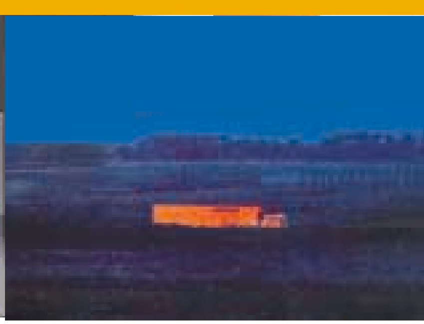
Handbook for fleet managers



TRANSPORT TRANSPORT TELEMATICS APPLICATIONS

COMETA

COMmercial vehicle Electronic and Telematic Architecture

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Introduction

This document describes the guidelines and recommendations for some key potential users of the COMETA system architecture, namely for freight and fleet management. Its subject is the optimisation of the use of on-board systems and their integration in the operator's information system and daily activity.

These guidelines are produced for decision-makers who decide upon the acquisition and implementation of new technologies and require their evolution, and for fleet managers. It is also intended for potential users of data produced, transmitted and processed by the tools that are implemented. This document seeks to present a set of reflections and "references" which will help potential users, in the broadest sense, to correlate their needs with possible ways by which they may be met.

The first chapter describes the COMETA project in general and shows how to find the key results and other relevant information.

The second chapter describes the strategic reasons for investing in ICT. It also demonstrates, through a brief description of a day in the life of a transport company, the application of technologies and their potential impacts.

The third chapter addresses costs/benefits aspects. The most relevant cost elements are mentioned and global indications of cost categories are given for cases where their prices are available and applicable. This is followed by a description of the benefits taking into consideration aspects of administration, safety, quality of service and flexibility.

The fourth chapter focuses on human aspects and describes the drivers' role and the way they perform their tasks in this new environment and, moreover, the difficulties they could meet in appropriating such devices. An overview of the impacts that will be induced by the introduction of new technologies is also given.

Chapter five gives an overview of tools (e.g. technologies) that are currently available to implement the interfaces described in the COMETA system architecture.

Finally, *chapter six* gives guidelines for the successful implementation of an on-board system.

Thus, this document is intended to serve as an "Introduction to the world of on-board systems", dedicated to the popularisation of this concept for a manager who has had neither the time nor the occasion to become familiarised with the different aspects of the concept and their global integration.

1 - What is COMETA?

About the COMETA project

In the coming years, as a result of on-board systems, new information technologies will have a direct impact on the task profiles of drivers and dispatchers. The risk associated with the introduction of new systems stems mainly from problems of interoperability and the ergonomy of on-board systems on trucks, and the multiplication of costs. The COMETA project has been initiated to reply to these concerns by defining and designing modular associations of various functions performed on-board, so as to allow for their interface within a global transport telematics system. This has resulted in on-board information systems architecture.

COMETA on-board architecture

Architecture is a structured way of describing a system with a view to ensuring interoperability between its components. The development of a system architecture starts with the identification of key user needs that must be addressed by the system and that will be rigorously traced across the different views.

COMETA has developed a common architecture for on-board systems in road freight transport. Starting from an extensive survey of transport companies, system manufacturers and policy makers, COMETA has developed three key architectural views:

- A functional and control architecture
- An information and management architecture
- A physical and communication architecture

These architectures have been used as a basis for identifying standardisation requirements as well as compiling a set of recommendations on how the COMETA architecture can be best exploited. These three architectures are described in more detail in appendix1.

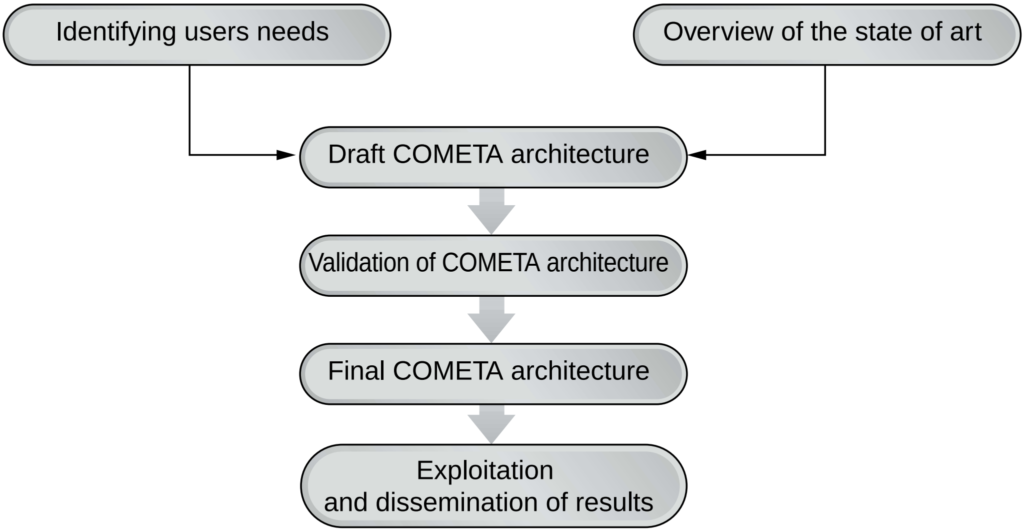
The main objectives

The objective is *to achieve an open system architecture for on-board freight, fleet and cargo management systems with standardised interfaces for Europe-wide applications*. Having explored and identified the possibility of integrating all on-board elements related to the driver/operator's function through an open data interchange system, COMETA subsequently took into account other relevant projects like KAREN (overall system architecture), FLEETMAP (standardising the communication between homebase and vehicle) and national projects concerning mobile EDI.

