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Abbreviations

AO: Authentication Oracle

AMF: Application Management Framework

AP: Access Point

API: Application Programming Interface

BGP: Border Gateway Protocol

BIA: Business Impact Analysis

C2C: Car-to-Car

C2CCC: Car to Car Communication Consortium

C2I: Car-to-Infrastructure

CA: Certification Authority

CAC: Connection Admission Control

COTS: Commercial Off-The-Shelf

CRC: Cyclic Redundancy Coding

DFCD: Decentralised Floating Car Data

DM: Diagnostic Manager

DoS: Denial of Service

ETSI: European Telecommunications Standards Institute

FCD: Floating Car Data

FEC: Forward Error Correction

GMP: Group Membership Protocol

GPRS: General Packet Radio Service

GPS: Global Positioning System

GSM: Global System for Mobile communication

GSPN: Generalised Stochastic Petri Nets

HW: Hardware

IEEE: Institute of Electrical and Electronics Engineers

IFIP: International Federation of Information Processing

IM: Intermediate Model

IMS: IP Multimedia Subsystem

IP: Internet Protocol

ISO: International Organization for Standardization

J2SE: Java 2 Standard Edition

JVM: Java Virtual Machine

LLC: Logical Link Control

MAC: Medium Access Control

MDA: Model Driven Architecture

MIP: Mobile IP

MSC: Message Sequence Chart

MW: Middleware

NeMo: Network Mobility

ODP: Open Distributed Processing

OS: Operating System

OSI: Open System Interconnection

OTS: Off-the-Shelf

PCO: Points of Control and Observation

PHY: Physical layer

PLCP: Physical Layer Convergence Protocol

PKI: Public-Key Infrastructure

QoS: Quality of Service

RACS: Resource and Admission Control Subsystem

RFID: Radio Frequency Identification

RM: Reference Model

RecM: Reconfiguration Manager

RepM: Replication Manager

R&SA Clock: Reliable and Self-Aware Clock

RSU: Road Side Unit

SA Forum: Service Availability Forum

SCTP: Stream Control Transmission Protocol

SD: Streaming Data

SDL: Specification and Design Language

SIL: Safety Integrity Level

SINR: Signal to Interference-plus-Noise Ratio

SIP: Session Initiation Protocol

SME: Small and Medium sized Enterprise

SNMP: Simple Network Management Protocol

SOP: Start Of Production

SRN: Stochastic Reward Nets

SW: Software

TAI: International Atomic Time

TCO: Trust and Cooperation Oracle

TCP: Transmission Control Protocol

TPH: Tamper Proof Hardware

TTP: Trusted Third Party

UDP: User Datagram Protocol

UML: Unified Modelling Language

UMTS: Universal Mobile Terrestrial Access

VoIP: Voice on Internet Protocol

V&V: Verification and Validation

WIMAX: Worldwide Interoperability for Microwave Access

WLAN: Wireless Local Area Network

1. Introduction

This document contains an additional Annex to Deliverable D1.3 providing the details of the business impact analysis performed in HIDENETS. For a number of focus areas of the European Community the wide deployment of services based on today's and future network architectures is critical. Prominent examples are automotive, telecommunications, travel, and support for the elderly. The list below relates these application areas to important socio-economic aspects.

- **Safety**: In the automotive sector, the management of continuously increasing traffic within and between EU member states will heavily depend upon the acceptance and wide use of mobile services, e.g. for the fast communication of local traffic information from one car to the next behind or in front (icy curve, jam ahead, keep distance) or of short/midrange traffic warnings and route directions from roadside infrastructures to moving traffic. Such services will also reduce the waste of resources and improve everyday life of EU citizens.
- **Profits, dependability:** In telecommunications it is expected that Voice over IP (VoIP) infrastructures will be a major business driver for convergent services. The EU economies will depend heavily on its wide proliferation and use. Their usefulness for SMEs (Small and Medium sized Enterprises) will require high service availability.
- **Economic use of resources:** Travel and transport are major drivers of the quality of life of EU citizens and of European integration (e.g. harmonised railway infrastructure across Europe). Only by the efficient use of mobile services will we be able to manage the implied transport requirements. At the same time, it will be mobile services, which will help regional entities to respond directly to potential customers driving by when searching a hotel, a site to visit or a restaurant to eat.
- **Comfort, safety:** Last but not least, support for the elderly will be critical with the ongoing aging process in our communities. Mobile services can help to improve the living condition of people who are sick, alone or in need for help. But only if these services are trustworthy.

The above examples are closely related to the use of mobile services by individuals or SMEs. To improve their productivity, EU businesses, in particular SMEs must be able to focus on core business processes and leverage the economies of scale provided by excellent communication infrastructures. This is only possible with high quality mobile services and infrastructures, dependability and resilience being critical qualities therein.

The HIDENETS solutions are expected to contribute to a user perception of trustworthiness of future wireless services, as this perception is strongly impacted by availability and resilience aspects. Such perception is critical for the technical and business success of these services. The solution development and analysis require a holistic approach combining aspects of communications, middleware, service deployment and access. The research work comprises leading industrial partners as well as highly recognised research teams on resilient distributed systems: Aalborg University (AAU)(Aalborg, Denmark), Budapest University of Technology and Economics (BME)(Budapest, Hungary), Fundação da Faculdade de Ciências da Universidade de Lisboa (FCUL)(Lisbon, Portugal), Universita Degli Studi di Firenze (UNIFI)(Florence, Italy), Centre National de la Recherche Scientifique (LAAS-CNRS)(Paris, France), Twente Institute for Wireless and Mobile Communications (WMC)(Enschede, Netherlands), Carmeq GmbH (Carmeq)(Berlin, Germany), Telenor (TELENOR)(Fornebu, Norway), Fujitsu Siemens Computers (FSC)(Munich, Germany).

The research results show, how resilience solutions for new mobility-aware distributed applications with critical dependability requirements can be designed, implemented, and evaluated on open communication infrastructures (see in particular this document and [43]).

1.1 BIA objectives and research question

From the point of view of engineers, the project represents a step further in assuring end-to-end dependability in highly dynamic ad hoc networks. The main question for this business related study is:

What is the impact of HIDENETS dependability results (services, methods, tools) on the market?

