infrastructure since many functions rely on what type of communication is available. Furthermore, weather forecast, traffic information, road conditions, speed advice and several new future services are all dependent on the service providers and what they see fit to introduce; often based on what feasible business models can be implemented.

1.2 Purpose of the document

On the basis of systems & functions identified in WP5 nomadic devices, the Nomadic Device team in FESTA has focused its efforts to find a generic method to answer these following questions:

- What are the relevant nomadic devices services to be tested in an FOT?
- What are the relevant use cases lists that correspond to mature systems?
- How to identify & prepare the research & questions towards nomadic devices?
- How to link hypotheses to indicators and concrete measurements during the FOT?

This document provides a procedure on how to build a list of functions and hypotheses taking into account issues with a holistic point of view on safety, mobility, environment, business and implementation. On the other hand, it is not aiming at providing an exhaustive list of functions or hypotheses which would need to be tested in an FOT.

This deliverable consists of two main parts. First the presentation of the common methodology and it link to the Nomadic Device FOT case. This part introduces the case of the Nomadic Devices and why they are relevant for the future FOTs. Then, a common methodology is presented following the five steps mentioned above and finally a short conclusion. The second main part of the document is the annex with an extensive list of interlinked Nomadic Device Functions, Use Cases and Hypotheses. Hyperlinks have been inserted in order to jump from one section of the Annex to the other. The Annex is taken directly from a common database format used across the WP3, WP4 and WP5 of FESTA.

2 Common methodology for the selection of nomadic device functions and their hypotheses

The main advantage of an FOT is that it has the potential to give insight in system performance in unobtrusive (or naturalistic) driving situations, i.e. as free as possible from any artefact resulting from noticeable measurement equipment or observers in the car. Therefore the first step when planning an FOT is to identify systems and functions where considerable knowledge about their impacts and effects in realistic (driving) situations is of major interest, but is still lacking (see Section 2.1). FOT have now the opportunity with the nomadic device introduction to evaluate same level of function on different systems. Another domain for FOTs is the area of systems and functions which need a certain penetration rate to work at a proper service level.

After the identification of the functions and system, which should be tested in a FOT, the goal is to define testable hypotheses and to identify matching measurable performance indicators. To reach this goal, several steps need to be taken, starting from a description of the functions down to an adequate level of detail (see Section 2.1). This means that the main aspects of a function, its intended benefits and intrinsic limitations have to be described to fully understand the functional objectives and constraints and to derive reasonable use cases.

Secondly, these use cases need to be defined (see Section 2.2). Use cases are a means to describe the typical conditions under which a function is intended to be used. A general starting point is given by the functional specifications itself. However, it might also be of interest how a function performs when certain preconditions are not met and then to identify unintended and unforeseen effects.

Starting from the use case definitions specific research questions need to be identified (see Section 2.3). Research questions are general question to be answered by compiling and testing related specific hypotheses. While research questions are phrased as real questions ending with a question mark, hypotheses are statements which can either be true or false. This will be tested by statistical means (see Chapter 9 of the FESTA handbook). One might already have a very clear idea from the beginning which hypotheses are to be tested in a very specific situation during the FOT. However, this very focused view might result in an extremely limited study design, where important unintended effects will not be considered. The aim of the process to define hypotheses developed in FESTA is to prevent these potential issues to occur.

Finally, hypotheses can only be tested by means of reasonable performance indicators (see Section 2.5).

These steps are shown as parts of the complete FOT and are elaborated further in the following sections. The Annex A consists of the results of the FESTA methodology to identify ND functions and systems and to develop hypotheses for the study designs. All steps, from the description of the systems and functions, the development of use cases and scenarios, as well as the research questions and hypotheses and the proposal of related performance indicators have been

accomplished. For this Annex, an example on how to proceed according to the proposed FESTA methodology for the Nomadic Device FOTs is provided. However, it is not an exhaustive list.

2.1 Step 1: Selection and description of ND Functions

Usually it is quite clear from the beginning what functions or at least what type of functions will be the object of an FOT. However, to select the specific functions but also in case the type of functions has not yet been decided, a Stakeholders Analysis is recommended. During this analysis, the needs of the different stakeholders need to be identified and merged into a common requirements description. Stakeholders are those whose interests are affected by the issue or those whose activities strongly affect the issue, those who possess information, resources and expertise needed for strategy formulation and implementation, and those who control relevant implementations or instruments, like customers, public authorities, OEMs, suppliers, and the scientific community. It is of vital importance that all relevant stakeholders are included in the analysis to guarantee that the selection process will not itself bias from the beginning the appraisal of the gained results.

It is recommended to evaluate the stakeholders' needs by means of questionnaires, workshops or well documented interviews of stakeholders' representatives. It is also important to describe the selection process sufficiently to prevent from misjudgement.

The basis for all following steps is a sufficient description of the selected functions. For these purposes a spreadsheet template has been prepared and is presented in the Annex[2] to collect the necessary information. It provides two main parts: First, the functional classification, where a short high level description of the main aspects of the function should be given. This information is usually provided through the system specifications given by the system vendor or OEM. The second part of the description comprises of limitations, boundary conditions and additional information which is necessary to understand how the function works.

The boundary conditions part describes where and under which circumstances the system/ function will operate according to its specifications, where the FOT should take place and which type of data needs to be recorded during the FOT to enable a good interpretation of the results. It consists of:

- Infrastructure and nomadic device requirements. Here all required actors besides the actual system need to mentioned, which might have an impact on system performance, service availability or similar. It is intended to trigger the consideration of factors which are external to the system/ function under evaluation;
- Demographical Requirements/ Driver Requirements: Usually the driver systems are designed according to 'design for all' principle. To fulfil this, several aspects listed below should be considered and covered. Especially the user or driver recruitment needs to take into account, whether a function is particularly designed for a specific group of users or drivers. Drivers differ on a large variety of characteristics, which may all have an influence on how

they drive and use different systems and services. These differences may be important to take into account when planning a FOT. Four categories of driver characteristics may be distinguished:

  - Demographic characteristics: gender, age, country, educational level, income, socio-cultural background, life and living situation, etc.;
  - Driving experience, and driving situation and motivation: experience in years and in mileage, professional, tourist, with or without passengers and children etc.;
  - Personality traits and physical characteristics: sensation seeking, locus of control, cognitive skills, physical impairments or weaknesses etc.;
  - Attitudes and intentions: attitudes towards safety, environment, technology etc.

- Geographical Requirements/ Road Context: This description is necessary for systems which, concerning their functionality, depend strongly on the horizontal or vertical curves of the road layout or on the road type. For example, certain speed limit information systems depend largely on the availability of speed limit information in a digital map, which is up to now only commercially available on high class roads.
- Geographical Requirements/ environmental restrictions: Certain systems are especially designed for specific environmental conditions or, on the other hand, specifications might indicate that the system under evaluation will not work under certain environmental conditions. In this case the location of the FOT needs to be selected carefully and the relevant data must be recorded during the FOT. e. g., most of the functions using perception system will be affected by adverse weather conditions. If this is the case it is necessary to log respective data and take it into account for later data analysis.
- Geographical Requirements/ Traffic Context: The performance of certain systems might depend on the traffic context, that is, the traffic density (e. g. given by the Level of Service) or might even be designed to work in specific traffic densities only. Like the other geographical requirements, this needs to be taken into account when an FOT is planned, performed and the data is analysed.
- Other Limitations: All other limitations need to be mentioned, which might have considerable impact on the performance of functions or systems, since these limitations have major impact on the experimental design and data analysis.

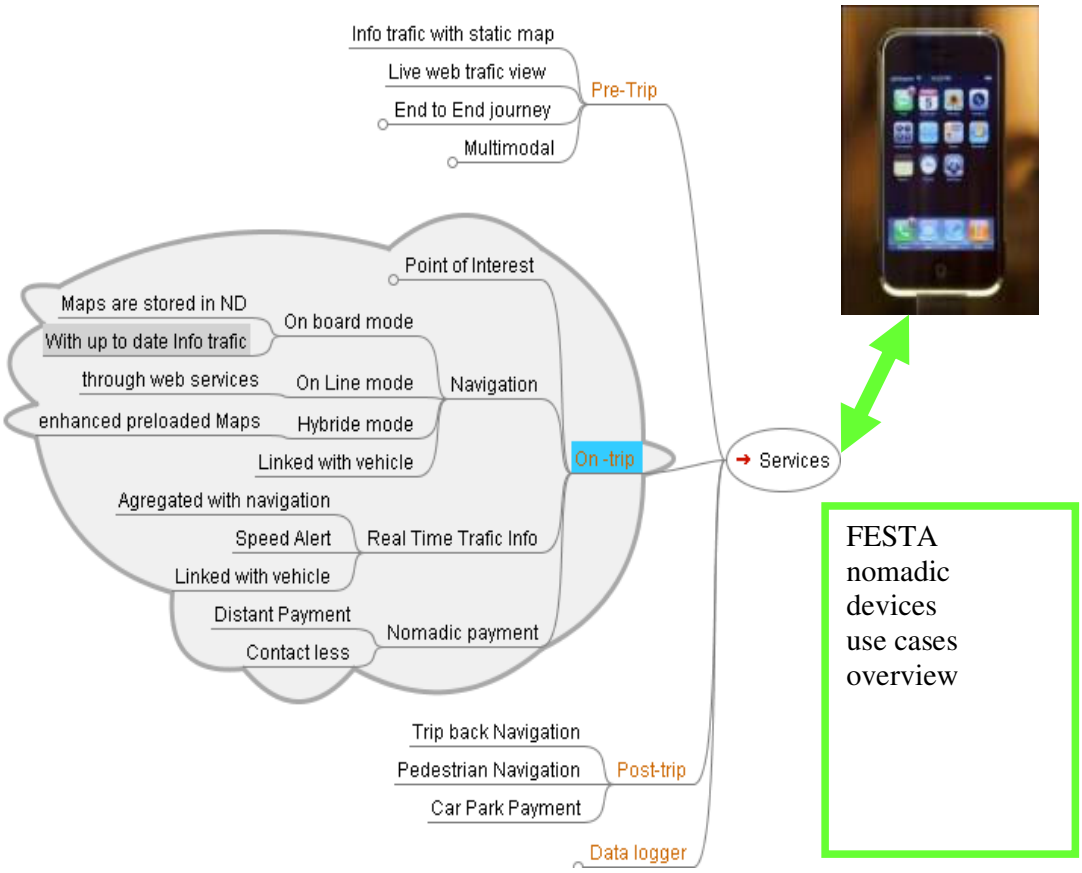


Figure 2.1: A tentative FESTA list of Nomadic Device use cases

2.2 Step 2: Definition of use cases and situations

FOTs will test technically mature ICT systems. Therefore, systems and functions to be tested are on the market or close to market and can be easily implemented. But the list grows too long if all possible implementation variations and technologies are considered separately. 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.

Table 2.1: Use Cases, Situations, Scenarios, and their mutual dependence.

Subject	Definition	Comment	Example
Use Case	Target condition in which a system is expected to behave according to a specified function	A use case is a system and driver state, where “system” includes the road and traffic environment.	Car driven on a road with a nomadic speed limit system
Situation	A combination of certain characteristics of a use case. Situations can be derived from use cases compiling a reasonable permutation of the use	Thus a situation is a state of the environment or system.	Speed above speed limit + sparse traffic

	cases characteristics.		
Scenario	A use case in a specific situation	Use case + situation = scenario	Car on a road with a speed limit + speed over speed limit + sparse traffic

A use case is a textual presentation or a story about the usage of the system told from an end user's perspective. Jacobson et al (1995) defined the use cases: "When a user uses the system, she or he will perform a behaviourally related sequence of transactions in a dialogue with the system. We call such a special sequence a use case." Use cases are technology-independent and the implementation of the system is not described. Use cases provide a tool for people with different background (e. g. software developers and non-technology oriented people) to communicate with each other. Use cases form the basic test case set for the system testing. There are number of different ways to define a use case. Use cases in FESTA are very general descriptions, like e. g. "car following". This general description needs to be refined to a reasonable level of detail. This refinement is done by describing so called situations (see Table 2.1). It is the detailed scenario description which triggers the development of specific hypotheses for later analysis.

The situational descriptors are selected in a way that relevant information can be gathered to distinguish between main differences while evaluating systems. The situational descriptors can be distinguished in static and dynamic, while the static describe attributes which will not change significantly during one ride of the vehicle, like age or gender of the driver. Nevertheless this information needs to be stated, since it is one of the main inputs to filter the huge amounts of data in the later stage of data analysis. The second part of attributes is dynamic, since it can change during a ride of the vehicle, like the system action status (system on or off), the traffic conditions, road characteristics or the environmental situation.