Methodology of the Project

The COMETA project has lasted two years (1998-2000). The methodology is shown in figure 1.

Figure 1: Methodology of the COMETA project



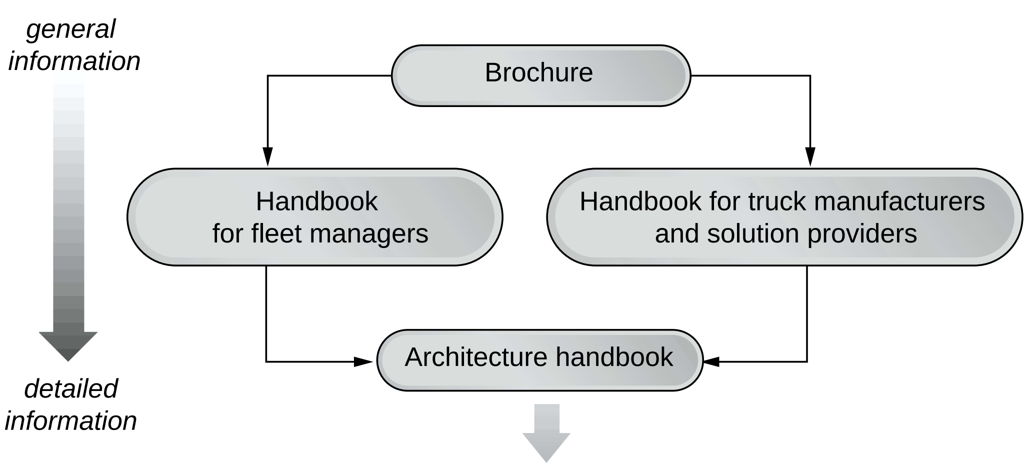
As figure 1 shows, the consortium has carried out the following activities:

• Precise identification of the needs of users through audits and questionnaires;
• Review of existing tools and solutions and their potential for integration;
• Design of COMETA draft architecture and description of the main trends in HMI, software, costs and architecture;
• Construction of national pilots to validate the COMETA draft architecture;
• Production of final COMETA architecture and the provision of guidelines and recommendations to transport companies, truck manufacturers and solution providers, along with the drawing-up of proposals for standardisation;
• Exploitation and dissemination of the key results of the project, these being the COMETA final architecture, an extensive list of user needs and an overview of the state of the art.

Roadmap to COMETA results

The COMETA project has produced a series of results. These results are available through a number of 'products', varying from a global brochure to very detailed deliverables. A roadmap to the COMETA results is shown in figure 2.

Figure 2: Roadmap to COMETA results



COMETA Website (www.cometa-project.com) contains:
• Key results: architecture, user needs, state of the art and standardisation proposals
• All project deliverables/reports

2 - A strategic perspective on ICT investments

In this chapter the strategic reasons for investing in ICT are described from a fleet manager's point of view. Furthermore, an example of a possible day in the life of a driver in the near future is given.

2.1 - Strategic perspective

The transport market, which is the main market for the fleet manager, is highly competitive. This causes pressure on prices and margins. Clients demand more customer service and more detailed information. Increased flexibility is also required to be able to respond to concepts and trends such as JIT (Just In Time) delivery and e-commerce. To remain competitive and to avoid falling behind their rivals, fleet managers must continue to improve their transport activities.

There are several potential solutions available to fleet managers to address the need for continued improvement. One solution is to invest in ICT (Information and Communication Technology) in order to reduce costs, improve the quality of information, send information to the client faster, etc. Another solution, in order to reduce the fixed costs over the year as a whole, is to use chartered drivers in periods where there are peaks in demand. A third solution is optimal use of equipment. This means making better use of the equipment currently available. Of course, a combination of such solutions is also possible.

With respect to ICT, an important aspect is the use of all available information in the system by the fleet manager. All the different components in the transport chain are linked to each other: supply chain, home base and vehicles. The information from these different components needs to be linked and the relevant information needs to be available to the fleet manager.

Linking relevant information from all the different components requires an adequate information system. In order to do this, fleet managers have to deal with a number of difficult issues:

- What do I need/ What do my clients want?
- Which functionality is required?
- What is the migration path from the old to the new situation?
- Which type of integration is required?
- Which functionality should be in the homebase and which functionality belongs to the vehicle?
- What should the information plan look like?
- Which type of hardware and software should be bought?
- Which specific systems should be bought?
- What are the costs and benefits involved?

COMETA is principally concerned with helping to provide answers to questions, such as those given above, in so far as they relate to the in-vehicle part of the overall company information system. It does this in the following ways: helping to make a checklist for the required functionality, helping to make an information plan, giving consideration to human aspects, providing a basis for estimating costs and benefits, and identifying types of technologies.

Specific case: owner-driver.
In COMETA special attention is given to the owner-driver who uses his truck as his office and who requires additional functionality on-board his vehicle.