To study this question, two semi-hypothetical new services - Navisave and Medigate - have been introduced, which are described in detail in the next chapter. Navisave is an incarnation of the Floating Car Data use case (see [37]) and supports drivers in many different aspects (road condition, speed warnings, traffic jams). Medigate is an incarnation of the Streaming Data use case (see [37]) and shortens the time between an injury and getting expert treatment through online interfacing to hospital resources from an ambulance. Preliminary implementations for such applications are available. The aim of this study is to find out whether the dependability qualities which can be added using HIDENETS results do change the market/price model for such applications. Presently there are no application offerings of similar high quality on the market (one result of the study, see chapter 2 below) – thus Navisave and Medigate provide would provide a unique offering to the market. But: will they be marketable? Considering the development process of new products by Kotler [56], these applications are in the stage of concept testing. The first two phases being complete (idea generation and idea screening), the next step is to test the concept and its attractiveness on the market. Assumptions are made regarding costs, price, and quality requirements. All of them need to be tested. The test is made using a questionnaire comprising both technical and economic questions. The questionnaire is fully listed in annex 2.

The overall objective of this study is to determine the possible market impact of using dependability services, methods and tools in relevant applications should they be commercialised. This objective is broken down into the following more detailed sub-objectives:

- Determine if the assumptions within the HIDENETS work are acceptable from an economic perspective.
- Validate the economic model - the answers from the questionnaire are set in relation to the initial assumptions.
- State possible effects on the market by introducing applications such as Navisave and Medigate.

1.2 Related work

There is only little material publicly available on the business aspects of car-to-car communication as well as on the business effects of increased dependability in communication systems in ad-hoc environments in general. Two relevant publications in this field are [54], [55]. There, the general problems and difficulties with respect to the market introduction of car-to-car communication are analysed. One result is that the mechanisms are different than equipping cars with new technology which independent of other cars in the surroundings or the functioning of infrastructure applications. Reason is that the functioning of a car-2-car application depends heavily on other cars being equipped with car-to-car devices as well, whereas other new technologies may have a direct benefit for the user on their own.

This business impact analysis does not consider these general market introduction mechanisms. It rather assumes that the cars are equipped with the required technology. It is the lack of dependability and the introduction of dependability means on which we are focusing.

1.3 Overview

The study is structured in five chapters. The first (this) chapter introduces the key topics of the HIDENETS project and the background of the BIA study together with the study objectives. The second chapter focuses on the economic model and introduces the specific focus applications used in the study. The third chapter explains the development and analysis of the BIA questionnaire. Chapter four interprets the results and

summarises the impact of the HIDENETS project from a business perspective. Also in this chapter, the research questions are answered. Chapter five summarises the results and recommends future work. The verity of the analysis presented in the study is underscored by the information presented in the appendices (the market research background, the questionnaire developed and the received responses).

2. Market research and analysis

Within this chapter, we describe scope and work process used for this study. The description includes the use cases and specific applications (Navisave and Medigate) which are the basis for the analysis. The economic model for understanding the relationship between high availability services (assured dependability level) and potential socio-economic impacts (savings due to HIDENETS characteristics) is introduced as well.

2.1 Scope of the study

The overall objective of HIDENETS is to develop innovative technologies to enable the design and validation of applications and services in mobile scenarios that have to satisfy stringent dependability and resilience requirements while depending on components and communication links that are inherently unreliable. HIDENETS follows a holistic end-to-end system approach, jointly considering communication aspects as well as service and middleware functionalities. Technical solutions are developed for applications with critical dependability requirements in the context of selected use-cases of ad-hoc car-to-car communication with infrastructure service support. A key goal of this study is to get a better understanding of the use of dependability services, tools, methods and their potential social and economic impact.

The study focuses on the following steps:

- Initially, a business model is developed to analyse the flow of data and dependencies between the involved market players (software manufacturers, service users, car owners…)
- Then a questionnaire was defined to be sent to a limited number of experts in the field for completion. To make the feedback as specific as possible, two specific applications were referenced in the questionnaire: Navisave and Medigate.
- Finally, the responses were analysed and generalised for their implications on dependability work and dependability requirements in mobile, ad-hoc applications.

Deliverable D1.1 “Use case scenarios and preliminary reference model” [37] presented a wide range of use cases relevant for HIDENETS. It was decided that the business impact study will focus on two specific use cases: Floating Car Data (FCD) and Streaming Data (SD). For practical reasons, specific applications were specified: The Navisave application represents the FCD use case, the Medigate application represents the SD use case. The following key reasons support this decision:

- Be as specific as possible in the analysis work to complete the task in the available resource bounds.
- As an external audience had to be involved (with a questionnaire to be sent out), a clear understanding on the applications under review was necessary.
- Also, the external audience should be allowed to draw on own experience and background information and provide as much feedback as possible.

Medigate application

Streaming data is a use case covering radio programs, music and video on demand, and TV applications. In the Medigate service, we consider a specific scenario where streaming data is applied in emergency events when a patient is transported from an accident scene to a nearby hospital in an ambulance. Relevant data (pulse, blood pressure, emergency vehicle position; in future extensions and depending upon the bandwidth of the available wireless connections video and audio data may also be transferred) is transferred from the ambulance to the hospital in order to constantly report on the patient’s current status and allow the hospital optimal preparation before the patient arrives. This helps doctors and nurses at the hospital to get ready for

treating the patient based on an accurate picture of the degree of emergency and the specific means required to save the patient's life.

Navisave application

Floating car data (FCD) describes the process of collecting traffic flow information and calculating up-to-date information about the current traffic situation on roads and feeding it back to participants of a corresponding service. Navisave, the application described here, comprises both, centralised and decentralised collection and distribution of data. A central server collects traffic data and derives information on the traffic situation at a specified time and location. The information is re-distributed to vehicles on the road via wireless communications. Decentralised floating car data (DFCD) assumes that each vehicle which is equipped with the required devices, periodically transmits its current location, speed and driving direction and other relevant information e.g. on road conditions or from sign posts. This results in a very detailed understanding of the traffic flow state around important for vehicles when on the road. In order to make sure that the amount of information remains within reasonable limits, the information is processed inside vehicles and condensed before it is sent to central sites for further processing and combination with centrally accumulated data.

2.2 Economic model

Both applications above are evaluated w.r.t. the following economic aspects (see Figure 1):

- *Assured dependability level*: is the starting point of the analysis and represents requirements and expectations on the implemented services from a usage perspective.
- *Costs for applying Hidenets services*: the costs for dependability measures (specifically, measures developed in the course of the HIDENETS project) to achieve the assured dependability level need to be understood as they will influence the price of the services.
- *Application price*: The price needs to be acceptable from a buyer's perspective, but is dependent upon the costs to implement the product.
- *HIDENETS impact on acceptance of applications*: Only if the application of dependability (concrete: HIDENETS) measures result in a higher acceptance of the service, will buyers be willing to spend money.
- *Market penetration of applications*: The market penetration will depend upon the *overall market*, but also on the price for using the application and the acceptance of the application.
- *HIDENETS business influence*: is one important factor to be clarified with the BIA study covering both the business which can be expected around HIDENETS services and their productization as well as their use.