The situations are defined as a combination of certain characteristics of a use case. Situations can be derived from use cases compiling a reasonable permutation of the use cases characteristics. The identification of possible situations was made using three viewpoints:

1. Nomadic device based systems and vehicle specification,
2. environmental conditions specification and
3. driver characteristics and status specification.

The situational descriptors in FESTA conforms the following structure:

IDENTIFICATION AND DESCRIPTION

Use case name	A name for identification purposes.
Description	General description of the use cases with necessary depth of information to get a quick overview.
Occurrence	Information about the anticipated quantity of occurrences

	has implications for the amount of data to analyse.
SYSTEMS AND VEHICLES	
System status	Depending on the hypotheses the analysis might concentrate on situations where the system is activated or present. *Example: ON / OFF or not present (baseline)*
System action status	Depending on the hypotheses the analysis might want to compare the driving performance between different system statuses, e. g. whether the system is actively controlling the vehicle or not. *Example: acting/ not acting (meaning e. g. speed alert, active or not)*
System/ function characteristics	Depending on the hypotheses an analysis of system or driver performance with respect to special system/ function characteristics might be conducted, e. g. differences in system performance between nomadic devices (phone, Smartphone, PND,...) or depending on the vehicle type. *Example: passenger vehicle/ truck/ bus*
Interaction between systems	System and especially driver behaviour might change depending on whether the system under evaluation is the only active support system or whether interactions between two or more systems are foreseen. *Example: interaction between Curve Speed Warning and Speed Alert Warning.*
ENVIRONMENTAL CONDITIONS	
Traffic conditions	Performance of some systems might differ depending on traffic density. Others might only be reasonable with a minimal traffic density. *Example: Level of Service*
Environmental situation	System performance differs depending on lighting and weather conditions like rain/ snowfall/ icy roads, etc. *Example: normal/ adverse weather conditions*
Road characteristics	e. g. type of road gradient, super elevation, curvature, curviness, …, since some systems are dedicated to improve driving performance in curves etc. *Example: urban roads/ rural roads/ highways*
Geographical characteristics	Information about geographical characteristics relevant for testing the systems. *Example: mountained/ flat areas, metropolises with high street canyons.*
DRIVER CHARACTERISTICS AND STATUS	
Driver specification	Characteristics of the users have an impact on the driving performance. Even if no specific impacts are expected of certain characteristics, some outcomes may be explained better with more knowledge about the participants. A minimum set of data such as age, gender, income group and educational level is easy to gather from participants. Information about

	driving experience is also important. For further understanding of driver behaviour one may consider to use questionnaires on attitudes, driving behaviour and personality traits. A well-known questionnaire about (self-reported) driving behaviour is the Driver Behaviour Questionnaire (DBQ). Some widely used personality tests are the Five Factor Model (FFM) test and the Traffic Locus of Control (T-LOC) test. Special attention may be given to the personality trait of sensation seeking, which is correlated with risky driving. The Sensation Seeking Scale (SSS) measures this trait. These questionnaires are available in many different languages, but they are not always standardized, and cultural differences may play a role. Personality traits are very easy to measure, just by administering a short questionnaire. However, the concepts and interrelations of factors are very complex, and results should be treated with caution. When evaluating the acceptance and use of new systems in the car, drivers' acceptability of technology is important. Both social and practical aspects play a role. Technology acceptance has different dimensions, such as diffusion of technology in the drivers' reference group, the intention of using the technology, and the context of use (both personal and interpersonal). Measuring acceptability can be realized via (existing) standardized questionnaires, in-depth interviews before and after "use" (driving), and focus groups. When it comes to Nomadic Devices, all functions and services made available via the ND might make the platform by itself more acceptable. It is then important to certify that it is the acceptance of the traffic related functions made available via the ND that are addressed.
Driver status	Mindset of the driver *Example: attentive/ distracted/ impaired*
Purpose, distance, duration	Describes the different attributes of a trip (time between ignition on and ignition off). All three aspects have an impact on driver behaviour and hence on patterns in the data.

When ND-based functions are studied for in-vehicle use, the data acquisition must also cover the direct operation of the ND itself. HMI issues and other related topics must be included as must a logging of the use of the ND itself. A ND can be introduced into the vehicle compartment as a stand-alone unit or by means of a

vehicle-based gateway. All possible arrangements around the in-vehicle use of a ND must be addressed, related to the way a driver will use the ND while driving.

A set of basic rules has been set for the design of the situations for an FOT:

1. Complementary: situations are not allowed to overlap.
2. Entirety: the sum of all situations should describe the complete use case.
3. Baseline: The same situation without the use of the systems (system off or non-present) is defined as the baseline. The baseline is the basis for the benefit assessment of the system and the comparison between systems. Therefore, for the same use case, there can be many baselines depending on the number of situations.
4. Comparability: functions compared in an FOT need to have the same use case and therefore same baseline and situations.
5. Variability of situation parameters: depending on the point of view (user, trip, vehicle, single FOT, multiple FOTs, etc…), attributes describing a situation can vary considerably or not.

This list is non-exhaustive and might be extended if necessary.

Finally, out of all the possible situations, one will need to select the relevant ones for scenarios of interest in an FOT. The scenarios are defined as a use case in a specific situation and therefore one or more scenarios should be considered from each use case. All other situations should be considered out of the scope of the FOT study. However, data should, if possible, still be collected from all situations in case an alternative study would like to reuse the same data.

During FESTA a list of functions and use cases was produced based on technically mature ICT systems and functions on the market. The list was consolidated based on the feedback from a stakeholders workshop and a dedicated questionnaire.

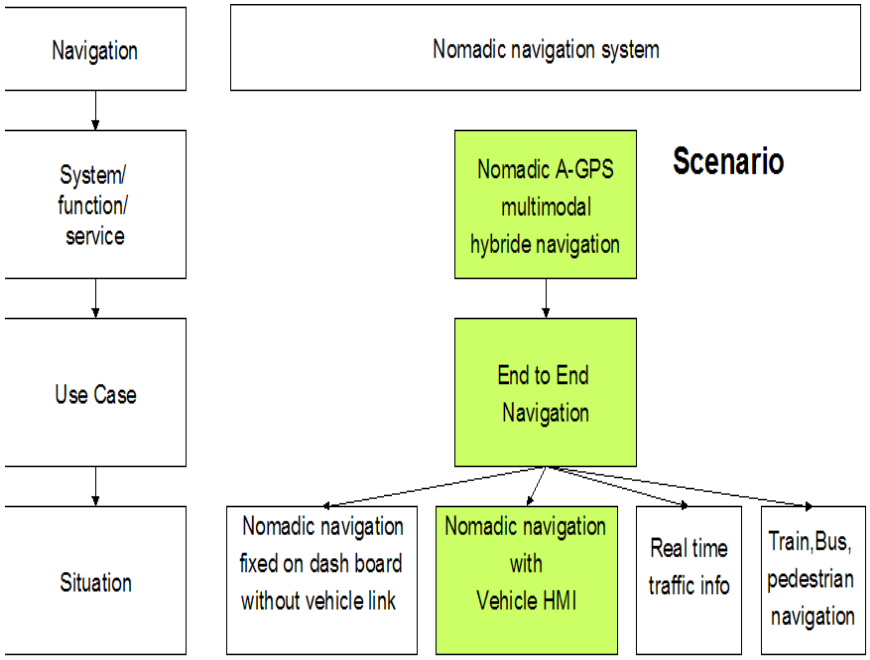
The process of defining the use cases will help the FOT for the next steps: the definition of the research questions and hypotheses and finally the identification of the needed indicators. The scenarios as they are defined at this stage of the FOT are not detailed enough for data analysis purposes. For this reason, after the definition of the indicators, the scenarios (and their situations) will need to be further described in terms of *events* for data analysis purposes. Only then, the scenarios can be classified with a quantitative measurement tools in function of the defined indicators. It should be noted that the “linear approach” visible in figure 1.1 must be combined with an iterative process, where the different stages of the process results in more and more refined results.

Example: End to End navigation use case

The End-to-end navigation use case, taken as an example, in this section is one of the most obvious use cases that was used as a testing base for the methodology presented in this document. More use cases are described in the Annex A along with the interlinked functions and hypotheses.

Use Case:	**End to end navigation use case**
Version:	0.2
Summary:	The user owns a A-GPS nomadic device with a navigation application. This application allow him to prepare its trip at home or at office before its departure to select the most appropriate transport mode (multimodal). Depending on traffic conditions, the system suggests the personal vehicle mode, public transport and pedestrian guidance
Frequency:	- Pre trip preparation - Just before departure for transport mode selection depending of traffic conditions - On demand depending of traffic conditions (on trip)
Actors:	Driver, map provider, GPS equipment provider, road authorities, mobile network operator
Pre-conditions:	Nomadic Multimodal Navigation system (Vehicle, pedestrian, POIs) User position (EX_1) Digital maps with traffic informations Optional Live traffic web cam near vehicle position Optional speed limits / speed alert informations Optional public transport mode
Description:	The nomadic navigation system is a personal user application that uses nomadic positioning sensor into a road/street network and propose the most appropriate guidance choice depending of the user profile. Information (Maps, Traffic, POIs,...) are downloaded on user request before departure (pre trip with on trip traffic update) or already stored in the device. In this second case the obsolescence of the information as important as of the in-vehicle navigation system. In general, three steps are observed to ensure optimal safety usage: 1- Pre-trip : The driver prepare its itinerary before departure with up to date the traffic conditions 2- On-trip : Before departure, the nomadic is positioned (EX_1) and

	linked to the vehicle system : power & audio as minimum requirements (EX_3) 3- On-Trip: The navigation system provide route guidance to the driver with no or very limited driver's interactions (EX_1, EX_2) There are different types of nomadic navigation systems that not using the same level of information and user interactions, depending of system (autonomous off board, hybrid, static). The navigation concept provides to the driver the route guidance through the nomadic screen or the nomadic audio if the nomadic is not linked to the vehicle (EX_3). For safety reasons, the nomadic is connected to the vehicle audio system to allow the driver to follow its route guidance or by the visual channel like a display mounted on (aftermarket device) or integrated (OEM) in the dashboard. The concept provide a turn by turn method which can have extended functionality like speed limits, green driving, pushed live traffic web cam, POIs, speech recognition ... to enhance the route guidance. The current position of the vehicle (EX_1) can be obtained either by means of A-GPS technology of mobile phone network, external GPS sensor, in-vehicle sensors. The applications is running completely on the nomadic device or in a cooperative mode with the in-vehicle system. The route guidance quality is depending of traffic information refresh cycle (EX_2,EX_4). The multimodality level (EX_4) of service is depending of the service provider and the type of the nomadic device (Storage, CPU, Payment mode (contact less NFC or not...)
Exceptions:	EX_1: Actual position cannot be detected. Error message is displayed. EX_2: Outside of the stored route guidance information. Warning message is displayed. EX_3: Nomadic link to vehicle unavailable. Warning message displayed. EX_4: Alternative multimodal mode unavailable. Information message displayed

Figures:	
Post-conditions	Driver will comply by following the route guidance.

2.3 Step 3: Identification of the Research Questions

The research questions specific to an FOT can only be identified once the overall goal of an FOT has been established.

In general terms the goal of any FOT is to investigate the impacts of mature ICT technologies in real in-vehicle use. The core Research Questions should therefore focus on impacts but there are other questions that 'surround' this core. The range of possible questions is listed below and should be considered a first step in any FOT and not a comprehensive set of questions.

Research questions focusing on the level of system usage can very often be based on use cases. In addition, in the case of ND, it might be highly useful to analyse specific (a) sub-tasks while using these devices, (b) sub-tasks of driving task and (c) interactions of these tasks while driving. Wickens' Multiple-Resource Theory (presented in Wickens & Hollands 2000) provides some insight into this type of dual task performance. The theory suggests that the resources available to perform a task may be defined by three dimensions: (1) encoding modality such as auditory or visual, (2) processing code such as verbal or spatial and (3) response modality such as manual or vocal. Each combination of these dimensions may be thought of as having a particular capacity or resource availability. Furthermore, if two tasks are characterised by non-overlapping combinations of these dimensions, the person engaged in the two tasks could be expected to perform as well performing them

concurrently as he/she would if they performed them separately. Luoma (2005) provides a couple of examples of such kind of analyses.