2.2 - A Day in the life of a driver

Hereafter an illustrative example is presented of the day in the life of a driver in the near future, supported by a range of on-board applications.

Upon reception through EDI from the principal of the transport order (commercial information), the planning and dispatching software, and the dispatcher transform the order into specific tasks, then into task orders to be transmitted to the appropriate vehicle / driver (operational information).

The driver starts his trip by inserting a smart card into the on-board computer and confirms the tasks that have been sent by the dispatcher to the on-board computer. The on-board systems needed for the tasks are automatically checked by the system. All the documents required for transport have previously been sent electronically to the vehicle. The trip and route planning has been done at the homebase and is sent to the vehicle as well. The goods have been loaded according to the loading plan, which has been drawn up at the homebase.

The driver starts his trip to his first destination. For the first part of his route he uses a toll-road. The toll is paid using an electronic payment functionality integrated on-board his vehicle. On his way, the driver also stops at a gas station to refuel. He pays using the same electronic payment functionality. When he reaches the motorway again, the on-board computer has received traffic information indicating that there is a traffic jam 5 kilometres ahead. This message is automatically sent to the homebase, where a new route is calculated, which is then sent immediately to the vehicle. The driver sees the new route on his screen and takes another road, in order to arrive at his destination on time.

Suddenly, the driver sees a warning signal on the display indicating there is a problem with his new Advanced Driver Assistance System (ADAS). At the same time a message is sent to the garage or a third party service provider, including relevant data from the vehicle. After analysing the data a message is sent back to the driver describing how to solve the problem. After carrying out these instructions (and perhaps, unfortunately, having temporarily disconnected the ADAS which usually helps him to drive more safely and smoothly) the driver continues his trip.

During his trip, the on-board system was polled, and possibly weighed, when passing in front of beacons on the infrastructure (connected to the authorities' inspection system), so as to check that there were no infringements of the regulations (weight, driving time, safety status of the vehicle, etc.).

Upon arrival at his destination (aided by a navigation device or simply by a digital map, if this destination is complex and new to the driver), the goods are unloaded from the vehicle. The driver uses a barcode scanner to scan all the unloaded goods. The client uses an electronic signature to sign for the goods. This signature is immediately sent to the homebase in order to create an electronic invoice, which can be sent via EDI to the client.

When the driver arrives at the homebase all the data recorded by the on-board systems is automatically downloaded.

During all of these tasks, (even mandatory rest) the vehicle and driver (and cargo and equipment) could be remotely monitored and positioned.

According to instructions given or on request, the on-board system and/or the driver could trigger and fill in task reports providing the dispatcher (or other partners if agreed upon) with status information.

3 - Costs and benefits related to the implementation of the COMETA architecture

This chapter provides a general overview of the costs and benefits of an on-board system in relation to the current operational environment of a transport company. In arriving at this overview, two COMETA scenarios are outlined and relevant developments in future environments like Internet and the mobile-office are described and compared.

3.1 - Costs

3.1.1 - Description of the two COMETA **scenarios**

The costs of on-board systems are related to the implementation of the COMETA system architecture for commercial vehicles. The following two scenarios will be distinguished (see also figure 3):

- Employee-driver (ED) or Fleet Driver.
- Owner-driver (OD) or Independent or Chartered Driver.

Figure 3: Two COMETA scenarios

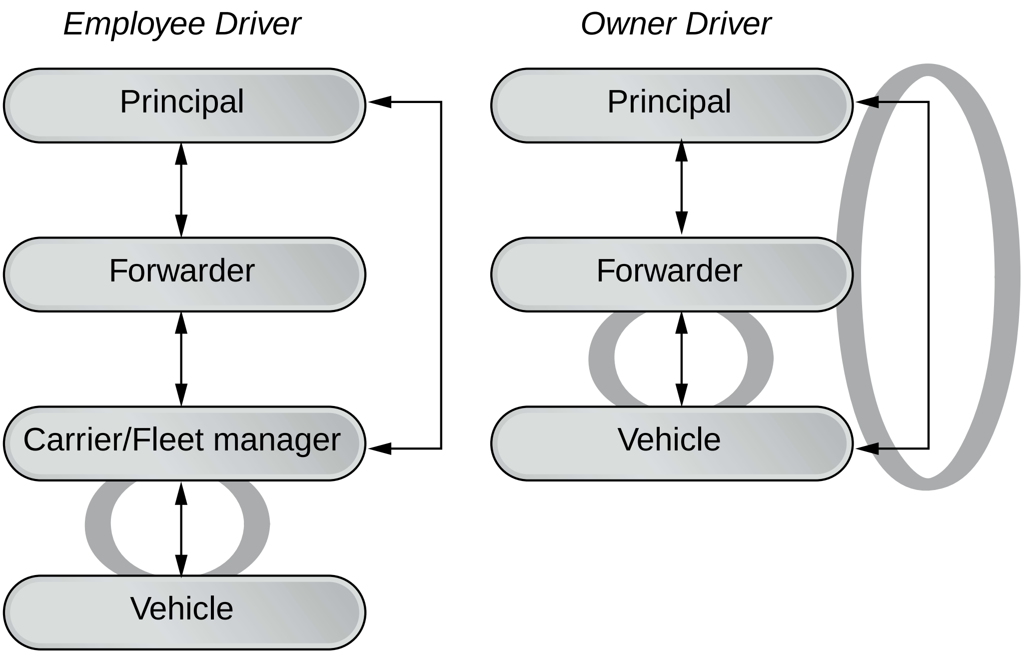


Figure 3 identifies the two basic scenarios. The first scenario (employee-driver) illustrates how a principal can present a transport opportunity to a forwarder, who then forwards it to a transport company. In the second scenario (owner-driver) the order will be directly sent to the on-board computer of an independent driver. In this case the task of the carrier/ fleet-manager is also carried out on-board the vehicle. This will mean higher investment costs, since the on-board equipment has to be able to handle more functionality.