Economic savings due to HIDENETS characteristics: should provide feedback on the potential impact of using HIDENETS tools, methods, services from a macro-economic perspective.

The dependencies between these factors are depicted in Figure 1. The same model is applied to both applications (Navisave and Medigate), knowing that for example the business model or the market participants behind both services are very different (e.g. hospitals vs. drivers in a car).

The initial data needed for using the model were based on assumptions which are derived from research on the Internet. As resulting intelligence was not sufficient for analysing the model, it was decided to acquire more data by using a questionnaire which was sent to a relevant but limited audience (colleagues, project participants, and other specialist in the domains of interest). By analysing the responses we have received based on the questionnaire additional data could be gathered for completing the analysis based on the economic model.

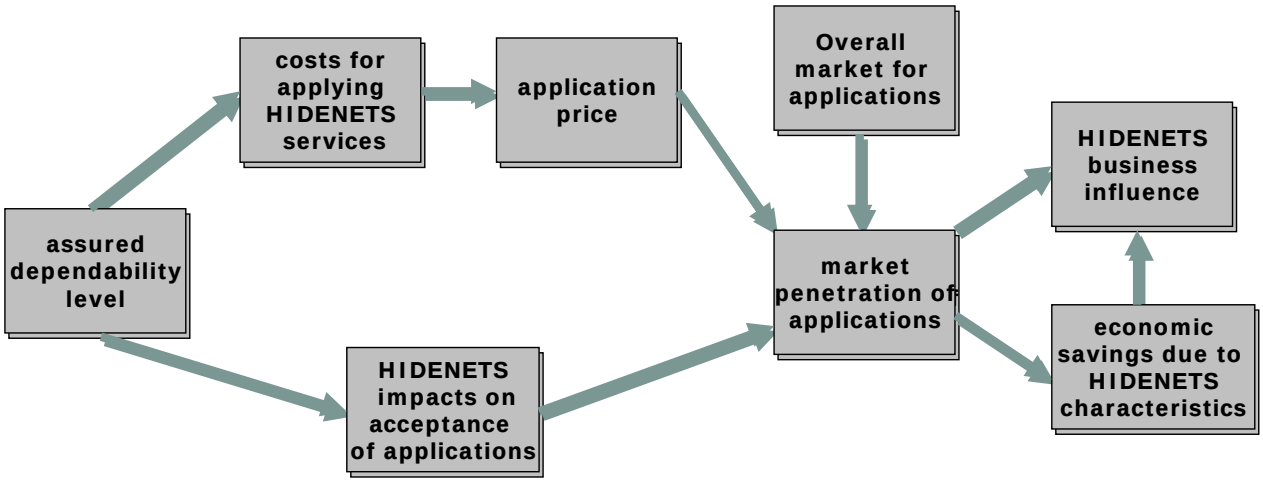

Figure 1: Data model of the Business Impact Analysis

Assured dependability level

As the overall goal of HIDENETS is to develop end to end dependability solutions, the economic model starts and is based on the assured dependability level (Figure 1). Every service has to have an assured dependability level in order to become marketable and as a natural consequence, to be accepted by potential customers.

In our case, the assured dependability level is determined by middleware level properties and qualities. All these properties in different combinational levels determine the assured dependability level presented in the HIDENETS economic model. For Navisave, the following dependability levels have been taken into account: 50%, 60%, 70%, 80%, 90%, while for Medigate, two level seemed appropriate: 80% and 99%). Each level of assured dependability determines costs, prices, market penetration rates and economic savings. In particular, this is reflected in the costs, the assured dependability level determines the dependability (HIDENETS) functions and measures which are necessary to achieve the assumed level.

Table 1 : Assured dependability level

		personal savings
“no”	0%	0%
“good”	50 %	15%
	60 %	30%
	70 %	45%
“excellent”	80 %	60%
	90 %	75%

To understand somewhat better what can influence the assured dependability level, and implicitly the costs, important middleware level properties are summarised below (more detailed information in D1.1 – use case scenarios and preliminary reference model [37]). It should be noted that in the questionnaire respondents were asked for their estimate, which of the HIDENETS functions are required to implement these properties (see chapter 3 and annex 2).

- **Timeliness of data:** This property is necessary when some application needs to ensure that it is up-to-date (within some given bound), with respect to the context or environment in which it is being deployed. Timeliness of data is also necessary for real-time applications in general (e.g. like video conferencing, on-line gaming). Timeliness imposes constraints on communication delays to lower layers. It also requires a minimum level of connectivity.
- **Logical consistency:** This property is essentially relevant when considering replication of data. It ensures that the state (the value) of every replica is consistent with each other.
- **Temporal consistency:** This property is essentially relevant in the context of real-time data representation. In brief, it ensures that at any point in time the value of some (real-time) entity stored at a replica is not too far apart from the real value of that entity at that same point in time.
- **Trustworthiness of data**: The concept of trustworthiness refers to the degree of confidence a service user may have that the service will perform as expected and, in particular, that it will satisfy a set of security properties.
- **Robustness:** This specialised secondary attribute of dependability characterises systems that are dependable with respect to external faults. Therefore, the robustness of middleware solutions is especially meaningful when external faults constitute a relevant threat.
- **Message ordering:** Different properties with respect to message ordering can be considered.
- **Completeness, accuracy and timeliness (of failure detection):** The requirement for failure detection can be specialised with particular properties that failure detectors must exhibit. *Completeness* refers to the ability of a failure detector to detect every failure that occurs. *Accuracy* refers to the ability of the failure detector to not make mistakes, that is, wrongly detect failures when they do not occur. *Timeliness* refers to the ability of the failure detector to detect failures within given time bounds.

Economic savings

The economic savings are determined differently for the two services. In the case of Medigate, the indicators and savings are in terms of saved human lives (or reduced medical costs due to immediate and radically shortened first treatment) by receiving the data needed in time or help with the right diagnosis while the patient is still in the ambulance.

For Navisave, the economic savings can be directly measurable, because there are measurable indicators: time and use of energy (gas).Each increasing level of assured dependability implies increased savings. Assuming, for example, an assured dependability of 50% for FCD the driver can save up to 15% in terms of time for travelling and used gas (personal savings). These savings will increase with the increase in the level of assured dependability (Table 1). That means, the more dependable the Navisave application is, the higher will be the potential savings for an individual driver. By extending the individual savings to a macro-economic scale, costs for oil imports can be reduced and the emission of carbon oxides can be reduced.

The data used to support the assumption in the economic model are of two types ([56], [57], [58], [59]). First of all, secondary data has been researched on the Internet. The secondary data is not always sufficient for a good market analysis, and it does not offer precise solutions to the issues. Therefore the analysis has been supported and complemented with primary data through a questionnaire, detailed in the next chapter.