Furthermore, it is important to note that the impacts of system usage require a wider scope than focusing on use cases or the analysis of driver tasks. Specifically, the impacts may be either intended or unintended and they may appear in many unexpected ways (see 2.4.2).

LEVEL OF SYSTEM USAGE

Which factors affect the usage of the function?

- Purpose of journeys where system is used
- Familiarity with routes where system is used
- Portion of journey for which system is used
- Types of road on which system is used
- Traffic density
- Headway
- Weather condition
- Ambient lighting

How do driver characteristics affect usage of the function?

- Personal characteristics (e. g. age, vision)
- Socio-economic characteristics (e. g. family, friends, employment status)
- Journey-related characteristics (e. g. other car occupants, shared driving)

IMPACTS OF SYSTEM USAGE

What are the impacts on safety?

- exposure
- risk of accident or injury
- incidents and near accidents
- accidents?

What are the impacts on personal mobility?

- individual driving behaviour
- travel behaviour
- Comfort

What are the impacts on traffic efficiency?

- traffic flow (speed, travel time, punctuality)
- traffic volume
- Accessibility

What are the impacts on the environment?

- CO_2 emissions
- Particles
- Noise

IMPLICATIONS OF MEASURED IMPACTS

What are the implications for policy?

- Policy decisions
- Laws, directives & enforcement

- Future funding
- Public authority implications
- Emergency service implications

What are the implications for business models?

- Predictions for system uptake
- User expectations
- Pricing models

What are the implications for system design & development?

- HMI design & usability
- Perceived value of service
- Device design
- Communications networks
- Interoperability issues

What are the implications for the public?

- Public information/education
- Changes in legislation
- Inclusive access to systems
- Data protection

2.4 Step 4: Creation of Hypotheses

Once the key research questions for the FOT have been identified, hypotheses can be derived. The process of formulating hypotheses translates the general research questions into more specific and testable hypotheses.

There is no process that can assure that all the "correct" hypotheses are formulated. To a large extent, creating hypotheses is an intuitive process, in which a combination of knowledge and judgement is applied and an iterative element is often used. Nevertheless, a number of recommendations can be made about how this process should be conducted. These recommendations have been tested in a FESTA workshop and modified based on the experience of and feedback from that workshop.

Two complementary ways to develop hypotheses have been used (sections 2.4.1 and 2.4.2)). Both ways need to be followed, while it is not of importance which step is taken first. One of the steps follows the sequential check of specific areas in which functions can have an impact; the other step is fully based on the description of specific scenarios. While the one step results mainly in general hypotheses, the other step triggers the development of very specific hypotheses in specific driving situations or scenarios.

2.4.1 Deriving hypotheses from the scenarios

The main reasoning to describe functions, their use cases, situations and scenarios in detail according to Steps 1 and 2 is to trigger the generation of hypotheses for very specific scenarios. The hypotheses generation should be conducted by a team of experts, consisting of human factors experts, development engineers and traffic

engineers and all of them need to fully understand the functions/ systems with all aspects and limitations.

Scenarios should be covered systematically. It is recommended that a structured approach be used and that the situations are checked sequentially for related hypotheses.

2.4.2 The six areas of impact

The six areas of impact defined by FESTA are based on Draskóczy et al. (1998). This approach was originally designed for formulating hypotheses on traffic safety impacts, but it has been adapted in the FESTA work to include all types of impacts; i.e. also for efficiency, environment, etc.

The six areas are:

- Direct effects of a system on the user and driving.
- Indirect (behavioural adaptation) effects of the system on the user.
- Indirect (behavioural adaptation) effects of the system on the non-user (imitating effect).
- Modification of interaction between users and non-users (including vulnerable road users).
- Modifying accident consequences (e. g. by improving rescue, etc. — note that this can effect efficiency and environment as well as safety).
- Effects of combination with other systems.

It is not of particular importance to which of these areas a particular hypotheses is allocated. The six areas are instead to be used as a checklist to ensure consideration of multiple aspects of system impact.

In applying this procedure, it should be noted that:

- Area 1 includes the human-machine interaction aspects of system use.
- The driving task (see **Errore. L'origine riferimento non è stata trovata.**) can be defined, following Rumar (1993, based on Michon (1985), into the four levels of strategic, navigation, manoeuvring and controlling tasks..
- Consideration should be given to such mediating factors as user/driver state, experience, journey purpose, etc.

It should also be noted that the effects of system use may be:

- Short-term or long-term in terms of duration and
- Intended or unintended in terms of system design.

This additional step for hypotheses generation assures that very general hypotheses are not forgotten as well as hypotheses on unintended, short term and long term effects. It is intended to serve as a means for crosschecking.

Table 2.2 Four Levels of Driving Tasks, (Rumar (1993) based on Michon (1985))

Strategic tasks (choice of transport mode, time of departure, localise targets, order of targets, routes)

Navigation tasks (to follow the chosen or changed route in traffic)

Manoeuvring tasks (to manoeuvre the vehicle so that a, b, c and d are reached)

a. *Road tasks* (to choose position and course on the road)

b. *Speed control* (choice of speed in and before every situation)

c. *Traffic tasks* (to interact with other road users in such a way that mobility is maintained but collisions avoided)

d. *Rule compliance* (following rules, signs, signals)

Controlling tasks (to handle the vehicle, using the controls, etc.)

2.4.3 Fine-tuning and prioritising the hypotheses

Several iterations of hypotheses formulation are needed, each iteration after on set of development (combining 2.4.1 and 2.4.2) has been applied. This will lead to a necessary fine-tuning of the hypotheses, and increase their applicability in the study designs to be developed.

The prioritisation among the generated hypotheses is a difficult process. No specific advice can be given on how to proceed, but there are some general guidelines:

A complete list of the hypotheses that have been developed should be recorded. If it is considered that some are too trivial or too expensive to address in the subsequent study design and data collection, the reasons for not covering them should be recorded. In general, it should be left to the judgement of the experts acting as hypotheses generators which hypotheses are likely to reflect the real driving situation. Those should then be prioritized, keeping in mind that also unintended effects are very important.

2.5 Step 5: Link Hypotheses with indicators for quantitative analyses

Some of the hypotheses will already incorporate an indicator which needs to be measured, e. g. a very concrete hypothesis like “The function will decrease average speed”. In this case it is obvious which indicator to choose, while the method to measure average speed might include specific procedures and/ or measurement equipment not only based on GPS data. The handbook gives an overview about many reasonable indicators but not all of them are adapted to a nomadic device FOT. One should consider these indicators when planning the study design, since a detailed description how to calculate the indicators from measurements is also provided.

Other hypotheses might be rather unspecific, but still reasonable after being rephrased into testable ones. This goes hand in hand with the identification of related indicators. For example, a hypothesis like “Driver stress and uncertainty will decrease” is not directly testable, since “Driver stress and uncertainty” is not an indicator itself. Hence, surrogate measures must be identified to evaluate lane change performance. These surrogate measures or indicators can e. g. be found in publications of corresponding research projects. If appropriate information cannot be found or is not accessible, new performance indicators need to be developed. Those indicators and the measurement methodology must be valid, reliable and sensitive, that is, the measurement must actually measure what it is supposed to measure, they must be reproducible and the measurands must be sensitive to changes of the variable. A sensitivity analysis should be performed beforehand during a pilot study to make sure that the new performance indicator is suitable. When one or more surrogate measures have been identified, the initial hypothesis can be reformulated into one or more testable hypotheses. In the above mentioned example, reasonable indicators associated to “lane change performance” might be: use of turning indicator or the number of lane change warnings. The initial hypothesis will then be reformulated into: “The system will increase the use of the turning indicator.” and “During the system use, the number of lane departure warnings will decrease.”. The next step is then to evaluate how the indicators “use of turning indicator” and “lane departure warnings” can be measured. In this context, the handbook provides useful information.

3 Conclusions from point of view of Nomadic Device FOT

The nomadic devices of tomorrow will continuously be developed to combine more and more features and functions. Today they include telecommunication functions, Bluetooth, Wi-Fi networks, assisted GPS, speech recognition, digital television and high-end operating systems with huge mass storage capacity. A future trend is the increasing number of nomadic devices that will be carried and used by passengers and drivers in the vehicles. This new situation has to be fully described and understood in order to indentify the risks related to driver distraction or to the way nomadic devices are mounted in the vehicle. They should not interfere and limit the drivers' field of view increasing the risk for accidents. The European Automobile Manufacturers' Association (ACEA) as well as driver organisations (like ADAC in Germany) are trying to promote the use of the ESOP on HMI (ESOP 06) for a safer integration of nomadic devices.

Usage aspects of Nomadic Devices from the driver behaviour & acceptance, environmental and traffic conditions also need to be evaluated in an FOT. This requires a careful definition of functions, analysis of appropriate use cases and driver tasks, definition of specific research questions and hypotheses as well as performance of appropriate analyses. The generation of indicators in the FESTA project aimed to compare on/off board solutions will in the longer term be of help to provide drivers with appropriate and safe services forwarded via in-vehicle use of nomadic devices.

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Annex A Selection of Nomadic Device functions, use cases and hypotheses

The list presented in this annex is not meant to be exhaustive. It provides a list of nomadic device functions, use cases and hypotheses that the FESTA WP5 consortium considered to be relevant for the future FOTs on nomadic devices. Some aspects were inspired from the stakeholder's workshop in December 2008 and the interaction with the nomadic device forum. Also several partners of WP5 will participate to the TELEFOT project funded by the EC investigating nomadic devices in large scale trials.

The Annex A is divided in 3 sections: Systems and Functions, Use Cases, and Research Question and Hypotheses. Each function, use case and hypothesis was given a KEY to help this navigation. Hyperlinks have been inserted in order to jump from one section of the Annex to the other. Therefore, the sections A.1, A.2 and A.3 are meant to be navigated rather than read in a sequential manner.

The tables below follow the common methodology describe in Chapter 2.

Each hypothesis is linked to the main research questions. Indicators are proposed as candidates for quantitative measurement which could verify the given hypothesis. Also we provided an indication (+,0,-) on the impact of the hypothesis for each of the high-level research questions:

- impact on Traffic Safety and safety related driving performance,
- impact on Mobility aspects,
- impact on Environmental aspects,
- impact on Transport and traffic efficiency, and finally,
- impact on Usage, acceptance and trust.

The indication on the impact will help to classify the hypothesis and facilitate the final impact analysis on the high-level research questions. Note that the impact on Business & technical impacts is mentioned but was left out of the scope of the evaluation.

List of all Systems and functions, Use cases, and Hypotheses

A.1 Nomadic Device systems and functions

ND01 PreTrip Traffic Info

ND02 PreTrip End2End Journey

ND31 OnTripPOIs

ND32 OnTripNavigation

ND33 OnTripRealTimeTrafficInfo

ND34 OnTripSpeedLimit

ND35 OnTripSpeedAlert

ND36 OnTripPayment

ND50 PostTripBackPreparation

ND51 PostTripPesdestrianNavigation

ND52 PostTripDriverDebriefing
ND70 NomadicScreenInterface
ND71 NomadicVocalAssistant
ND72 NomadicTextToSpeech
ND73 NomadicVehicleAudioLink
ND74 NomadicVehicleRemoteControl
ND75 NomadicVehicleRessouceSharing
ND76 NomadicVehicleServiceSharing
ND77 NomadicPositioning
ND78 NomadicShortRangeCommunication
ND79 NomadicLongRangeCommunication
ND80 MultiModal capabilities

A.2 Nomadic Device Use Cases

UC_ND_01 Traffic conditions information
UC_ND_02 PreTrip PreliminaryActions
UC_ND_31 OnTrip RealTime Traffic Info
UC_ND_32 OnTrip travel from point A to B
UC_ND_33 OnTrip « Green Driving »
UC_ND_34 OnTrip traffic jam avoidance and alternative transport mode
UC_ND_35 OnTrip Service payment for booking,ticketing, payperuse
UC_ND_37 OnTrip PhoneBookHndl
UC_ND_38 OnTrip PhoneCallHndl
UC_ND_39 OnTrip MessagingHndl