The following cost categories, which will be described in more detail in the following paragraphs, can be distinguished:

- Investment costs for hard- and software
- Installation for hard- and software
- Maintenance costs for hard- and software
- Operational costs (technical, organisational)
- Costs for application software
- Communication costs
- Training costs

3.1.1.1 - Investment costs for hard- and software

The costs for hard- and software are shown in the next table.

1 - Overview of indicative hard and software costs

Tools and medium devices	Per vehicle[1] Price (Euro)
On-board computer	500 - 2000
Peripheral equipment[2]	100 - 2000
Tachograph interface	50 - 100
Navigation systems	1000 - 3000
Location positioning	50 - 150
Mobile communication unit	300 - 3000
Tools and medium devices	**Homebase Price (Euro)**
Mobile data communication hard- and software	1000 - 6000
Freight and fleet management software	2000 - 25000

1 For the OD (owner driver) scenario costs might be higher because of more advanced systems with more functionality
2 Examples: trailers automatic identifier: 150 - 200 Euro ; printer: 700 - 1200 Euro, etc.

3.1.1.2 - Installation costs

Installation costs may vary with the quantity and complexity of the hard- and software to be installed. The time required for installation may vary from half a day to one day, and in both scenarios the installation costs have to be paid.

3.1.1.3 - Maintenance costs

Maintenance costs for hardware are usually 10% of the hardware investment costs per year. For software maintenance, suppliers will often calculate an amount that is twice this percentage because of the complexity of software bugs. A common trend in software maintenance is to include maintenance and new releases in the initial software prices.

3.1.1.4 - Communication and subscription costs

Data communication costs are derived from a combination of the fixed subscription costs and the variable transmission costs. Variable transmission costs will depend on the actual amount of data or number of messages sent and on the type of subscription. Depending on the situation, the chosen subscription should be one giving the lowest overall data communication costs. Since the communication costs vary with the length and the number of messages and, in addition, the network, it is not possible to give detailed cost figures.

3.1.2 - Cost developments

Prospects for future developments of costs of on-board computing are influenced by several developments in the main cost categories of on-board systems: hardware, software and data communication.

Hardware
Rapidly decreasing prices for on-board computers, navigation systems, other systems, data capture devices or peripheral equipment are possible if developments like mass production, increased use in different areas, more competition, and more standardisation persist.

Developments such as increased competition, standardisation, open rather than proprietary systems, increasing functionality, and usage of on-board systems might lead to decreases of 10% in hardware prices per year.

Software
Because of lack of competition, the use of proprietary systems rather than open systems, and the use of tailor-made software instead of 'off-the-shelf' applications, software prices will remain stable.

Communication
With respect to communication, the most likely scenario is that transmission costs will continue to decrease by as much as 20% per year.

Comparing the two scenarios used to develop the physical implementation of the COMETA system architecture for commercial vehicles, the owner-driver requires additional functionality from the on-board systems and/or additional equipment compared to the employee-driver.

3.2 - Benefits

In this section, the benefits deriving from the functions carried out on-board computing systems will be given. Seven types of benefits have been identified:

1 - administrative benefits: some administrative functions will be carried out with appertaining benefits;
2 - safety benefits: the investment in the on-board system will generate benefits in the sphere of security, reliability and safety;
3 - travel (time) savings: the on-board system will enable a truck company to reduce travel costs;
4 - increase in service level/flexibility: a truck company will be able to increase its service level to clients and to employees and to increase its flexibility;
5 - operational benefits for trucks: on-board systems can help to reduce truck operating costs;
6 - information benefits: the on-board computer will be able to record and store all kinds of data;
7 - Miscellaneous benefits: benefits that do not belong to the other categories.

Table 2 gives an overview of the benefits for each category. These are benefits that can be made as a result of the use by drivers of a range of on-board telematic systems, varying from mobile communication to advanced driving assistance applications.

Table 2: Benefits overview

Administrative benefits	
	Shorter response time
	Ability to compare more attractive offers
	Faster invoicing
	Increased electronic document security
Safety benefits	
	Driver can stay in cab
	Improved security/ liability
	Decrease in the number of accidents
	Limitation of consequences in case of emergency
	Less stress
	Cross check possible
Travel (time) saving	
	Less chance of delays/ corrective actions
	Fewer fines
	More liability
	Less driver overtime
	Less mileage/ travel time
Increase in service level flexibility	
	Extra services to the client
	Easier substitution of drivers/ trucks
	Interoperability
Information benefits	
	Faster data
	More reliable data
Truck operational benefits	
	Optimised driving behaviour
	Preventive vehicle maintenance
Miscellaneous benefits	
	Minimisation of communication costs
	Suppression of errors during manual entry
	Improved operations

3.3 - Methodology for evaluation of return on investment

This methodology is based on scenario simulation (without/with), developed and refined with the co-operation of transport companies themselves.