3. The questionnaire and its analysis

A questionnaire was developed to provoke feedback by experts in the communications and dependability domains on the services Navisave (FCD) and Medigate (SD). The feedback is then used to validate the assumptions used in the economic model as introduced above and thereby to increase the confidence in the data applied in the economic model.

3.1 Methodology

As mentioned in the previous chapter, the questionnaire and its answers are used to sustain and also, gather more information for supporting the economic model. A questionnaire was developed and distributed to research institutions, industry consortia and industrial partners of the project. The objective was to reach as many people as possible but limited to related entities such as SA Forum member companies, HIDENETS project members, and personal contacts active in the fields under analysis. The global aim was to receive feedback on the usefulness of Hidenets dependability functions and whether the quality improvements on applications when applying technologies developed within the HIDENETS project can be marketable. The questionnaire was made public, but the number of recipients was limited as the facilities for handling a more extensive inquiry were far beyond the scope of the project. The respondents' coverage was global from a geographical point of view (North America, Western Europe and Japan). The ratio of respondents was at 17,5% (35 respondents out of 200 questioned). The feedback data are mainly based on personal experience and exposure to services similar in function (not necessarily quality) to Medigate and Navisave.

The questionnaire comprises questions for both services (Medigate and Navisave) that will be analyzed in the next section. As HIDENETS results allow to create applications with many new features, there were two types of questions that answers were sought for: questions regarding the quality requirements needed by Navisave and Medigate to be marketable and questions regarding the costs and prices that could be achieved for those services on the market.

The questionnaire's layout therefore consists of two parts. The first part contains a brief presentation of the Navisave and Medigate features to introduce the reader to the topics and provide the necessary background for answering the questions. The second part with the individual questions consists of

- a few introductory questions and questions regarding the familiarity of the respondent with both services and services alike (Q1-Q4);
- questions on quality, costs and price expectations (Q5 – Q9),
- estimate for the market acceptance (Q10)
- and some generic feedback on the project (Q11).

The responses were introduced and analyzed using MS Excel. The analysis is based on basic mathematical methods (x, /, +, -) taking into account the whole population. Each respondent's answer was transcribed in the database created in MS Excel and then the responses for the open questions were grouped according to their meaning. The detailed responses in table form are available in annex 3 of this report.

3.2 Analysis of the questionnaire responses

From the introductory questions (regarding the business activity and profession of the respondent) combined with the answers from the third and eleventh questions, the fact can be derived that the answers have a strong technical focus (annex 3). Most of the respondents are engineers (21) and scientists (7) working as researchers (19), developers/planners (12) and in other areas. The fact that 13 of them come from industry is increasing the confidence on feedback on the market potential of both services.

As it can be seen (annex 1), the first part of the questionnaire tested people on their familiarity with Navisave and Medigate features. The first three questions concentrate on finding out if the respondent has heard about

similar services before and if the answer is positive, to exemplify. From the answers it can be understood that some of the features presented in the two services are well known, but not all of them and not in the same service, therefore Navisave and Medigate are seen as a novelty by the majority of the respondents (Table 2).

Table 2

Q1: Have you heard about the same or similar commercial service offerings before	Medigate	Navisave
Yes	16	15
No	19	20

The aim of the question number four was to discover the ranking in uniqueness/unimitability of the two services. Example services are already introduced on the market and the responses are based on experience. More than 80% attested medium to high service uniqueness (annex 3).

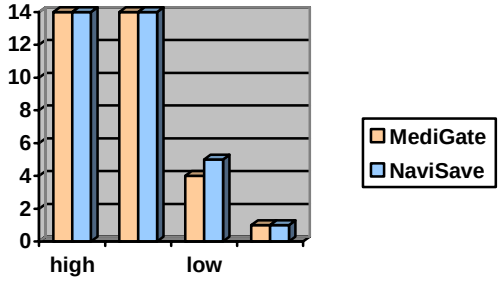

Figure 2: Uniqueness/Unimitability of Medigate and Navisave

From this first part of the questionnaire, it is clear that Navisave and Medigate provide new qualities and features and people are very interested in hearing more, so the next questions embody the quality, costs and acceptance expectations of the two services.

First and foremost, the quality expectations are depicted by questions five and six. Question five enlists a series of possible quality requirements assumed in the economic model, as essential for a good coordination and support of the two services. The next question gives the respondent the possibility to expand on these requirements if the respondents thought this to be necessary.

Table 3

Q5: How do the phrases below reflect your expectations on	Fully agree	Agree	Disagree
Navisave			
1. I can rely on the Navisave results. (Reliability)	13	18	4
2. The Navisave results are available when I need them (availability)	11	22	2
3. I can trust the Navisave results[1]. (Trustworthiness)	15	16	5
4. The Navisave service gives me timely guidance (timeliness)	12	21	1

[1] E.g. absence of malicious attacks

5. Navisave data is based on all available sources for traffic information.	8	17	10
6. My expectations are met by existing navigation services already.		3	31
Medigate			
1. The Medigate service should provide continuous communication between a doctor and an ambulance.	20	14	1
2. Patient data provided through Medigate should be current and correct.	26	9	0
3. Medigate data should be secure against malicious attacks	26	8	1
4. These expectations are met by existing ambulance services already.	1	3	28

As can be seen in Table 3 above, in the Navisave case, all five requirements are very important, but the most important are availability (33) and timeliness (34) followed close by reliability and trustworthiness. This point is stressed further in the answers of the sixth question. For Medigate services, the respondents strongly agree with all the assumptions made: the communication between the doctor and ambulance has to be continuous and the data should be correct and current and protected against malicious attacks. There is no room for errors. In both cases, hardly any of the respondents are pleased with the existing services and have a lot of suggestions regarding what technical requirements can be included (the most frequent are: reliable networks, check pointing, fast recovery; see also annex 3).

Secondly, the cost expectations are given in the answers to the next three questions (seven till nine). Questions seven and eight review the expected costs for development and implementation of both services. In terms of man power, the expectations are relatively high: more than 100 PY for Navisave and between 40 and 100 PY for Medigate.

Table 4

Q7: What resources (manpower) do you assume will be required to implement the service to fulfil your expectations?	>100PY	40-100PY	5-40PY	<5PY
Navisave	10	9	9	0
Medigate	6	15	6	2

The expected costs (in terms of money) are also estimated to be very high for both services: between 1 M € and 10 M € and more than 10 M €. In other terms, almost all respondents expect a very high concentration of man power and financial costs in this project. A fact that is not unexpected considering the multitude of parameters and standards that have to be met in order to reach the high expected service quality.