A.3 Research Questions and Hypotheses

H101 The number of unfamilar car journeys will increase
H102 The number of car journeys will increase
H103 The number of car journeys will decrease
H104 The number of car journeys in high density traffic will decrease
H105 Visual workload will increase
H106 Cognitive workload will decrease
H107 The number of near-accidents will decrease
H108 The number of accidents will decrease
H109 The number of high speed accidents will decrease
H110 The number of speed limit violations will decrease
H111 The number of car journeys will increase
H112 The number of car journeys will decrease
H113 The number of unfamiliar car journeys will increase
H114 The number of car journey diversions ('exploration') within an area will increase
H115 Drivers will shift journeys to other modes
H116 Low-occupancy car journeys will decrease

H117 Drivers will shift journeys to other times of day

H118 Journey time will decrease

H119 The number of rapid braking situations will decrease

H120 Driver rest breaks will increase

H121 Driver stress and uncertainty will decrease

H122 The number of unintended speed violations will decrease

H123 Concerns about being tracked will increase

H124 Journey time will decrease

H125 Overall traffic volume will decrease

H126 Traffic volume will be more evenly distributed around the transport system

H127 Traffic volume will be more evenly distributed over time

H128 Traffic volume will increase on minor roads/villages

H129 Levels of CO2 emissions will decrease

H130 Levels of particle emissions will decrease

H131 Road noise levels will decrease

H201 The number of car journeys will increase (due to ability to 'explore' surrounding areas)

H202 Visual workload will decrease (due to pre-planning taking place out of car)

H203 Cognitive workload will decrease (due to pre-planning taking place out of car)

H204 Drivers will plan journeys prior to getting in the car

H205 Car journeys will be replaced by public transport journeys

H206 Driver stress and uncertainty will decrease (due to ease of use of one device across modes)

H207 Traffic volume will be more evenly distributed over time (because drivers will delay, or bring forward, their trip)

H208 There will be an increased use of modes with a low carbon footprint

H301 Visual workload will increase

H302 Cognitive workload will increase

H303 Injuries in accidents will be increased due to loose objects

A.1 Nomadic Device systems and functions

A.1.1 Pre Trip functions

Pretrip can be defined as the time span encompassing the initiation of a movement need (of goods and/or people) and the following period in time when a suitable trip plan to meet the transport demand (of goods and/or people) is met by means of a combination of available transport options (might be using different transport modes). The end result is a trip plan, either for goods, for people or for both on which the end user have time (safe environment like home or office) to select options depending of his preferences.

ND01 PreTrip Traffic Info

System Name and Abbreviation	Function Classification	KEY
PreTrip Traffic Info	**Nomadic device**	**ND01**

Connected Use Cases	Connected Hypotheses
UC_ND_01, UC_ND_02, UC_ND_50	H103, H104, H106, H112, H115, H117, H118, H121, H124, H125, H126, H127, H128, H129, H130, H202, H203, H204, H205, H206, H207, H208

Description	Before driving, check traffic conditions: Info traffic with static maps, POIs which have Live traffic Cam View, RSS feeds, weather forecasts along the planned route, weather forecasts on the specific area.
Functionality	The driver check on his nomadic the traffic conditions (through Web portal, MMS, dedicated application) in order to select the most appropriate transport mode
System/ function is designed to? Need addressed and potential benefits	The function is intended to inform and influence the driver to choose the most convenient transport mode depending of his objectives in term of arrival time, environment, pricing...

Boundary Conditions	
Infrastructure requirements	A Telecom infrastructure with service portal to deliver aggregate traffic information
Demographical requirements/ driver requirements	n/a
Road context	A geo-localised traffic information availability on the nomadic device
Environmental restrictions	no restrictions
Traffic context	road traffic, public transport traffic, ...
Other limitations	none

ND02 PreTrip End2End Journey

System Name and Abbreviation	Function Classification	KEY
PreTrip End2End Journey	**Nomadic device**	**ND02**

Connected Use Cases	Connected Hypotheses
UC_ND_01, UC_ND_02, UC_ND_31, UC_ND_50	H102, H103, H106, H111, H112, H114, H115, H116, H117, H118, H121, H124, H125, H126, H127, H128, H129, H130, H202, H203, H204, H205, H206, H207, H208

Description	Trip Planning with Nomadic Navigation system enriched with traffic information for in vehicle usage and also for pedestrian usage.
Functionality	The driver at the office or at home can prepare its journey by setting up its own nomadic device navigation system to enhance its

		safety while he will drive.
System/ function is designed to? Need addressed and potential benefits		Prevent non safety nomadic devices usage in vehicle by preparing trip before being in the vehicle
Boundary Conditions	Infrastructure requirements	A nomadic device navigation system with GPS and an infrastructure to host the navigation & traffic service
	Demographical requirements/ driver requirements	n/a
	Road context	MAP service provider, Traffic info service provider
	Environmental restrictions	no restrictions
	Traffic context	Vehicle & pedestrian navigation
	Other limitations	none

A.1.2 On Trip functions

Ontrip is defined as the time period during which an existing trip plan is either realised in practice or in the case of changing movements needs when a re-planning exercise is needed and is performed in order to meet the new transportation demands by a modified trip plan in function of the traffic by example.

ND31 OnTripPOIs

System Name and Abbreviation	Function Classification	KEY
OnTripPOIs	**Nomadic device**	**ND31**

Connected Use Cases	Connected Hypotheses
UC_ND_32, UC_ND_34	H101, H102, H105, H106, H111, H113, H114, H120, H121, H128, H201, H206

Description		Point of interests like car park, gas station, infotainment, ... provided by nomadic device which could be linked with in vehicle system
Functionality		Inform the driver on Point of interests like Gas Stations, Castles to visit around him by displaying them on the map or by text to speech
System/ function is designed to? Need addressed and potential benefits		Anticipate next stop for having a rest, avoiding fuel run out, ...
Boundary Conditions	Infrastructure requirements	
	Demographical requirements/ driver requirements	
	Road context	

	Environmental restrictions	
	Traffic context	
	Other limitations	

ND32 OnTripNavigation

System Name and Abbreviation	Function Classification	KEY
OnTripNavigation	**Nomadic device**	**ND32**

Connected Use Cases	Connected Hypotheses
UC_ND_32, UC_ND_31, UC_ND_34	H101, H102, H105, H106, H107, H108, H111, H113, H114, H118, H121, H123, H124, H125, H126, H128, H129, H130, H201, H202, H203, H206

Description	Navigation function on nomadic device which provide up-to-date Maps and traffic information
Functionality	having a Nomadic navigation system with driver settings independently of the vehicle. Bringing route guidance on old vehicle
System/ function is designed to?	Getting the « Green Driving Attitude » by knowing the best itinerary available
Need addressed and potential benefits	

Boundary Conditions	Infrastructure requirements	
	Demographical requirements/ driver requirements	
	Road context	
	Environmental restrictions	
	Traffic context	
	Other limitations	

ND33 OnTripRealTimeTrafficInfo

System Name and Abbreviation	Function Classification	KEY
OnTripRealTimeTrafficInfo	**Nomadic device**	**ND33**

Connected Use Cases	Connected Hypotheses
UC_ND_31, UC_ND_33, UC_ND_34	H104, H105, H106, H107, H108, H115, H118, H119, H121, H124, H126, H128, H129, H130, H131, H202, H203, H206

Description	Real Time Traffic Information function provided by nomadic device throw multiple bearers depending of the availability of the information. Could be integrated with Navigation
Functionality	Getting information on traffic in real time via the nomadic device traffic application through different bearer 3G, TMC, DVB, DAB ...
System/ function is designed to?	Getting the « Green Driving Attitude » by knowing the status of the traffic
Need addressed and potential benefits	

Boundary Conditions	
	Infrastructure requirements
	Demographical requirements/ driver requirements
	Road context
	Environmental restrictions
	Traffic context
	Other limitations

ND34 OnTripSpeedLimit

System Name and Abbreviation	Function Classification	KEY
OnTripSpeedLimit	**Nomadic device**	**ND34**

Connected Use Cases	Connected Hypotheses
UC_ND_32, UC_ND_33	H105, H106, H107, H108, H109, H110, H119, H121, H122, H123, H129, H130, H131, H206

Description	Speed Limitation (Static) function provided by Nomadic. Could be integrated with Navigation
Functionality	-
System/ function is designed to?	-
Need addressed and potential benefits	

Boundary Conditions	Infrastructure requirements	
	Demographical requirements/ driver requirements	
	Road context	
	Environmental restrictions	
	Traffic context	
	Other limitations	

ND35 OnTripSpeedAlert

System Name and Abbreviation	Function Classification	KEY
OnTripSpeedAlert		**ND35**

Connected Use Cases	Connected Hypotheses
UC_ND_32, UC_ND_33,	H105, H106, H107, H108, H109, H110, H119, H121, H122, H123, H129, H130, H131, H206

Description	Speed Alert (Static & Dynamic) function provided by nomadic . Could be integrated with Navigation
Functionality	-
System/ function is designed to?	-
Need addressed and potential benefits	

Boundary Conditions	Infrastructure requirements	
	Demographical requirements/ driver requirements	
	Road context	
	Environmental restrictions	
	Traffic context	
	Other limitations	

ND36 OnTripPayment

System Name and Abbreviation	Function Classification	KEY
OnTripPayment	**Nomadic device**	**ND36**

Connected Use Cases		Connected Hypotheses
UC_ND_31, UC_ND_32, UC_ND_33, UC_ND_34, UC_ND_35		H105, H106, H115, H123, H206
Description	Contactless payment for Car Park , Gas station, Info Fueling,... and distant payment via web portal for travelling facilities	
Functionality	allowing simple payment transaction for gas station, ticketing, booking via the nomadic device	
System/ function is designed to?	to limit the wasting time at the gas station, car park, train station	
Need addressed and potential benefits		
Boundary Conditions	Infrastructure requirements	
	Demographical requirements/ driver requirements	
	Road context	
	Environmental restrictions	
	Traffic context	
	Other limitations	

A.1.3 Post Trip functions

Post trip is defined as the time period after a trip plan (or a modified/updated one) has been concluded (either with or without mishaps) and when the experience from this realisation is gained for future use, either systematically or by personal preferences.

ND50 PostTripBackPreparation

System Name and Abbreviation	Function Classification	KEY
PostTripBackPreparation	**Nomadic device**	**ND50**

Connected Use Cases		Connected Hypotheses
UC_ND_31, UC_ND_32, UC_ND_33, UC_ND_34, UC_ND_35		H117, H118, H121, H124, H126, H127, H128, H129, H130, H202, H203, H204, H206, H207
Description	Trip Back preparation function on nomadic to allow on trip functions to be reconfigured	
Functionality		
System/ function is designed to?		
Need addressed and potential benefits		
Bou nda	Infrastructure requirements	

	Demographical requirements/ driver requirements	
	Road context	
	Environmental restrictions	
	Traffic context	
	Other limitations	

ND51 PostTripPesdestrianNavigation

System Name and Abbreviation	Function Classification	KEY
PostTripPesdestrianNavigation	**Nomadic device**	**ND51**

Connected Use Cases	Connected Hypotheses
UC_ND_32, UC_ND_34, UC_ND_37	H101, H102, H111, H113, H118, H121, H123, H124, H201, H206

Description	Pedestrian Navigation function when the driver is outside of its vehicle to find its final destination by foot
Functionality	
System/ function is designed to?	
Need addressed and potential benefits	

Boundary Conditions	Infrastructure requirements	
	Demographical requirements/ driver requirements	
	Road context	
	Environmental restrictions	
	Traffic context	
	Other limitations	

ND52 PostTripDriverDebriefing

System Name and Abbreviation	Function Classification	KEY
PostTripDriverDebriefing	**Nomadic device**	**ND52**

Connected Use Cases	Connected Hypotheses
UC_ND_31, UC_ND_32, UC_ND_33, UC_ND_34, UC_ND_35	H103, H112, H115, H116, H129, H130, H208

Description	Collect all vehicle related service operations and costs, gas fillings, oil changes, washes, repairs, maintenance. Also green driving issues are included.

Functionality		Application in ND that can be used to help the driver to collect all vehicle related service operations and costs, gas fillings, oil changes, washes, repairs, maintenance. Also green driving issues are included.
System/ function is designed to? Need addressed and potential benefits		This helps the driver to track all the vehicle costs. Green driving debriefing helps the driver to adopt economical driving habits.
Boundary Conditions	Infrastructure requirements	
	Demographical requirements/ driver requirements	
	Road context	
	Environmental restrictions	
	Traffic context	all
	Other limitations	vehicle connection needed

A.1.4 Core functions

A ND is normally a multi-purpose device with several core functions related either to traffic/transport applications or to other applications/services using the ND as a platform for communication and control. Core functions relevant for the traffic/transport area are navigation, weather information, speed alert, etc.