Each activity (for example the functions identified in COMETA) relating to data acquisition and/or data exchange and/or data processing[1] is considered according to its frequency and through a "without/ with" analysis. Thus, for a given relevant scenario based on the use of the on-board tool(s) to be implemented, the specific impact of the new on-board tool(s) can be estimated.

According to each scenario, a number of parameters and variables can be analysed, as shown in table 3.

1 E.g. transport or mission order transmission and related acknowledgement, loading and unloading reporting, consignment and incident data, routine contact, queuing at loading/unloading, changing order, traffic information acquisition, dynamic route planning, etc. (a list of up to 30 different activities is available).

Table 3: parameters and variables to be analysed

A / Can the time wasted by the driver be saved?	- is this time saving consistent enough? - is this time saving potentially workable? - up to how much? - can it be accumulated with others from other scenarios? - in what sort of unit can it be measured? - only comfort (qualitative)? - fewer extra wages? - fewer overall wages (i.e. fewer people needed for the same production)? - additional transport operations? without additional costs with only marginal costs - saved overtime - etc.
B / Can wasted kilometres be avoided?	- direct impact: their marginal cost (up to what %)? - indirect impacts: what kind of "other" kilometres can stand for them (up to what %)? split to be made: - saved kilometres translated into saved time (see A), - saved kilometres translated into efficient ones.
C / Missed transport operations? New transport operations?	- how many could be gained? - potential income/benefit?
D / Better load factor?	- potential for load factor optimisation? - % and value of additional loads? - with or without related charges to be assumed?
E / More valuable freight operations?	- Potential? ... - values? ...
F / Fewer incidents and litigations?	- average cost of an incident? of a litigation? - potential for reductions? ...
G / Time saved by the dispatcher	could it be re-used? - fewer dispatchers will manage the same number of vehicles/drivers and/or operations - same number of dispatchers will manage more vehicles/drivers and/or operations
H / Other saved time	- saved time for people employed in accounting, invoicing, establisment of wages, maintenance planning, . . .
I / Reduction/Increase - in communication costs?	balanced valuation

When all the relevant isolated activities in a given company, with their related "scenarios", have been worked out, an integrated global scenario (linking the chronological occurrences) can be finalised. This can be used to check the relevance of a "new global management profile" for this activity, and to exclude double counting, or, where appropriate, assess new hypothesis, corresponding to B in table 4:
- same activity with reduced fleet and staff,
- staff restructuring,
- reconsidering of activity,
- potential of increased activity/productivity with the same resource level.

The result of the cost calculations and benefit estimates should be brought together in one picture, which represents the annual costs and benefits.

Table 4: Annual costs and benefits

Costs		Benefits	
Depreciation costs	(a1)	Wasted driver time can be saved?	(b1)
Investment costs per year	(a2)	Wasted kilometres can be saved?	(b2)
Interest costs per year	(a3)	Missed transport operations? New transport operations?	(b3)
Installation cost	(a4)	Better load factor?	(b4)
Maintenance costs	(a5)	Better paid freight operations?	(b5)
Communication costs - Subscription - Transmission	 (a6) (a7)	Fewer incidents and litigations?	(b6)
Training costs	(a8)	Saved dispatcher time	(b7)
		Other saved time	(b8)
		Reduction/Increase in communication costs	(b9)
Total annual costs	(A)	Total annual benefits	(B)

Based on the costs and benefits described in this chapter a cost-benefit analysis can be made in order to decide whether or not to invest in a specific on-board system. Table 4 provides an overview of all the costs and benefits that have to be calculated. As many benefits cannot be expressed in monetary terms, a practical solution is to calculate the difference between annual costs and annual benefits from the table, and decide if the remaining benefits are higher than this difference.

4 - Considerations of Human aspects

This section describes relevant issues related to the impact (from a minimum in the employee driver scenario to a maximum in the owner driver scenario) of on-board systems on the human element. In particular the impact on the driver and his communication partners will be considered, and some concerns expressed with respect to the input and output devices in the vehicle.

4.1 - Driver's Tasks

Increased availability and use of electronic devices and systems in the vehicle causes a change in the role of the driver and his tasks, even in the employee driver scenario. In the past the main concern of the driver was with driving the vehicle and only a few on-board systems were needed to carry out his task.

Nowadays, and in the coming future, the driver is also required to be able to use the available on-board systems in order to carry out his tasks. Understanding of the use of on-board systems is necessary to communicate with the home base and other parties, and to send, process and receive information. Using these systems is becoming an essential part of the driver's tasks. The driver needs to be able to use these systems himself and therefore becomes more independent from the home base. And, at the same time, greater responsibilities are given to the driver.

4.2 - Driver's concerns

The following items show the driver's point of view, based on a survey carried out during the first COMETA phase. There are some insights into the support and/or resistance and conditions for approval when implementing in-board systems.