Table 5

Q8: What costs do you assume will be required to develop and implement the service to fulfil your expectations?	>€10M	€1M - €10M	€100K - €1M	<€100K
Navisave	12	12	5	0
Medigate	9	15	5	0

Question nine is concerned with the prices that a customer is willing to pay for the high quality of service and where these costs should be incurred. From the responses to the fifth question, it was quite obvious that in this moment the respondents are quite unsatisfied with present services. This fact strongly is underlined by

the answers from the ninth question. In both cases, it is considered worthwhile Table 6 to pay a high price or additional costs (monthly or one time fees) in order to have an outstanding service:

- *It is worthwhile investing in applications such as Medigate: 15 fully agree and 16 agree.*
- *Users will pay a higher price for a high quality Navisave service – 21 agree.*
- *Users expect navigation services to offer the advanced Navisave features at no additional costs – 16 disagree!*

In the Medigate case, the prices are not assumed to be paid directly by consumers, but indirectly by paying insurance (17 respondents) or hospital treatments, including the charges for the ambulance service (16 respondents). For Navisave, the prices will be paid directly by the consumer. By being an open question (*How much are customers willing to spend on an advanced navigation service such as Navisave [please guestimate an amount in Dollars or Euros]?*), the amount and way of paying is quite vast: the option chosen most often was monthly payment of 10€ to 20€ (15 respondents), followed quite close by a monthly fee of more than 100€ (9 respondents); there is also the option to pay once an amount varying from 500€ to 1500€ (5 respondents).

Table 6

Q9: What are acceptable costs from a user's perspective for dependable applications such as Navisave and Medigate

Navisave	higher price	No additional costs	Increment/month 0	10-20	50	>100
fully agree	4	7				
agree	21	9	3	15	4	8
disagree	8	16				

Medigate	Invest worthwhile	>health insurance	>hospital costs	>ambulance charges
fully agree	15			
agree	16	17	6	16
disagree	1			

Last but not least, question ten asks about the expected market acceptance in terms of years to achieve a sufficient penetration. The respondents were very optimists in their answers. In five years Navisave is expected to acquire 38% of the market share, expectations relatively high considering the status of technology and the required infrastructure. The same can be said about the Medigate application with 25%. An increase of this magnitude shows that the two applications are perceived as needed on the market.

Table 7

Q10: Acceptance expectations (in percent of ambulances resp. cars overall)	Year 1	Year 2	Year 3	Year 4	Year 5
Navisave	3	8	17	28	38
Medigate	2	4	10	17	25

4. Comparing the assumptions in the economic model and the answers to the questionnaire

Earlier, in chapter 2 the economic model was described and assumptions which were made on the assured dependability respectively the economic savings. The questionnaire was issued in a supportive action to confirm or dismiss the assumptions which had been made. The feedback to the questionnaire is summarised in chapter 3. We are now going to discuss, if the responses can confirm the assumptions made earlier.

Medigate

The first assumption made was on the assured dependability level (*80% and 99% - medical world needs a high level of assured dependability level*). Unanimously, the questionnaire responses confirm that the information has to be correct, current and extremely secure: 34 out of 35 respondents agree with this assumption (question five).

The next assumptions made were concerning costs, prices, and market acceptance. In all cases the assumption was proven correct. The respondents acknowledge the need of strong investments of capital both in the development and implementation of the service; if the service delivers, then it is worthwhile the investment (between 1M € and 10M € and more than 10 M €, Q7 and Q8). Considering the forecast for market acceptance (Q10), these investments will be covered in no time. Also, taking into account that Medigate will be used by ambulances and their number is not very high (only around 20 000, [60], [61], [62]), if the quality expectations are met, then in a very short time all ambulances can be equipped with a Medigate like service.

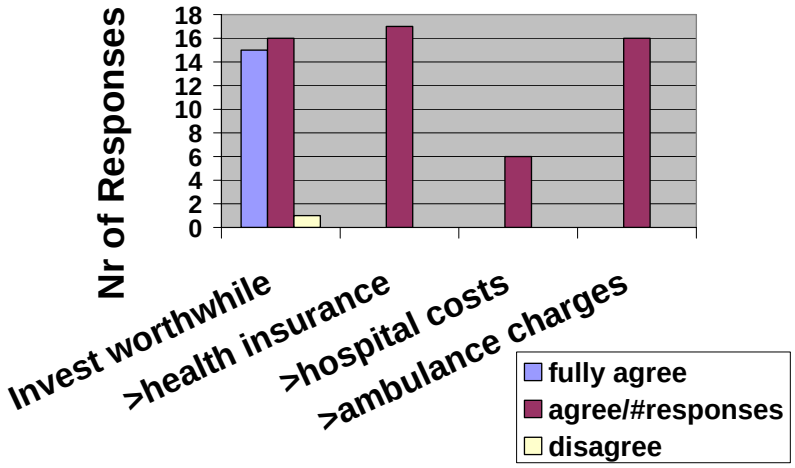

Figure 3: Acceptable payment models for Medigate services

In terms of economic savings, it can be deducted that with a high quality service the costs involved (to make appropriate estimations of the patient's medical care – diagnosis, medication, hospitalization) will be drastically reduced. In the case of an accident, the hospital can prepare better if they know exactly the medical situation of the patients being in the ambulance on the way to the hospital (in terms of medication, x-rays, surgeries, medical staff, etc. needed). Therefore, time consuming activities (such as transmitting and rechecking of the vital status) needed today, can be shortened by a large degree. With a proper communication between for example day care at a patient's home (as a slight extension of the Medigate

application) and the hospital, a patient can receive medication and care at home, without having to be hospitalised.

Navisave

The Navisave business case allows a more detailed analysis of the potential economic savings (one reason is the broader understanding of cars and traffic systems and relevant market intelligence, [63]).

The assumptions start with the assured dependability level. At the beginning, it was assumed that an entry dependability level of 50 % would be acceptable. But based on the questionnaire results, it can be seen that consumers are willing to pay more for a high quality service (Q9), therefore the starting stage should be at least 70% assured dependability level for a good service.