ND70 NomadicScreenInterface

System Name and Abbreviation	Function Classification	KEY
NomadicScreenInterface	**Nomadic device**	**ND70**

Connected Use Cases	Connected Hypotheses
all use cases	H301, H302, H303

Description		Pen/Finger interface with touch screen, Keyboard interface
Functionality		The Nomadic needs to have any kind of useful interface to the user, either in kind of a keyboard (like Blackberry) or via sensitive touchpad's which become more and more popular. This enlarges automatically the display size and offers better readability.
System/ function is designed to? Need addressed and potential benefits		Easy access to the Nomadic (and via a link to the in-car infotainment system) is beneficial for the user acceptance. Intuitive usage is required and need to be supported by intelligent HMI structure
Boundary Conditions	Infrastructure requirements	
	Demographical requirements/ driver requirements	

	Road context	
	Environmental restrictions	
	Traffic context	
	Other limitations	

ND71 NomadicVocalAssistant

System Name and Abbreviation	Function Classification	KEY
NomadicVocalAssistant	**Nomadic device**	**ND71**

Connected Use Cases	Connected Hypotheses
UC_ND_01, UC_ND_31, UC_ND_32, UC_ND_34, UC_ND_35	H302

	Description	Vocal assistant function provided by a call centre
	Functionality	Connectivity to a call centre where the driver/passenger can get enhanced information, which he can't get locally out of the infotainment system. This is mainly supportive information
	System/ function is designed to?	This helps the driver to get any kind of information he is heading for but can't access within a given time by himself. This also gives him always the feeling that he can contact someone wherever he is, whatever he needs
	Need addressed and potential benefits	
Boundary Conditions	Infrastructure requirements	
	Demographical requirements/ driver requirements	
	Road context	
	Environmental restrictions	
	Traffic context	
	Other limitations	

ND72 NomadicTextToSpeech

System Name and Abbreviation	Function Classification	KEY
NomadicTextToSpeech	**Nomadic device**	**ND72**

Connected Use Cases	Connected Hypotheses
UC_ND_31, UC_ND_32, UC_ND_33, UC_ND_39	H302

	Description	Text to speech function
	Functionality	To keep the driver concentrated onto the traffic, a well developed text to speech system for e.g. SMS reading, traffic information

		provided by TMC or wireless network shall be implemented
	System/ function is designed to?	To avoid driver distraction and to keep the eyes on the street, a text to speech system is the right approach to support this function.
	Need addressed and potential benefits	
Boundary Conditions	Infrastructure requirements	
	Demographical requirements/ driver requirements	
	Road context	
	Environmental restrictions	
	Traffic context	
	Other limitations	

ND73 NomadicVehicleAudioLink

System Name and Abbreviation		Function Classification		KEY
NomadicVehicleAudioLink		**Nomadic device**		**ND73**
Connected Use Cases			Connected Hypotheses	
UC_ND_31, UC_ND_32, UC_ND_33, UC_ND_34, UC_ND_35, UC_ND_37, UC_ND_38, UC_ND_39			H302	
Description		Audio link between vehicle & nomadic device to provide traffic information & route guidance information		
Functionality		A bidirectional audio interface shall be supported to route audio information from the Nomadic to the vehicle infotainment system and vice-versa		
System/ function is designed to? Need addressed and potential benefits		A right audio handling between the in-car infotainment system and the Nomadic disburden the driver from any kind of manual audio routing. He doesn't need to take care how to get the sound from the MP3 files from his Nomadic played on the in-car sound system		
Boundary Conditions	Infrastructure requirements			
	Demographical requirements/ driver requirements			
	Road context			
	Environmental restrictions			
	Traffic context			
	Other limitations			

ND74 NomadicVehicleRemoteControl

System Name and Abbreviation	Function Classification	KEY
NomadicVehicleRemoteControl	**Cooperative System**	**ND74**

Connected Use Cases	Connected Hypotheses
UC_ND_31, UC_ND_32, UC_ND_33, UC_ND_34, UC_ND_35	H301, H302

Description	Nomadic linked to vehicle to be remotely controlled to let the driver focused only on in vehicle HMI. This contains steering wheel buttons and hands-free voice control.
Functionality	Seamless integration of HMI functions. The Nomadic can be controlled by the OEM installed buttons and rotary knobs as well using the in-car display
System/ function is designed to? Need addressed and potential benefits	Using only one set of HMI buttons and screen to control in-car infotainment system and Nomadic helps the drivers to keep his eyes onto the street.
Boundary Conditions: Infrastructure requirements	
Boundary Conditions: Demographical requirements/ driver requirements	
Boundary Conditions: Road context	
Boundary Conditions: Environmental restrictions	
Boundary Conditions: Traffic context	
Boundary Conditions: Other limitations	

ND75 NomadicVehicleRessouceSharing

System Name and Abbreviation	Function Classification	KEY
NomadicVehicleRessouceSharing	**Vehicle System**	**ND75**

Connected Use Cases	Connected Hypotheses
UC_ND_31, UC_ND_32, UC_ND_33, UC_ND_34, UC_ND_35	H301, H302

Description	Availability of vehicle steering wheel buttons, screen, GPS sensor... to share with the nomadic devices
Functionality	This goes in line with ND74 with enhancement in sharing needed sensor data in the Nomadic. E.g. the navigation function needs GPS data, wheel pulse and yaw rate. It would be beneficial to get access to those data via any kind of bus or wireless connection
System/ function is designed to? Need addressed and potential	See ND74

benefits	
Boundary Conditions	Infrastructure requirements
	Demographical requirements/ driver requirements
	Road context
	Environmental restrictions
	Traffic context
	Other limitations

ND76 NomadicVehicleServiceSharing

System Name and Abbreviation	Function Classification	KEY
NomadicVehicleServiceSharing	**Vehicle System**	**ND76**

Connected Use Cases	Connected Hypotheses
UC_ND_31, UC_ND_32, UC_ND_33, UC_ND_34, UC_ND_35	None

Description	Availability of vehicle services like navigation, audio, to share with nomadic devices
Functionality	A certain set of functions and therefore resources can be shared between the in-car infotainment system and the Nomadic. Explicitly as an example this is valid for the navigation function, where the navigation engine runs in the nomadic while the vehicle
System/ function is designed to? Need addressed and potential benefits	An intelligent use of Nomadic functions (assuming intelligent HMI integration) reduces the need of onboard infotainment functions. E.g. a navigation function in the Nomadic requires only the buttons and a display in the car, which are anyhow there. The in
Boundary Conditions: Infrastructure requirements	
Boundary Conditions: Demographical requirements/ driver requirements	
Boundary Conditions: Road context	
Boundary Conditions: Environmental restrictions	
Boundary Conditions: Traffic context	
Boundary Conditions: Other limitations	

ND77 NomadicPositioning

System Name and Abbreviation	Function Classification	KEY

NomadicPositioning	Nomadic device	ND77
Connected Use Cases	Connected Hypotheses	
UC_ND_31, UC_ND_32, UC_ND_33, UC_ND_34, UC_ND_35	None	
Description	Positioning based system function to provide geo-localised services. Sensors like GSM, GPS , Assisted GPS, WLAN...	
Functionality	See ND75. Highly accurate GPS data allows support for location based services	
System/ function is designed to?	Synergy of already installed functions	
Need addressed and potential benefits		
Boundary Conditions: Infrastructure requirements		
Boundary Conditions: Demographical requirements/ driver requirements		
Boundary Conditions: Road context		
Boundary Conditions: Environmental restrictions		
Boundary Conditions: Traffic context		
Boundary Conditions: Other limitations		

ND78 NomadicShortRangeCommunication

System Name and Abbreviation	Function Classification	KEY
NomadicShortRangeCommunication	**Nomadic device**	**ND78**
Connected Use Cases	Connected Hypotheses	
UC_ND_02, UC_ND_31, UC_ND_33, UC_ND_35, UC_ND_37, UC_ND_38, UC_ND_39	None	
Description	Bluetooth, WUSB, USB, WiFi ...	
Functionality	A general trend in the consumer electronic area, where the Nomadic belongs to, is the permanently grow in functions and in wired and wireless communication paths. The Nomadic needed to be prepared to accumulate all those links to get adapted with all ki	
System/ function is designed to?	Nomadic with e.g. near field communication function (NFC) can be used to authorized the user to certain functions in the car. Also short range communication can be used to exchange data with other devices brought into the car, like MP3 player, photograph	
Need addressed and potential benefits		
Boundary Conditions: Infrastructure requirements		
Boundary Conditions: Demographical requirements/ driver requirements		

	Road context
	Environmental restrictions
	Traffic context
	Other limitations

ND79 NomadicLongRangeCommunication

System Name and Abbreviation	Function Classification	KEY
NomadicLongRangeCommunication	**Nomadic device**	**ND79**

Connected Use Cases	Connected Hypotheses
UC_ND_31, UC_ND_32, UC_ND_33, UC_ND_34, UC_ND_35	None

Description	GSM, 2G, 3G, LTE
Functionality	This is a given that Nomadic will have all kind of advanced long range communication links (GSM; UMTS, WiMAX, etc.). National and international standards are implemented and adaptations to the networks will permanently follow newer revisions of Nomadic.
System/ function is designed to? Need addressed and potential benefits	Communication to every point on the globe was and still is a wish of the humanity. Long range communication through any kind of cellular systems supports that wish.

Boundary Conditions	Infrastructure requirements
	Demographical requirements/ driver requirements
	Road context
	Environmental restrictions
	Traffic context
	Other limitations

ND80 MultiModal capabilities

System Name and Abbreviation	Function Classification	KEY
MultiModal capabilities	**Nomadic device**	**ND80**

Connected Use Cases	Connected Hypotheses
UC_ND_01, UC_ND_02, UC_ND_35, UC_ND_50,	None

Description	Pay per use , public transport ticket booking, Car park booking, trip info fuelling...

Functionality		Contact less payment , Distant payment from office, home, nomadic, vehicle & public terminals for added value trip services
System/ function is designed to? Need addressed and potential benefits		This function is to allow payment for trip services. Contact less payment , Distant payment from office, home, nomadic, vehicle & public terminals for added value trip services
Boundary Conditions	Infrastructure requirements	A whole chain connection from service provider , bank, Telecom service, end user
	Demographical requirements/ driver requirements	
	Road context	roaming agreement for payment systems
	Environmental restrictions	no restrictions
	Traffic context	all
	Other limitations	none

A.2 Nomadic Device Use Cases

UC_ND_01 Traffic conditions information

Use Case Name and Abbreviation	KEY
Traffic conditions information	**UC_ND_01**
Connected Systems	Connected Hypotheses
ND01, ND02, ND71, ND80	H103, H104, H106, H112, H115, H117, H118, H121, H124, H125, H126, H127, H128, H129, H130, H202, H203, H204, H205, H206, H207, H208
Description	During navigation driver requests information on the traffic conditions on his route. System determines the car position (EX_1), checks user access rights (EX_2) to the traffic information service, queries about the traffic on the route (EX_3) and presents information to the user. According to the situation user can demand bypass (EX_4) of the difficult part of the route. System proposes changes the route, user approves the new route and system starts the guidance according to the changed route. When the difficult part of the route is still far away from the current car position, system warns user about such situation and offers set of solutions to omit the difficulties.
System and Vehicle Specification	System Status System Action Status Characteristics Interaction between Systems
Environmental Specifications	Traffic Conditions Environmental Situation Road Characteristics Geographical Characteristics
Driver	Driver Specification Driver Status
Frequency	

UC_ND_02 PreTrip PreliminaryActions

Use Case Name and Abbreviation	KEY
PreTrip PreliminaryActions	**UC_ND_02**
Connected Systems	Connected Hypotheses

ND01, ND02, ND78, ND80		None
Description		Actions needed when the driver enters the vehicle. Placing the ND into a cradle, or in a secure place, connecting cables (power, data cables), and/or activating wireless data transfer, starting the necessary applications
System and Vehicle Specification	System Status	System powered up (ON/OFF) Application started (ON/OFF) Link to positioning (ON/OFF) Data link for off board or auxiliary services (ON/OFF)
	System Action Status	ACTING NOT ACTING
	Characteristics	With or without communication system - Static / Dynamic information On board, off-board or hybrid mode of operation Self locating or not locating - GPS or non-GPS connected
	Interaction between Systems	Nomadic – Vehicle Link Power connection Data link GPS Antenna Vehicle sensors (eg CAN bus)
Environmental Specifications	Traffic Conditions	The Vehicle is parked, or stationary Vehicle is moving
	Environmental Situation	Day or night time (ease of docking, connecting cables etc)
	Road Characteristics	Not relevant
	Geographical Characteristics	Perceived safety of the area (willingness to display a ND)
Driver	Driver Specification	
	Driver Status	
Frequency		Familiarity of the driver with the device (own device or other device) Familiarity of the driver with the car, and docking or wireless connection procedure