If driver support for the vocal mobile telephone is unreserved, there is also strong support for an on-board communication tool in data transmission mode. Drivers clearly understand that the integration of tools for automatic identification and entry, EDI or pre-formatted messages, or automatic feedback of tachograph and tracking data will (also) simplify their tasks, and enhance working conditions.

Contrary to a widespread notion, drivers are not by any means opposed to itineraries being communicated (or even imposed), particularly if such itineraries are visualised on a digital map on screen, which shows the position of the vehicle, traffic disturbances and an alternative itinerary. If on top of that, the on-board system can determine the time remaining before arrival at the destination, taking into account statutory break (and rest) periods in compliance with legal provisions, the approval ratings of the tools soar.

The communication system must be open, particularly to allow exchanges with family and relatives, ideally in vocal mode, but even in data transmission mode (E-mail), which would also allow the driver to communicate directly with consignors, consignees and principals. The approval rate is even higher if the system could provide user-friendly pre-formatted or mobile EDI messages and/or electronic documents, which can be filled in (almost) automatically.

There is also widespread support for displaying tachograph data on-board, with notice of (driving) deadlines and of time still available, as well as, generally speaking, malfunction alarms. The same goes for the prospect of tachograph data being verified by the authorities without having to stop the vehicle. Lastly, all driving aids are approved, as well as any tool contributing to safety.

Globally, drivers feel that although the integration of such tools will not give them greater freedom or more responsibility, they will nonetheless reduce the risk of error, enhance working conditions, increase safety, and reinstate the use of their rest time.

4.3 - Input and output techniques

The physical interface (screen, keyboard, etc) between the driver and the on-board system is of the utmost importance. Some aspects are mentioned below.

■ Speech recognition (input)
For drivers that have to keep their attention on the road ahead, identifying the drawbacks of speech recognition might not be as easy as describing the benefits. Mobile settings are, however, often a bit noisy and voice recognition systems in service today are not equipped to handle interference noise and are easily disturbed and may lead to the users instructions being misinterpreted.

■ Keyboard and mouse (input)
A standard keyboard and mouse are not types of input devices that are suitable for a mobile environment. The user might associate the on-board system with different types of systems as appeared to be the case in a Swedish study in 1998. The users, in this case truck drivers, did not like using the on-board system because they thought of it as a computer which they regarded as something used by office workers and not part of a truck driver's job.

■ Screens (output)
The use of screens in a car or truck, similar to our case, requires that the vehicle is either stationary or driving very slowly in order to let the driver's attention move from driving to the screen without any risk of accident. Using the screen while driving should be prevented by the system set-up rather than by regulations.

■ Sound (output)
The car/truck is an environment that is already prepared for voice output since almost every single unit has speakers. The voice output reads menus, texts, emails and much more at the request of the user. It sounds futuristic but it is already in use in many prototype cars and systems.

4.4 - Driver's working conditions

■ Overall feeling
In general, drivers feel that the new tools bring them more comfort in the execution of their duties, reducing both stress and wasted time.

■ Comfort, time saving and task control:
The use of on-board equipment would give drivers more freedom and autonomy and, as a consequence, they would be more independent of dispatchers. The only negative effect is related to the "Big Brother effect". Finally, due to the asynchronous transfer mode which allows messages to be forwarded to the home base even when the dispatcher is not available (at night for instance), the drivers feel a significant improvement.

■ Reduction of stress:
There is a unanimous appreciation at the driver's level concerning the wide reduction in stress. Doubts are eliminated, uncertainties are reduced and as a consequence drivers are less likely to infringe rules (speed limits) and/or regulations dealing with driving and rest times.

■ Driving and safety:
A great improvement in safety has been noted when a communication link uses a written form (data information exchanges) instead of a radiotelephone. As messages received can be memorised within the system, data communication avoids stopping the car to write down information from the dispatcher or to memorise it by heart.

The only constraint, which is mainly a point of safety, is to prevent drivers getting the messages when driving. By using warnings (low to high), the driver is informed of the reception of a new message and consequently either stops his vehicle or is provided with voice messages.

■ Task contents and changing procedures:
Following the introduction of a new tool, the driver's task contents are duly modified. In practice, the process still consists of exchanging information, but operational procedures will be reorganised.

■ Added value:
The simple allocation of equipment to a driver is for the time being perceived as a status symbol.

4.5 - Dispatcher/Planner working conditions

The dispatcher is the nodal point in the transport information system, at least with regard to the interface with the mobile unit (driver/vehicle). He or she is the person who receives transport orders from customers or from the sales department, who processes these orders, matches demand and supply on an optimum basis, allocates the drivers, and then transmits the orders and instructions to the drivers. At the dispatcher's level, the added value applies more to the company (in terms of marketing approach) as a whole, than to the dispatcher.

■ General feeling:
The new tools at the dispatcher's level contribute to reducing stress, saving time, providing real comfort in task execution, giving reliable information about position, and minimising uncertainties. It also increases the dispatcher's responsibilities and job interest. Users foresee that they will operate in an optimal situation and expect that working conditions will improve and the quality of work will increase.

■ Comfort, time saving and task control:
Dispatchers appreciate the permanent access to equipped drivers because uncertainty, due to waiting for driver calls, disappears. There is real improvement for the operations management as vehicle allocation is more reliable and more relationships with the principal and real-time status reports exist.