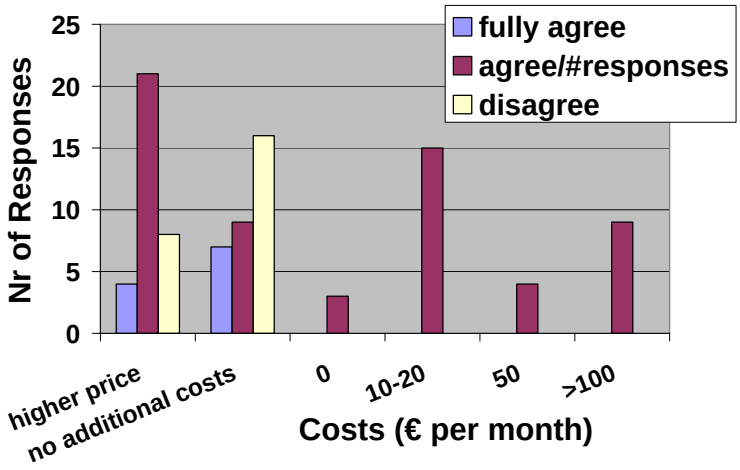

Figure 4: Acceptable user costs for Navisave

The questionnaire underlines the fact that availability (*The Navisave results are available when I need them*) and reliability have to be considered as very important in determining the quality requirements (Q5). If timeliness (*The Navisave service gives me timely guidance*) and trustworthiness are considered as important, the implementation costs increase. Expected implementation costs are actually expected to be relatively high (Q8): 1 million Euros plus. However, based upon the acceptable costs per month (see Figure 4 above), such costs would be compensated by additional revenue for the high-quality applications (taking the expected market penetration – Q10 – and number of cars – 50 million – into account). Also the question: *Should there be only one price or a monthly subscription?* could be answered: 15-30 respondents opted for a monthly subscription fee of 10-20€ (Q8).

5. Conclusions and recommendations

The objective of the study was to determine the possible market impact of using dependability services, methods and tools. Having analysed the present market, it can be derived that its main weakness is their limited dependability. Limitations are seen in security, collection and distribution of data, etc. The main research question was: What is the impact of HIDENETS dependability results (services, methods, tools) on the market? The answer drawn in this study is: the impact will be certainly positive. None of the present products satisfies the customers or fulfils their dependability expectations. They are looking for higher dependability, higher reliability in the products. The market for HIDENETS methods and tools is vast and opportunities for business are extensive.

Even though this research is very limited (number of recipients of the questionnaire), the coverage is global. The conclusion is that HIDENETS is not only a step ahead from the technical point of view, but it is also marketable. This study is the first step in discovering the level of success (acceptance) of introducing HIDENETS on the market. Considering the success of this first step, a more extensive and concrete market analysis should be conducted in the future.

Annex 1: Conceptual framework

Marketing research

The conceptual framework of this study (report) has as a base marketing research theory, which supports the issue and analysis of a survey. Therefore, it deserves to discuss in more detail how a marketing research should be carried out. [59] provided the foundation of this theory.

Typical steps in the market research progress (source: Holbert and Speece 1993 p. 27) [59]

Define the problem;

Define information needs;

Set priorities of information;

Develop a research plan and budget;

Pilot/exploratory research-qualitative;

Large scale survey-quantitative;

Research design-determine how to get information;

Instrument design- make the tool for getting the information;

Test the instrument;

Collect data;

Analyze and interpret data;

Write up report/prepare presentation;

Oral and written presentation.

The following sections describe the steps from the list above which are most important for this project. Others, which did not seem to be applicable for this study will be just mentioned and not discussed further.

Problem definition

Before starting a marketing research, the first thing to do is to define the problem. If the problem identification goes wrong, the whole research could be a waste of time.

Defining information needs

According to Holbert and Speece in [59], after the problem formulation, a list should be written with all the information that is needed in order to solve the problem. It should be taken into consideration how and where this information could be obtained from. Of course, here intervenes a matter of costs that is taken in consideration when budgeting the market research.

Information gathering

There are two types of data: primary and secondary. Secondary data are data that already exist somewhere, having been collected for another purpose. To gather all this information, here are recommendations where they could be researched: national statistical office, publication of international organizations like: United Nations, World Bank, OECD, EU Commission, Eurostat, International Monetary Fund, GEM (Global Entrepreneurship Monitor), Chamber of Commerce, etc. As for the primary data, it contributes to the more precise solutions to the marketing problems (they are collected for the specific purpose at hand). With secondary data one may never achieve all the information that is needed to solve the marketing problems.

They are sufficient to preconceive a general overview of the market, but they can rarely lead to a detailed understanding of markets and the costumers or companies that make up markets.

There are several ways how to gather primary data:

- *observation*, by watching what happens in a situation (ex: by fitted cameras);
- by asking people about their thoughts, feelings regarding a specific product/service (personal meetings, through mails or emails, through telephone or other ICT related ways such as videoconference etc). The base of data collection is the survey or a questionnaire which is used in different ways according to the previous thought. In the case when the questionnaire is not sent through post or electronic way, it is considered to be an interview. However, there are differences between interviews and surveys, as interviews are more personal than surveys on one hand. On the other hand, the interviews are carried out on a smaller scale, compared to the surveys. A third difference between the two notions relies in the result: the surveys are usually analyzed through different statistical methods and they provide more quantitative oriented results, whereas the interviews provide more qualitative results and perhaps without any sophisticated analysis.

Having discussed the different ways of data collection and data sources, it is important to know what the surveys/questionnaires should contain. Now, being in the middle of a market research, typical survey information would be to find out how different people buy things for different reasons. According to [59], the typical survey information would be:

- *Attitudes*: to measure *attitudes*, there is a need for information such as the people's knowledge about the product. In addition to knowledge, attitudes consist of some feeling about the product. For instance they like or dislike the product, and the feeling can go in different intensities (strongly, moderately (dis)like).
- *Image* is a kind of mental "picture" of a product" [59]. Images of products are based on how people perceive various aspects, or attributes of the product.
- *Decision- making:* Information on the *decision-making* process is another common goal of survey research. Here the researcher aims to find out how the customers come to a decision to purchase the product (contacts with friends, family, media, etc.)
- *Behaviour:* the information we get from the behaviour represents the present. For past and future behaviour we have to ask people. The most uncertain is to plan the decisions on information provided by future behaviours, because these might change over time, people might have second thoughts.
- *Demographic data:* Nearly every survey research project gathers *demographic* data. These data are usually used for sample validation. For instance at the beginning of research, the researcher chooses a target population to get information from. Demographics help show how the survey did at getting information from those people. Another important reason for using demographics in surveys is for information association. At the end of the survey might be possible to look at certain demographic characteristic and have a quite good idea about how they might view the product.

All the information about consumer's attitude towards a product represents a guide in the determination of *price sensitivity*. According to people's view and knowledge about the product, they decide whether it is worth the money or not.

Research types

Having discussed the survey research method above, it is time to categorise the project based on a given research type. Among the three types – exploratory; descriptive and causal research – this project belongs somewhere between the first two types [59].