UC_ND_31 OnTrip RealTime Traffic Info

Use Case Name and Abbreviation	KEY
OnTrip RealTime Traffic Info	**UC_ND_31**
Connected Systems	Connected Hypotheses
ND02, ND32, ND33, ND36, ND50, ND52, ND71, ND72, ND73, ND74, ND75, ND76, ND77, ND78, ND79	H104, H105, H106, H107, H108, H115, H118, H121, H124, H125, H126, H128, H129, H130, H202, H203, H206, H301, H302, H303
Description	Getting Traffic info's driver request on his nomadic through

		his favorite HMI (Vehicle Screen, Vocal, ...)
System and Vehicle Specification	System Status	Positioning ON OFF Nomadic Vocal services ONLY Nomadic Data services ADDON
	System Action Status	ACTING NOT ACTING
	Characteristics	- With or without communication system -> Static / Dynamic information - Dedicated applications or web application (Off Board , Hybrid)
	Interaction between Systems	Nomadic – Vehicle Link - Power - Data - Antenna -Sensors
Environmental Specifications	Traffic Conditions	Trip Reconfiguration – Multimodal – Public Transport
	Environmental Situation	standard weather conditions adverse weather conditions
	Road Characteristics	any kind
	Geographical Characteristics	Telecom Network coverage for on line applications
Driver	Driver Specification	
	Driver Status	
Frequency		Depending of HMI Driver preferences (Vocal, Nomadic, Vehicle)

UC_ND_32 OnTrip travel from point A to B

Use Case Name and Abbreviation	KEY
OnTrip travel from point A to B	**UC_ND_32**
Connected Systems	Connected Hypotheses
ND31, ND32, ND34, ND35, ND36, ND50, ND51, ND52, ND72, ND73, ND74, ND75, ND76, ND77, ND79	H101, H102, H105, H106, H107, H108, H109, H110, H111, H113, H114, H118, H120, H121, H123, H124, H125, H126, H128, H129, H130, H201, H202, H203, H206, H301, H302, H303
Description	Reaching destination point with nomadic navigation system by following route guidance information through the selected HMI (Vocal, Pictographic, Maps, ...). Getting an up to date traffic information with itinerary recalculation option if requested

System and Vehicle Specification	System Status	Positioning ON « mandatory » Network Link ON OFF Nomadic-Vehicle Link ON OFF
	System Action Status	ACTING NOT ACTING
	Characteristics	- With or without communication system -> Static / Dynamic information - Dedicated applications or web application (Off Board , Hybrid)
	Interaction between Systems	Nomadic – Vehicle Link - Power - Data - Antenna -Sensors
Environmental Specifications	Traffic Conditions	Alternative itinerary Public Transport Alternative
	Environmental Situation	standard weather conditions adverse weather conditions
	Road Characteristics	any kind
	Geographical Characteristics	Telecom Network coverage for on line applications
Driver	Driver Specification	
	Driver Status	
Frequency		Depending of HMI Driver preferences (Vocal, Nomadic, Vehicle)

UC_ND_33 OnTrip « Green Driving »

Use Case Name and Abbreviation	KEY
OnTrip « Green Driving »	UC_ND_33
Connected Systems	Connected Hypotheses
ND33, ND34, ND35, ND36, ND50, ND52, ND72, ND73, ND74, ND75, ND76, ND77, ND78, ND79	H105, H115, H124, H129, H130, H206, H208, H301, H302, H303
Description	Speed Alert, Speed Limit according to traffic with static or dynamic capabilities. Also a special application that assists and indicates the driver to change the gear at optimal point, this app. can be in ND or a part of the HMI apps.

System and Vehicle Specification	System Status	Positioning ON « not mandatory » Network Link ON « not mandatory » Nomadic-Vehicle Link ON « not mandatory »
	System Action Status	ACTING NOT ACTING
	Characteristics	Additionally traffic information can be used but is not mandatory
	Interaction between Systems	Nomadic - Vehicle Link (e.g. CAN) - Power - Sensor data - Antenna - Wireless network (telco provider)
Environmental Specifications	Traffic Conditions	Alternative itinerary Public Transport Alternative
	Environmental Situation	standard weather conditions adverse weather conditions
	Road Characteristics	any kind
	Geographical Characteristics	Telecom and radio Network coverage for on line applications
Driver	Driver Specification	
	Driver Status	
Frequency		Experienced driver / power user may interpreted the route guidance differently as newcomer or occasional users

UC_ND_34 OnTrip traffic jam avoidance and alternative transport mode

Use Case Name and Abbreviation	KEY
OnTrip traffic jam avoidance and alternative transport mode	**UC_ND_34**
Connected Systems	Connected Hypotheses
ND31, ND32, ND33, ND36, ND50, ND51, ND52, ND71, ND73, ND74, ND75, ND76, ND77, ND79	H104, H105, H106, H107, H108, H115, H118, H119, H121, H124, H125, H126, H128, H129, H130, H202, H203, H205, H206, H208, H301, H302, H303
Description	Multi-modal capability with public & private transport services like Train, Bus, Taxi, ...

System and Vehicle Specification	System Status	Positioning ON « mandatory » Network Link ON OFF Nomadic-Vehicle Link ON OFF
	System Action Status	ACTING NOT ACTING
	Characteristics	Receiving TMC data and/or traffic advices from mobile network
	Interaction between Systems	Nomadic - Vehicle Link (e.g. CAN) - Power - Sensor data - Antenna - Wireless network (telco provider)
Environmental Specifications	Traffic Conditions	Alternative itinerary Public Transport Alternative
	Environmental Situation	standard weather conditions adverse weather conditions
	Road Characteristics	any kind
	Geographical Characteristics	Telecom and radio Network coverage for on line applications
Driver	Driver Specification	
	Driver Status	
Frequency		Experienced driver / power user may interpreted the route guidance differently as newcomer or occasional users

UC_ND_35 OnTrip Service payment for booking,ticketing, payperuse

Use Case Name and Abbreviation	KEY
OnTrip Service payment for booking,ticketing, payperuse	**UC_ND_35**
Connected Systems	Connected Hypotheses
ND36, ND50, ND52, ND71, ND73, ND74, ND75, ND76, ND77, ND78, ND79, ND80	H105, H115, H121, H123, H124, H206, H301, H302, H303
Description	Face2Face Payment (NFC Nomadic) for Car Park, Gas Station, WEB Distant Payment (Internet Nomadic) for Train Ticket booking, Bus Ticket, Bicycle ...

System and Vehicle Specification	System Status	Network Link ON OFF
	System Action Status	ACTING NOT ACTING
	Characteristics	Face2Face Payment ON : NFC Nomadic device « mandatory » Distant Payment ON : Internet Nomadic device required
	Interaction between Systems	Nomadic – Payment infrastructure
Environmental Specifications	Traffic Conditions	Alternative itinerary Public Transport Alternative
	Environmental Situation	standard weather conditions adverse weather conditions
	Road Characteristics	any kind
	Geographical Characteristics	Telecom Network coverage for on line applications
Driver	Driver Specification	
	Driver Status	
Frequency		no differences

UC_ND_37 OnTrip PhoneBookHndl

Use Case Name and Abbreviation	KEY
OnTrip PhoneBookHndl	**UC_ND_37**
Connected Systems	Connected Hypotheses
ND51, ND73, ND78	H105, H121, H124, H206, H301, H302, H303
Description	Needed actions to handle the phonebook of the ND. Browsing and selecting the desired contact; can be used with the steering wheel buttons or with speech recognition.

System and Vehicle Specification	System Status	Network Link ON OFF
	System Action Status	ACTING NOT ACTING
	Characteristics	Nomadic device ON « mandatory » In-car infotainment system ON « mandatory »
	Interaction between Systems	Nomadic - Vehicle Link (audio routing)

		- Power - Antenna - Wireless network (telco provider)
Environmental Specifications	Traffic Conditions	no influence
	Environmental Situation	no influence
	Road Characteristics	no influence
	Geographical Characteristics	Network coverage needed
Driver	Driver Specification	
	Driver Status	
Frequency		no influence

UC_ND_38 OnTrip PhoneCallHndl

Use Case Name and Abbreviation		KEY
OnTrip PhoneCallHndl		**UC_ND_38**
Connected Systems		Connected Hypotheses
ND73, ND78		H105, H106, H121, H124, H206, H301, H302, H303
Description		Needed actions to handle an incoming phone call (speech recognition, steering wheel buttons…)
System and Vehicle Specification	System Status	Network Link ON OFF
	System Action Status	ACTING NOT ACTING
	Characteristics	Nomadic device ON « mandatory » In-car infotainment system ON « mandatory »
	Interaction between Systems	Nomadic - Vehicle Link (audio routing) - Power - Antenna - Wireless network (telco provider)
Environmental Specifications	Traffic Conditions	no influence
	Environmental Situation	no influence
	Road Characteristics	no influence
	Geographical Characteristics	Network coverage needed
Driver	Driver Specification	
	Driver Status	
Frequency		no influence

UC_ND_39 OnTrip MessagingHndl

Use Case Name and Abbreviation		KEY
OnTrip MessagingHndl		**UC_ND_39**
Connected Systems		Connected Hypotheses
ND72, ND73, ND78		H105, H106, H121, H124, H206, H301, H302, H303
Description		Needed actions to handle a received message (speech recognition, steering wheel buttons, text to speech…).
System and Vehicle Specification	System Status	Network Link ON OFF
	System Action Status	ACTING NOT ACTING
	Characteristics	Nomadic device ON « mandatory » In-car infotainment system ON « mandatory »
	Interaction between Systems	Nomadic - Vehicle Link (audio routing) - Power - Antenna - Wireless network (telco provider)
Environmental Specifications	Traffic Conditions	no influence
	Environmental Situation	no influence
	Road Characteristics	no influence
	Geographical Characteristics	Network coverage needed
Driver	Driver Specification	
	Driver Status	
Frequency		no influence

A.3 Research Questions and Hypotheses

A.3.1 BASELINE = FUNCTION TURNED OFF.

These hypotheses are generated by the presence of the function.

H101 The number of unfamilar car journeys will increase

Hypothesis			KEY
The number of unfamiliar car journeys will increase			**H101**
Related Research Question		**Safety - what are the impacts on exposure?**	
Related System		ND31, ND32, ND51	
Related Use Case		UC_ND_32	
Proposed indicator		Number of unfamiliar car journeys per unit time	
Estimated impact on	Traffic Safety and safety related driving performance	-	
	Mobility impacts	0	
	Environmental impacts	-	
	Transport and traffic efficiency	-	
	Usage, acceptance and trust		
	Business & technical impacts		

H102 The number of car journeys will increase

Hypothesis **The number of car journeys will increase**			KEY **H102**
Related Research Question		**Safety - what are the impacts on exposure?**	
Related System		ND02, ND31, ND32, ND51	
Related Use Case		UC_ND_32	
Proposed indicator		Number of car journeys per unit time	
Estimated impact on	Traffic Safety and safety related driving performance	-	
	Mobility impacts	0	
	Environmental impacts	-	
	Transport and traffic efficiency	-	
	Usage, acceptance and trust		
	Business & technical impacts		

H103 The number of car journeys will decrease

Hypothesis **The number of car journeys will decrease**		KEY **H103**
Related Research Question	**Safety - what are the impacts on exposure?**	
Related System	ND01, ND02, ND52	
Related Use Case	UC_ND_01	
Proposed indicator	number of car journeys per unit time	
Estimated impact on: Traffic Safety and safety related driving performance	+	
Estimated impact on: Mobility impacts	0	
Estimated impact on: Environmental impacts	+	
Estimated impact on: Transport and traffic efficiency	+	
Estimated impact on: Usage, acceptance and trust		
Estimated impact on: Business & technical impacts		

H104 The number of car journeys in high density traffic will decrease

Hypothesis **The number of car journeys in high density traffic will decrease**		KEY **H104**
Related Research Question	**Safety - what are the impacts on exposure?**	
Related System	ND01, ND33	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_34	
Proposed indicator	Number of car journeys per unit time Traffic volume	
Estimated impact on: Traffic Safety and safety related driving performance	+	
Estimated impact on: Mobility impacts	0	
Estimated impact on: Environmental impacts	+	
Estimated impact on: Transport and traffic efficiency	+	
Estimated impact on: Usage, acceptance and trust		
Estimated impact on: Business & technical impacts		