■ Reduction of stress:
According to the dispatchers, one of the main reasons for the decrease of stress lies in the possibility of giving a delayed answer to a driver. Another reason consists of the tracking and tracing functions which are now a reality and which allow dispatchers to answer to questions from the consignor and consignee in real-time. It contributes to reducing stress and offers a better quality of service to partners.

■ Tasks content, occupation profile and changes to procedures:
Changes to the dispatcher's tasks can occur, depending on which tools are introduced. These can go from modifying the structure of the dispatcher's occupation profile towards increased qualification. Training and experience must be considered as real added value considering that the knowledge gathered will give more value to the employee and this will require a new definition of the workstation.

■ Added value:
On the one hand, the strengths and advantages of the system can be promoted during contacts with customers and on the other hand, a dispatcher will be enabled to manage more drivers simultaneously.

4.6 - Human Machine interface aspects

Based on the user needs list, resulting from user audits and surveys undertaken in the first phase of the COMETA project, an overview of the user needs related to Human Machine Interface (HMI) aspects can be given:

- Under the general statement "System must be user-friendly and safe", the first requirements are that most data acquisition be performed automatically, that the driver has preformatted, easily accessible, messages ready, and that driver interventions filling in the forms be minimised.

- The information, which the driver must read or manage, could be presented on two screens. The first screen must be large enough for the driver to see a digital map with clearly readable place and road names. A more advanced alternative would be for the most important names only to appear in "normal" mode, with the detailed site or street names appearing only on request. The screen corresponding to text or map visualisation should be located on the dashboard in front of the driver, on the dashboard in front of the passenger seat (turned towards the driver) or on the sunscreen level. The brightness of these screens should be adjustable, and even automatically reduced when the screen is not in use.

- A screen dedicated to tachograph and alarm data could be placed in the middle of the steering wheel, bearing in mind that alarms must be accompanied by a visual (blinking) and audible signal. Incoming messages must also set off a signal (the volume of which must be adjustable) which will stop only if the driver takes some action (reading the message or de-activating which will leave only the visual signal). In an advanced situation, a computer-generated voice will announce incoming messages and alarms, above and beyond their visual presentation. The driver will be able to trigger announcements of incoming messages by means of a push button located in the steering wheel, making it possible for the driver to react without taking his hands off the steering wheel.

• The keyboard controlling the communication and on-board screen management functions (use of the on-board applications) must be locked[1] (lock based on wheel movement or on the accelerator) or equipped with a cover, which opens only when the vehicle is stopped.

• The screens linked to reversing cameras are dedicated and located high up on both sides of the cabin.

• Information and communication systems of every kind which are installed in commercial vehicles, should not require two-handed operation, even for a moment, nor should they require the driver to give time-critical answers and reactions. Moreover, they should not require visual attention from the driver, which must be reduced to a minimum during the trip. This implies that information and communication systems should be installed in a place where the requirement for the driver to turn his eyes away from what is happening on the road is as small as possible.

• The primary driving task must be managed by the driver on his own at all times. Thus, the on-board system, by the appropriate usage of information technology facilities, must not lead to an operationally insecure vehicle, even in the event of a partial or total breakdown of the on-board system.

• The on-board system must not lead to a disturbance of other on-board system functions or of the vehicle itself.

• The on-board system should avoid long repetitive sequences of actions and present information to the driver in time and in appropriate portions, i.e. route guidance information should be presented sufficiently in advance so as to give the driver the time to react accordingly.

• The operating instructions should include an explanation about potential dangers and system limitations, as well as a note saying that vehicle information systems should only be used if they do not represent a risk for safe operation.

• Operating instructions shall be presented in a way that gives the future user the possibility to learn through practical use.

• Inputs using the keyboard should be reduced to a minimum during the trip, or it should be ensured that they could only be entered when the vehicle is not in motion. Or, alternatively, use should be made of no-hand systems, i.e. including facilities operated by voice commands instead of manual ones.

1 - this explains the importance of fonction buttons located in the steering wheel, for tachograph data, alarms, and possibly map visualisation

5 - Considerations of Technical elements

5.1 - Main physical units

An on-board system can be divided into the following main units:

- On-board computer
- Peripheral equipment (different types of peripheral equipment like printer, keyboard, display, warning system, etc.)
- Data capture devices (digital tachograph, barcode reader, weighing devices, smart cards read/write devices, etc)
- Communication devices (external communication units, like mobile voice and data communication equipment, internal communication busses, RDS-TMC receivers etc.)
- Navigation systems (connected to a location positioning device like GPS)
- Positioning devices (like GPS, GNSS, etc.)
- Sensors (like engine sensors, anti-theft sensors, cargo sensors, etc.)
- Other systems (like cameras, radar detection systems, etc)

In Appendix 2, an overview is given of the key technologies to be used to implement a COMETA-based system.

5.2 - Potential problems and risks

Apart from potential benefits, investment in and use of on-board systems may also be associated with potential problems and risks:

- One risk is the saturation of the mobile data network. Due to new services, the mobile phone network will need more and more capacity.

- There is a lack of information on future communication systems. Thus, investments undertaken now, could become technically outdated in only a few years.