- *Exploratory research* can be used to clarify concepts. It develops, clarifies and prioritises ideas. Exploratory research also uses secondary data; experience survey, talking to people within the industry about what they know is also common in this type of research.
- *Descriptive research* is characterised through precision and quantitative terms. One common focus of descriptive research is to describe characteristics of a certain groups of people related to the

product in question. It offers a demographic profile about the target group. Another common use of descriptive research is to estimate a proportion of the population with certain characteristics or behaviour. A third common use of descriptive data is to make predictions. Of course making predictions based on descriptive research through survey data could lead to false assumptions, so there is always a question mark in the prediction. Another form of prediction is forecasting, which is a form of taking the past secondary data and projecting it into the future through mathematical or statistical models. The result of forecasting can be as uncertain as in the former case, because things might change over time, especially people's thoughts and behaviour.

- *Causal research*, used to build more assurance in a research project about one thing causing another. For instance, more advertising causes more sales. However, there are limitations with this type of research as well.

Questionnaire design

As discussed earlier, a tool of marketing research is a questionnaire. Questionnaires contain all those questions that get precisely the requested information. According to Holbert and Speece in [59], questionnaires have a structure quite similar to a report. They must have an *introductive* part, which is kept short and simple, containing the name of the interviewee, the affiliation and the purpose of the survey. The organization of a questionnaire has to do with a lot of psychological scoops, for instance at the beginning, it is recommended to start asking the questions right after the introduction, also this question should be easy to answer, without thinking "so people do just answer it before they have had a second chance to think whether they want to spend a few minutes on the survey" ([59], p.121).

After the introduction comes the *body* of the questionnaire, where the real information needs are addressed. This part starts with general information related questions and goes on to the more specific ones. The questionnaire should flow smoothly from one issue to the next. Questions should be grouped into coherent topics. Questions about attitudes should be joined in a separate section; questions about behaviour as well. A very important concept is branching. It is used to guide people into the section they fit in. It is said that branching should not be used in mail surveys, because if it's too complex it may confuse the respondents.

The final part of the questionnaire should be constituted by the *demographics*. This is boring stuff to answer and might be sensitive for some of the respondents if being asked about their age and income: that is the reason why it should be left for the end. Even if they do not answer these questions, the interviewer has lost nothing, if the previous questions were answered.

As an overall hint, questionnaires should be simple, easy to answer, so in case of specific terminologies, it is a good idea to use *explanations* and clear *instructions* for branching for instance. As a final remark, the *presentation* is essential. To avoid any small mistake, or confusion, it is best to *test* the questionnaire on a small sample of the targeted population. The questionnaire is available in annex 2.

Data collection and analysis

The next step in the marketing research would be the data collection and analysis. This was done in chapter 3.

Presentation of results

The following step in the marketing research is the *presentation of results*. The written report has the following parts: introduction, methodology, result, limitations, conclusions and recommendations.

Annex 2: Questionnaire

HIDENETS is a research project with the aim of developing and analyzing end-to-end resilience solutions for distributed applications and mobility-aware services in ubiquitous communication scenarios. Technical solutions will be developed for applications with critical dependability requirements in the context of selected use-cases of ad-hoc car-to-car communication with infrastructure service support. One goal of the project is to get a better understanding of the use of dependability services, tools, methods and their social, economic impact. For this purpose, we have put together this questionnaire focussing on two application examples, Medigate and Navisave, as starting points to fill it out.

Medigate Application

Streaming is usually used in radio programs, music and video on demand, and TV applications. In the fictitious Medigate service, we consider the specific scenario where streaming is used in emergency events when a patient is transported from an accident scene to a nearby hospital. Typically, the streaming data (pulse, blood pressure, emergency vehicle position; in future extensions and depending upon the bandwidth of the available wireless connections video and audio data may also be transferred) is transferred from the ambulance to the hospital in order to constantly report on the patient's current status. This helps doctors and nurses at the hospital to get ready for treating the patient based on an accurate picture of the degree of emergency and the specific means required to save the patient's life.

Navisave Application

Floating car data (FCD) describes the process of collecting traffic flow information and calculating up-to-date information about the current traffic flow on roads. Navisave, the fictitious application described here, comprises both, centralised and decentralised collection and distribution of FCD.

Centralised FCD is handled by a central server which collects data and computes the traffic situation. The information is re-distributed to vehicles on the road via wireless communications.

Decentralised floating car data (DFCD) assumes that each vehicle which is equipped with the required devices, periodically transmits its current location, speed and driving direction. This results in a very detailed notion of the traffic flow state around receiving vehicles. In order to make sure that the amount of information remains within reasonable limits, the information is processed inside vehicles and condensed such that an intelligent piece of information is generated. This condensed information is then broadcast back into the network for further distribution.

Why do we need your help?

You have been identified as an expert contributor, because you are a dependability expert (developer or user of dependability services or tools) and at the same time you are a potential user (expert or layman) of

applications such as Navisave and Medigate. Your responses are very important for the success of this questionnaire.

Why you should answer!

Despite tremendous technical advances recently, the use of dependability services to enhance the quality of day to day mobility based or Web based applications is still lagging behind. By answering this questionnaire you will help improve the perception of dependability as an integral quality in a number of applications, Medigate and Navisave being just two relevant application examples. The effect is expected to be threefold:

- An ecosystem for dependability services can open new business opportunities for dependability service developers.
- More importantly: The and the wide demand for and acceptance of industrial, high-quality dependability services will facilitate the development, deployment and maintenance of new or improved applications opening up a wide range of market opportunities.
- With your input you underline the importance of high-dependability as an integral part of new applications thereby improving the day-to-day life of users.

So, independently whether you are a developer or a user of dependability services, by answering this questionnaire you will gain from increased dependability awareness and market opportunities around dependability.

Timelines

The questionnaire closes on October 31, 2007. The responses will be summarised for the Business Impact Analysis, a public deliverable. All respondents are entitled to a free copy of the results report (to be expected around mid 2008).

QUESTIONNAIRE

Name: (not mandatory):

Business activity[2] (developer, business developer, planner, finance, executive, marketing, medic (in ambulance), doctor (at the emergency service of a hospital), other):

…………………………….

Profession[3] (medical, engineering, scientist, telecoms, IT, other):

…………………………….

_.

Please mark your answer, or write down your opinion in full sentences.

1.) Have you heard about the same or similar commercial service offerings before?

Medigate:

Navisave:

2.) If yes, please name some?

---

[2] If applicable please underline your answer.

3.) Is your work focus on services similar to Medigate or Navisave?

……

4.) How would you rank the uniqueness/unimitability of the services as described above?

Please mark one box per application**.**

Medigate	
High	
Medium	
Low	
Not at all	

Navisave	
High	
Medium	
Low	
Not at all	

5.) How do the phrases below reflect your expectations and assumptions on the application quality?