H105 Visual workload will increase

Hypothesis **Visual workload will increase**		KEY **H105**
Related Research Question	**Safety - what are the impacts on risk of accident/injury?**	
Related System	ND31, ND32, ND33, ND34, ND35, ND36	
Related Use Case	UC_ND_31 UC_ND_32 UC_ND_33 UC_ND_34 UC_ND_35 UC_ND_37 UC_ND_38 UC_ND_39	
Proposed indicator	Glance duration Number of glances Eyes off road percentage time	
Estimated impact on	Traffic Safety and safety related driving performance	-
	Mobility impacts	
	Environmental impacts	
	Transport and traffic efficiency	
	Usage, acceptance and trust	-
	Business & technical impacts	

H106 Cognitive workload will decrease

Hypothesis **Cognitive workload will decrease**		KEY **H106**
Related Research Question	**Safety - what are the impacts on risk of accident/injury?**	
Related System	ND01, ND02, ND31, ND32, ND33, ND34, ND35, ND36	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_34 UC_ND_38 UC_ND_39	
Proposed indicator	NASA-TLX component indicators	
Estimated impact on: Traffic Safety and safety related driving performance	+	
Estimated impact on: Mobility impacts		
Estimated impact on: Environmental impacts		
Estimated impact on: Transport and traffic efficiency		
Estimated impact on: Usage, acceptance and trust	+	
Estimated impact on: Business & technical impacts		

H107 The number of near-accidents will decrease

Hypothesis		KEY
The number of near-accidents will decrease		**H107**
Related Research Question	**Safety - what are the impacts on incidents & near accidents?**	
Related System	ND32, ND33, ND34, ND35	
Related Use Case	UC_ND_31 UC_ND_32 UC_ND_34	
Proposed indicator	number of critical incidents per unit distance	
Estimated impact on: Traffic Safety and safety related driving performance	+	
Estimated impact on: Mobility impacts		
Estimated impact on: Environmental impacts		
Estimated impact on: Transport and traffic efficiency		
Estimated impact on: Usage, acceptance and trust	+	
Estimated impact on: Business & technical impacts		

H108 The number of accidents will decrease

Hypothesis **The number of accidents will decrease**			KEY **H108**
Related Research Question		**Safety - what are the impacts on accidents?**	
Related System		ND32, ND33, ND34, ND35	
Related Use Case		UC_ND_31 UC_ND_32 UC_ND_34	
Proposed indicator		number of accidents per unit distance	
Estimated impact on	Traffic Safety and safety related driving performance	+	
	Mobility impacts		
	Environmental impacts		
	Transport and traffic efficiency	+	
	Usage, acceptance and trust	+	
	Business & technical impacts		

H109 The number of high speed accidents will decrease

Hypothesis			KEY
The number of high speed accidents will decrease			**H109**
Related Research Question		**Safety - what are the impacts on accidents?**	
Related System		ND34, ND35	
Related Use Case		UC_ND_32	
Proposed indicator		number of accidents per unit distance exceeding Nkm per hour	
Estimated impact on	Traffic Safety and safety related driving performance	+	
	Mobility impacts		
	Environmental impacts		
	Transport and traffic efficiency	+	
	Usage, acceptance and trust	+	
	Business & technical impacts		

H110 The number of speed limit violations will decrease

Hypothesis			KEY
The number of speed limit violations will decrease			**H110**
Related Research Question		**Personal mobility - what are the impacts on individual driving behaviour?**	
Related System		ND34, ND35	
Related Use Case		UC_ND_32	
Proposed indicator		number of speed limit violations	
Estimated impact on	Traffic Safety and safety related driving performance	+	
	Mobility impacts	+	
	Environmental impacts	+	
	Transport and traffic efficiency		
	Usage, acceptance and trust	+	
	Business & technical impacts		

H111 The number of car journeys will increase

Hypothesis **The number of car journeys will increase**			KEY **H111**
Related Research Question		**Personal mobility - what are the impacts on individual travel behaviour?**	
Related System		ND02, ND31, ND32, ND51	
Related Use Case		UC_ND_32	
Proposed indicator		Number of car journeys per unit time	
Estimated impact on	Traffic Safety and safety related driving performance	0	
	Mobility impacts	0	
	Environmental impacts	-	
	Transport and traffic efficiency	-	
	Usage, acceptance and trust		
	Business & technical impacts		

H112 The number of car journeys will decrease

Hypothesis **The number of car journeys will decrease**		KEY **H112**
Related Research Question	**Personal mobility - what are the impacts on individual travel behaviour?**	
Related System	ND01, ND02, ND52	
Related Use Case	UC_ND_01	
Proposed indicator	Number of car journeys per unit time	
Estimated impact on	Traffic Safety and safety related driving performance	0
	Mobility impacts	0
	Environmental impacts	+
	Transport and traffic efficiency	+
	Usage, acceptance and trust	
	Business & technical impacts	

H113 The number of unfamiliar car journeys will increase

Hypothesis		KEY
The number of unfamiliar car journeys will increase		**H113**
Related Research Question	**Personal mobility - what are the impacts on individual travel behaviour?**	
Related System	ND31, ND32, ND51	
Related Use Case	UC_ND_32	
Proposed indicator	Number of unfamiliar car journeys per unit time	
Estimated impact on: Traffic Safety and safety related driving performance	0	
Estimated impact on: Mobility impacts	0	
Estimated impact on: Environmental impacts	-	
Estimated impact on: Transport and traffic efficiency	-	
Estimated impact on: Usage, acceptance and trust		
Estimated impact on: Business & technical impacts		

H114 The number of car journey diversions ('exploration') within an area will increase

Hypothesis **The number of car journey diversions ('exploration') within an area will increase**			KEY **H114**
Related Research Question		**Personal mobility - what are the impacts on individual travel behaviour?**	
Related System		ND02, ND31, ND32, ND51	
Related Use Case		UC_ND_32	
Proposed indicator		Distance driven off pre-planned route Purpose/destination of diversions	
Estimated impact on	Traffic Safety and safety related driving performance	0	
	Mobility impacts	0	
	Environmental impacts	-	
	Transport and traffic efficiency	-	
	Usage, acceptance and trust	+	
	Business & technical impacts		

H115 Drivers will shift journeys to other modes

Hypothesis **Drivers will shift journeys to other modes**			KEY **H115**
Related Research Question	**Personal mobility - what are the impacts on individual travel behaviour?**		
Related System	ND02, ND33, ND36, ND52		
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_33 UC_ND_34 UC_ND_35		
Proposed indicator	Number of journeys per mode per unit time		
Estimated impact on	Traffic Safety and safety related driving performance		
	Mobility impacts	0	
	Environmental impacts	+	
	Transport and traffic efficiency	+	
	Usage, acceptance and trust		
	Business & technical impacts		

H116 Low-occupancy car journeys will decrease

Hypothesis			KEY
Low-occupancy car journeys will decrease			**H116**
Related Research Question		**Personal mobility - what are the impacts on individual travel behaviour?**	
Related System		ND02, ND52	
Related Use Case		-	
Proposed indicator		Number of vehicle occupants Number of journeys per unit time Journey length	
Estimated impact on	Traffic Safety and safety related driving performance		
	Mobility impacts	0	
	Environmental impacts	+	
	Transport and traffic efficiency	+	
	Usage, acceptance and trust		
	Business & technical impacts		

H117 Drivers will shift journeys to other times of day

Hypothesis			KEY
Drivers will shift journeys to other times of day			**H117**
Related Research Question		**Personal mobility - what are the impacts on individual travel behaviour?**	
Related System		ND01, ND02, ND50	
Related Use Case		UC_ND_01	
Proposed indicator		Number of journeys per unit time	
Estimated impact on	Traffic Safety and safety related driving performance	0	
	Mobility impacts	0	
	Environmental impacts	0	
	Transport and traffic efficiency	+	
	Usage, acceptance and trust		
	Business & technical impacts		

H118 Journey time will decrease

Hypothesis **Journey time will decrease**		KEY **H118**
Related Research Question	**Personal mobility - what are the impacts on individual travel behaviour?**	
Related System	ND01, ND02, ND32, ND33, ND50, ND51	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_34	
Proposed indicator	Journey time	
Estimated impact on: Traffic Safety and safety related driving performance		
Estimated impact on: Mobility impacts	+	
Estimated impact on: Environmental impacts	+	
Estimated impact on: Transport and traffic efficiency	+	
Estimated impact on: Usage, acceptance and trust	+	
Estimated impact on: Business & technical impacts		

H119 The number of rapid braking situations will decrease

Hypothesis		KEY
The number of rapid braking situations will decrease		**H119**
Related Research Question	**Personal mobility - what are the impacts on comfort?**	
Related System	ND33, ND34, ND35	
Related Use Case	UC_ND_34	
Proposed indicator	Number of braking occurrence exceeding target metric	
Estimated impact on	Traffic Safety and safety related driving performance	+
	Mobility impacts	+
	Environmental impacts	+
	Transport and traffic efficiency	
	Usage, acceptance and trust	
	Business & technical impacts	

H120 Driver rest breaks will increase

Hypothesis **Driver rest breaks will increase**		KEY **H120**
Related Research Question	**Personal mobility - what are the impacts on comfort?**	
Related System	ND31	
Related Use Case	UC_ND_32	
Proposed indicator	Number of rest breaks per unit time Driving time between rest breaks	
Estimated impact on: Traffic Safety and safety related driving performance	+	
Estimated impact on: Mobility impacts	+	
Estimated impact on: Environmental impacts		
Estimated impact on: Transport and traffic efficiency		
Estimated impact on: Usage, acceptance and trust		
Estimated impact on: Business & technical impacts		

H121 Driver stress and uncertainty will decrease

Hypothesis **Driver stress and uncertainty will decrease**		KEY **H121**
Related Research Question	**Personal mobility - what are the impacts on comfort?**	
Related System	ND01, ND02, ND31, ND32, ND33, ND34, ND35, ND50, ND51	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_34 UC_ND_35 UC_ND_37 UC_ND_38 UC_ND_39	
Proposed indicator	NASA-TLX component indicators Rating scales of driver confidence	
Estimated impact on: Traffic Safety and safety related driving performance	+	
Estimated impact on: Mobility impacts	+	
Estimated impact on: Environmental impacts		
Estimated impact on: Transport and traffic efficiency		
Estimated impact on: Usage, acceptance and trust	+	
Estimated impact on: Business & technical impacts		

H122 The number of unintended speed violations will decrease

Hypothesis			KEY
The number of unintended speed violations will decrease			**H122**
Related Research Question		**Personal mobility - what are the impacts on comfort?**	
Related System		**ND34** **ND35**	
Related Use Case		-	
Proposed indicator		number of speed limit violations Driver attitudes to speed violations	
Estimated impact on	Traffic Safety and safety related driving performance	+	
	Mobility impacts	+	
	Environmental impacts	+	
	Transport and traffic efficiency		
	Usage, acceptance and trust	+	
	Business & technical impacts		

H123 Concerns about being tracked will increase

Hypothesis		KEY
Concerns about being tracked will increase		**H123**
Related Research Question	**Personal mobility - what are the impacts on comfort?**	
Related System	ND34, ND35, ND36, ND51	
Related Use Case	UC_ND_32 UC_ND_35	
Proposed indicator	Questionnaire data re privacy concerns	
Estimated impact on: Traffic Safety and safety related driving performance		
Estimated impact on: Mobility impacts	-	
Estimated impact on: Environmental impacts		
Estimated impact on: Transport and traffic efficiency		
Estimated impact on: Usage, acceptance and trust	-	
Estimated impact on: Business & technical impacts		

H124 Journey time will decrease

Hypothesis **Journey time will decrease**		KEY **H124**
Related Research Question	**Traffic efficiency - what are the impacts on traffic flow?**	
Related System	ND01, ND32, ND33, ND50, ND51	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_33 UC_ND_34 UC_ND_35 UC_ND_37 UC_ND_38 UC_ND_39	
Proposed indicator	Journey time	
Estimated impact on: Traffic Safety and safety related driving performance		
Estimated impact on: Mobility impacts	+	
Estimated impact on: Environmental impacts	+	
Estimated impact on: Transport and traffic efficiency	+	
Estimated impact on: Usage, acceptance and trust	+	
Estimated impact on: Business & technical impacts		