Navisave

	fully agree	agree	disagree
1. I can rely on the Navisave results. (Reliability)			
2. The Navisave results are available when I need them. (availability)			
3. I can trust the Navisave results[4]. (Trustworthiness)			
4. The Navisave service gives me timely guidance (timeliness)			
5. Navisave data is based on all available sources for traffic information.			
6. My expectations are met by existing navigation services already.			
7. Please name (some) navigation services which you feel meet yo expectations as stated:			

[3] If applicable please underline your answer.
[4] E.g. absence of malicious attacks

Medigate

	fully agree	agree	disagree
1. The Medigate service should provide continuous communication between a doctor and an ambulance.			
2. Patient data provided through Medigate should be current and correct.			
3. Medigate data should be secure against malicious attacks			
4. These expectations are met by existing ambulance services already.			
5. Please name existing ambulance services which you feel meet your expectations as stated:			

6.) For the tech whizzes: what kind of dependability functions/features/techniques do you think are necessary to implement the services to fulfil your expectations fully (examples: check-pointing, reliable timers, dependability testing, modelling, dependable development, others)[5]?

……
……
……
……

[5] For more details, you may want to refer to the Hidenets web page under: http://hidenets.aau.dk

7.) What resources (manpower) do you assume will be required to implement the service to fulfil your expectations?

Medigate	
> 100 PY	
40-100 PY	
5-40 PY	
<5 PY	

Navisave	
> 100 PY	
40-100 PY	
5-40 PY	
<5 PY	

8.) What costs do you assume will be required to develop and implement the service to fulfil your expectations?

Medigate	
> 10 Million EUR	
1 Million - 10 Million EUR	
100.000 - 1 Million EUR	
< 100.000 EUR	

Navisave	
> 10 Million EUR	
1 Million - 10 Million EUR	
100.000 - 1 Million EUR	
< 100.000 EUR	

9.) What are acceptable costs from a user's perspective for dependable applications such as Navisave resp. Medigate? Please respond to the following questions.

Medigate

	fully agree	agree	disagree
It is worthwhile investing in applications such as Medigate			

How should increased costs for the medical infrastructure incurred by a service such as Medigate be covered?	Please tick applicable
Increased health insurance	
Increased price for hospital treatment	
Charges for using the ambulance	
Others, please specify:	

Navisave

	fully agree	agree	disagree
Users will pay a higher price for a high quality Navisave service (see also 5.).			
Users expect navigation services to offer the advanced Navisave features at no additional costs.			
How much are customers willing to spend on an advanced navigation service such as Navisave (please guestimate an amount in Dollars or Euros)?			

10.) Acceptance Expectations

Navisave

Market figures show that currently 230 million vehicles are in use in Europe. The yearly growth rate is 2 % including the number of vehicles taken out of service.[6]

How many vehicles equipped with Navisave in percent of the overall number of vehicles would you forecast for the following years starting 2008 assuming Navisave would be available by the end of 2007?

Year 1	Year 2	Year 3	Year 4	Year 5

What in your thinking are the driving factors for Navisave acceptance in the market (governmental regulation, usefulness of service, costs, others, please use own wording if necessary)?

……
……
……

Medigate

According to [7],[8], on average there is one emergency vehicle per 15.000 citizens in Austria. Extrapolating this number to the overall population across the European Community we may assume an installed base of around 20.000 emergency vehicles across Europe.

[6] http://www.acea.be/home_page
[7] „Heuristic Solution of an Extended Double-Coverage Ambulance Location Problem for Austria", Karl F. Doerner, Walter J. Gutjahr, Richard F. Hartl, Michaela Karall, Marc Reimann; in Central European Journal of Operations Research
[8] The AMBULANCE Project, http://www.biomed.ntua.gr/emergency112/ambulance.html

In your view, how many ambulances equipped with Medigate in percent of the overall number of ambulances will be in operation in the following years starting 2008 assuming Medigate would be available by the end of 2007?

Year 1	Year 2	Year 3	Year 4	Year 5

What in your thinking are the driving factors for Medigate acceptance in the market (governmental regulation, usefulness of service, costs, others). What is required to allow Medigate use by emergency services? (Please use own wording):

……
……

11.) Please tell us about your impressions of the HIDENETS project and how (if) you relate to it[9].

……
……
……

Thank you for your time.

[9] If applicable – see also http://hidenets.aau.dk

Annex 3: Results of the questionnaire

Audience characteristics

Profession		
Research	**Technology**	**Industry**
15	7	13

Q1 Have you heard about the same or similar commercial service offerings before?		
Q2 If yes, please name some Car2car applications, ARMAS, use cases in car2car communication, TMC; TomTom, TV shows, …		
Medigate	**Navisave**	**Examples**
17	14	15

Q3 Is your work focus on services similar to Mediate or Navisave?	
No	**Yes**
21	13

Q4 How would you rank the uniqueness/unimitability of the services described above?				
	High	**Medium**	**Low**	**Not at all**
Medigate	14	14	4	1
Navisave	14	14	5	1

Q5 How do the phrases below reflect your expectations and assumptions on the application quality?

Medigate	**Continuous Communic.**	**Data current**	**Data secure**	**Existing services**		
fully agree	20	26	26	1		
agree	14	9	8	3		
disagree	1	0	1	28		
Navisave	**Reliability**	**Availability**	**Trustworthiness**	**Timeliness**	**All sources**	**Existing services**
fully agree	13	11	15	12	8	0
agree	18	22	16	21	17	3
disagree	4	2	5	1	10	31

Question 6: quotes from the responses:

- ✓ dependable real-time adaptation to the environment; checkpointing
- ✓ Medigate: high data reliability, medium availability
- ✓ Navisave: ultra high availability (frequent updates)
- ✓ modelling, redundancy, checkpointing, tunnelling, encryption
- ✓ and many more.

Q7 What resources (Manpower) do you assume will be required to implement the service to fulfil your expectations?				
	>100PY	**40-100PY**	**5-40PY**	**<5PY**
Medigate	10	9	9	0
Navisave	6	15	6	2

Q8 What costs do you assume will be required to develop and implement the service to fulfil your expectations?				
	>€10M	**€1M - €10M**	**€100K - €1M**	**<€100K**
Medigate	12	12	5	0
Navisave	9	15	5	0

Q9 What are acceptable costs from a user's perspective for dependable applications such as Navisave and Medigate						
Medigate	**Invest worthwhile**	**>health insurance**	**>hospital costs**	**>ambulance charges**		

fully agree	15					
agree/	16	17	6	16		
disagree	1					
				Increment/ month		
Navisave	**higher price**	**no additional costs**	**0**	**10-20**	**50**	**>100**
fully agree	4	7				
agree/	21	9	3	15	4	9
disagree	8	16				

Q10 Acceptance expectations (in percent of ambulances resp. cars overall)						
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Medigate	**2**	**4**	**10**	**17**	**25**	
Navisave	**3**	**8**	**17**	**28**	**38**	