H125 Overall traffic volume will decrease

Hypothesis **Overall traffic volume will decrease**		KEY **H125**
Related Research Question	**Traffic efficiency - what are the impacts on traffic volume?**	
Related System	ND01, ND02, ND32	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_34	
Proposed indicator	Traffic volume	
Estimated impact on	Traffic Safety and safety related driving performance	0
	Mobility impacts	+
	Environmental impacts	+
	Transport and traffic efficiency	+
	Usage, acceptance and trust	
	Business & technical impacts	

H126 Traffic volume will be more evenly distributed around the transport system

Hypothesis **Traffic volume will be more evenly distributed around the transport system**		KEY **H126**
Related Research Question	**Traffic efficiency - what are the impacts on traffic volume?**	
Related System	ND01, ND02, ND32, ND33, ND50	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_34	
Proposed indicator	Traffic volume per area per unit time	
Estimated impact on	Traffic Safety and safety related driving performance	0
	Mobility impacts	0
	Environmental impacts	0
	Transport and traffic efficiency	+
	Usage, acceptance and trust	
	Business & technical impacts	

H127 Traffic volume will be more evenly distributed over time

Hypothesis		KEY
Traffic volume will be more evenly distributed over time		**H127**
Related Research Question	**Traffic efficiency - what are the impacts on traffic volume?**	
Related System	ND01, ND02, ND50	
Related Use Case	UC_ND_01	
Proposed indicator	Traffic volume per unit time	
Estimated impact on: Traffic Safety and safety related driving performance	0	
Estimated impact on: Mobility impacts	0	
Estimated impact on: Environmental impacts	0	
Estimated impact on: Transport and traffic efficiency	+	
Estimated impact on: Usage, acceptance and trust		
Estimated impact on: Business & technical impacts		

H128 Traffic volume will increase on minor roads/villages

Hypothesis		KEY
Traffic volume will increase on minor roads/villages		**H128**
Related Research Question	**Traffic efficiency - what are the impacts on traffic volume?**	
Related System	ND01, ND02, ND31, ND32, ND33, ND50	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_34	
Proposed indicator	Traffic volume in target area per unit time	
Estimated impact on: Traffic Safety and safety related driving performance	-	
Estimated impact on: Mobility impacts		
Estimated impact on: Environmental impacts	-	
Estimated impact on: Transport and traffic efficiency	0	
Estimated impact on: Usage, acceptance and trust	-	
Estimated impact on: Business & technical impacts		

H129 Levels of CO2 emissions will decrease

Hypothesis **Levels of CO2 emissions will decrease**		KEY **H129**
Related Research Question	**Environment - what are the impacts on CO2 emission levels?**	
Related System	ND01, ND02, ND32, ND33, ND34, ND35, ND50, ND52	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_33 UC_ND_34	
Proposed indicator	CO2 emission level per unit time CO2 emission level per unit distance	
Estimated impact on: Traffic Safety and safety related driving performance	+	
Estimated impact on: Mobility impacts		
Estimated impact on: Environmental impacts		
Estimated impact on: Transport and traffic efficiency		
Estimated impact on: Usage, acceptance and trust		
Estimated impact on: Business & technical impacts		

H130 Levels of particle emissions will decrease

Hypothesis **Levels of particle emissions will decrease**		KEY **H130**
Related Research Question	**Environment - what are the impacts on particle emission levels?**	
Related System	ND01, ND02, ND32, ND33, ND34, ND35, ND50, ND52	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_33 UC_ND_34	
Proposed indicator	Particle emission level per unti time Particle emission level per unit distance	
Estimated impact on	Traffic Safety and safety related driving performance	
	Mobility impacts	
	Environmental impacts	+
	Transport and traffic efficiency	
	Usage, acceptance and trust	
	Business & technical impacts	

H131 Road noise levels will decrease

Hypothesis **Road noise levels will decrease**		KEY **H131**
Related Research Question	**Environment - what are the impacts on noise 'pollution'?**	
Related System	ND34, ND35	
Related Use Case	-	
Proposed indicator	Noise levels per unit time	
Estimated impact on: Traffic Safety and safety related driving performance		
Estimated impact on: Mobility impacts	+	
Estimated impact on: Environmental impacts	+	
Estimated impact on: Transport and traffic efficiency		
Estimated impact on: Usage, acceptance and trust		
Estimated impact on: Business & technical impacts		

A.3.2 LEVEL 2 HYPOTHESES: Baseline = fixed version of function

Most of these hypotheses are prompted by the 'portable/multi-modal' nature of the device

This is an additional condition to that defined by FESTA (i.e. baseline = system off) but it is highly relevant to the assessment of benefits & shortcomings for nomadic devices

H201 The number of car journeys will increase (due to ability to 'explore' surrounding areas)

Hypothesis		KEY
The number of car journeys will increase (due to ability to 'explore' surrounding areas)		**H201**
Related Research Question	**Safety - what are the impacts on exposure?**	
Related System	ND31, ND32, ND51	
Related Use Case	UC_ND_32	
Proposed indicator	Number of journeys per unit time	
Estimated impact on: Traffic Safety and safety related driving performance	-	
Estimated impact on: Mobility impacts	0	
Estimated impact on: Environmental impacts	-	
Estimated impact on: Transport and traffic efficiency	-	
Estimated impact on: Usage, acceptance and trust		
Estimated impact on: Business & technical impacts		

H202 Visual workload will decrease (due to pre-planning taking place out of car)

Hypothesis **Visual workload will decrease (due to pre-planning taking place out of car)**			KEY **H202**
Related Research Question		**Safety - what are the impacts on risk of accident/injury?**	
Related System		ND01, ND02, ND32, ND33, ND50	
Related Use Case		UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_34	
Proposed indicator		Glance duration Number of glances Eyes off road percentage time	
Estimated impact on	Traffic Safety and safety related driving performance	+	
	Mobility impacts		
	Environmental impacts		
	Transport and traffic efficiency		
	Usage, acceptance and trust	+	
	Business & technical impacts		

H203 Cognitive workload will decrease (due to pre-planning taking place out of car)

Hypothesis **Cognitive workload will decrease (due to pre-planning taking place out of car)**		KEY **H203**
Related Research Question	**Safety - what are the impacts on risk of accident/injury?**	
Related System	ND01, ND02, ND32, ND33, ND50,	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_34	
Proposed indicator	NASA-TLX component indicators	
Estimated impact on	Traffic Safety and safety related driving performance	+
	Mobility impacts	
	Environmental impacts	
	Transport and traffic efficiency	
	Usage, acceptance and trust	+
	Business & technical impacts	

H204 Drivers will plan journeys prior to getting in the car

Hypothesis			KEY
Drivers will plan journeys prior to getting in the car			**H204**
Related Research Question		**Personal mobility - what are the impacts on individual driving behaviour?**	
Related System		ND01, ND02, ND50	
Related Use Case		UC_ND_01	
Proposed indicator		Questionnaire data re location and timing of journey planning elements	
Estimated impact on	Traffic Safety and safety related driving performance		
	Mobility impacts	+	
	Environmental impacts		
	Transport and traffic efficiency	0	
	Usage, acceptance and trust	+	
	Business & technical impacts		

H205 Car journeys will be replaced by public transport journeys

Hypothesis			KEY
Car journeys will be replaced by public transport journeys			**H205**
Related Research Question		**Personal mobility - what are the impacts on individual travel behaviour?**	
Related System		ND01, ND02	
Related Use Case		UC_ND_01 UC_ND_34	
Proposed indicator		Number of journeys per mode per unit time	
Estimated impact on	Traffic Safety and safety related driving performance		
	Mobility impacts	0	
	Environmental impacts	+	
	Transport and traffic efficiency	+	
	Usage, acceptance and trust		
	Business & technical impacts		

H206 Driver stress and uncertainty will decrease (due to ease of use of one device across modes)

Hypothesis **Driver stress and uncertainty will decrease (due to ease of use of one device across modes)**		KEY **H206**
Related Research Question	**Personal mobility - what are the impacts on comfort?**	
Related System	ND01, ND02, ND31, ND32, ND33, ND34, ND35, ND36, ND50, ND51	
Related Use Case	UC_ND_01 UC_ND_31 UC_ND_32 UC_ND_33 UC_ND_34 UC_ND_35 UC_ND_37 UC_ND_38 UC_ND_39	
Proposed indicator	NASA-TLX component indicators Rating scales of driver confidence	
Estimated impact on: Traffic Safety and safety related driving performance	+	
Estimated impact on: Mobility impacts	+	
Estimated impact on: Environmental impacts		
Estimated impact on: Transport and traffic efficiency		
Estimated impact on: Usage, acceptance and trust	+	
Estimated impact on: Business & technical impacts		

H207 Traffic volume will be more evenly distributed over time (because drivers will delay, or bring forward, their trip)

Hypothesis **Traffic volume will be more evenly distributed over time (because drivers will delay, or bring forward, their trip)**		KEY **H207**
Related Research Question	**Traffic efficiency - what are the impacts on traffic volume?**	
Related System	ND01, ND02, ND50	
Related Use Case	UC_ND_01	
Proposed indicator	Number of journeys per unit time	
Estimated impact on	Traffic Safety and safety related driving performance	0
	Mobility impacts	0
	Environmental impacts	0
	Transport and traffic efficiency	+
	Usage, acceptance and trust	
	Business & technical impacts	

H208 There will be an increased use of modes with a low carbon footprint

Hypothesis **There will be an increased use of modes with a low carbon footprint**		KEY **H208**
Related Research Question	**Environment - what are the impacts on CO2 emission levels?**	
Related System	ND01, ND02, ND52	
Related Use Case	UC_ND_01 UC_ND_33 UC_ND_34	
Proposed indicator	Number of journeys per mode per unit time Calculated (or estimated) carbon footprint of journey	
Estimated impact on	Traffic Safety and safety related driving performance	
	Mobility impacts	
	Environmental impacts	+
	Transport and traffic efficiency	+
	Usage, acceptance and trust	
	Business & technical impacts	

A.3.3 LEVEL 3 HYPOTHESES: Baseline = No nomadic device in vehicle

These hypotheses will be quite generic and would apply to the presence of any device (OEM or aftermarket/nomadic) used by a driver

H301 Visual workload will increase

Hypothesis **Visual workload will increase**		KEY **H301**
Related Research Question	**Safety - what are the impacts on risk of accident/injury?**	
Related System	ND70, ND74, ND75	
Related Use Case	UC_ND_31 UC_ND_32 UC_ND_33 UC_ND_34 UC_ND_35 UC_ND_37 UC_ND_38 UC_ND_39	
Proposed indicator	Glance duration Number of glances Eyes off road percentage time	
Estimated impact on	Traffic Safety and safety related driving performance	-
	Mobility impacts	
	Environmental impacts	
	Transport and traffic efficiency	
	Usage, acceptance and trust	-
	Business & technical impacts	

H302 Cognitive workload will increase

Hypothesis **Cogntive workload will increase**		KEY **H302**
Related Research Question	**Safety - what are the impacts on risk of accident/injury?**	
Related System	ND70, ND71, ND72, ND73, ND74, ND75	
Related Use Case	UC_ND_31 UC_ND_32 UC_ND_33 UC_ND_34 UC_ND_35 UC_ND_37 UC_ND_38 UC_ND_39	
Proposed indicator	NASA-TLX component indicators	
Estimated impact on: Traffic Safety and safety related driving performance		
Estimated impact on: Mobility impacts		
Estimated impact on: Environmental impacts		
Estimated impact on: Transport and traffic efficiency		
Estimated impact on: Usage, acceptance and trust		
Estimated impact on: Business & technical impacts		

H303 Injuries in accidents will be increased due to loose objects

Hypothesis **Injuries in accidents will be increased due to loose objects**		KEY **H303**
Related Research Question	**Safety - what are the impacts on accidents?**	
Related System	ND70	
Related Use Case	UC_ND_31 UC_ND_32 UC_ND_33 UC_ND_34 UC_ND_35 UC_ND_37 UC_ND_38 UC_ND_39	
Proposed indicator	Nature, severity & causation of injuries	
Estimated impact on: Traffic Safety and safety related driving performance	-	
Estimated impact on: Mobility impacts		
Estimated impact on: Environmental impacts		
Estimated impact on: Transport and traffic efficiency		
Estimated impact on: Usage, acceptance and trust		
Estimated impact on: Business & technical impacts		