- Investments could even only be a minor part of the overall cost to be faced by transport operators using ITS when compared to information system re-engineering, subscriptions, training of employees, etc.

- The short-term risk is that a system developed on COMETA system architecture, which is supposed to meet the requirements of a one-man company, cannot be afforded by this target group due to the still rather high price.

- Another potential risk is the "Big Brother syndrome" for users through the use of more on-board systems. The system will allow the activity of drivers to be controlled. It is important to explain the positive effects of the use of these systems to drivers, in order to avoid strikes and social conflicts.

- The same risks apply for any other standard information network. It is considered to be more a problem of industrial culture and of laws than of technical possibilities.

- These systems should not threaten driving safety.

- Risks related to system architectures, such as the one developed by COMETA could increase managers' fear of taking strategic decisions in a fast moving environment.

- A multiple protocol, cheap and user friendly, with easy updating processes and an EDI translator, should be developed. It should not only be a technical translator, but also a language translator to allow a transport operator to widen its potential partnerships.

- Mobile EDI is not a standard for the time being and it is arguable whether transport companies all over Europe would like to extend the usage of EDIFACT to the mobile part of the information chain.

5.3 - Conclusion about technical elements

In this chapter an overview has been given of the main components of an on-board system. Some of the problems and risks that relate to the implementation of these systems have been described (e.g. integration problems, compatibility problems, lack of standards, etc). These problems and risks have been described so as to explain the implications related to the choice of a specific on-board system.

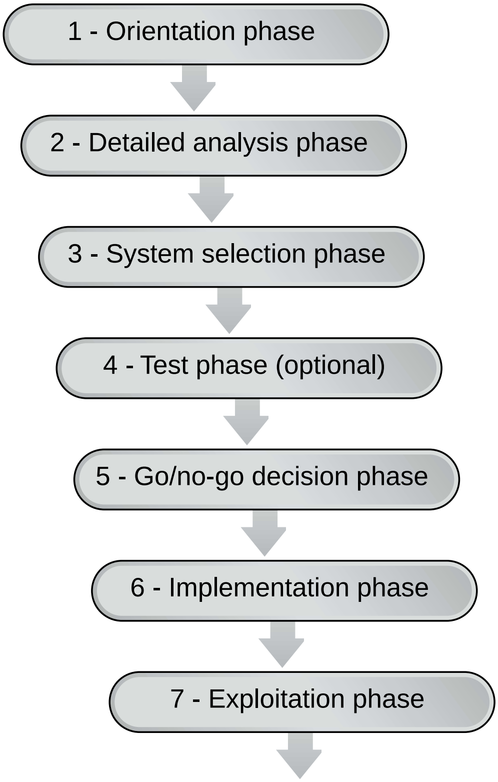
6 - Conditions and steps for successful implementation of on-board computer systems

Introducing on-board systems is a complex operation and has a great impact on an organisation. It means replacing manual activities by automated ones. It is necessary to introduce into the company the concept of information to be regarded as an "industrial end product" and applying to it to all business management principles. It is, therefore, advisable to set up a project team for the introduction of the on-board system. In most cases, a pilot scheme with the new system will also have to be organised. All the employees need to be associated with the definition and implementation of this new operating mode. It should be clear that the objective is not to increase the monitoring of employees or to reduce their roles, but to take collective advantage of more transparent procedures.

6.1 - Phases for successful implementation

Successful implementation consists of the seven important phases as shown in figure 4.

Figure 4: Implementation phases



6.1.1 - Orientation phase

First, the company has to decide whether or not introducing an on-board system is beneficial and advantageous for the company. Secondly, a general description has to be given of the goals of introducing an on-board system. If the company decides to continue the process, then a more detailed analysis should be carried out.

6.1.2 - Detailed analysis phase

First, all functions and procedures involving the driver/vehicle pair should be laid down. A more detailed description of the functions and the related systems required has to be made. After that, a functional specification of the on-board system has to be made. This should describe in detail the required functionality from the required system. Another important action is to make a list of performance criteria, including items like response time, reliability, security, flexibility, maintenance, user-friendliness, etc. All this information has to be combined to build the terms of reference for the on-board system(s) before it can be sent to the solution providers. Technically, it is advisable to target an optimum of automation and integration of on-board and home based applications. This means that one should be reasonable when selecting between what is worth an EDP and what should remain human (assisted) procedures.

6.1.3 - System selection phase

Following the terms of reference, a shortlist should be established of potential solution providers who could offer the required functionality. The offers should be compared and -if needed- professional consultants can be hired for complete guidance during system selection and possibly implementation or other phases. Clear agreements with the selected solution provider have to be made. One should refer to, and if needed participate in, on-going standardisation in this field. Very important is that one should be very demanding and critical of solution providers as regarding the degree of openness, integration, but also the flexibility of their offer.

After this, several possibilities are to be considered:

1 - One system is selected and will be installed directly. There is no test phase, a "go" decision is made and the implementation phase will start immediately.
2 - After the selection there will be a pilot with one system. If the pilot runs well, a "go" decision will be taken. Otherwise, a definite "no-go", or a temporary "no-go" decision will be taken.
3 - After the selection, there will be a pilot with two competitive systems. Based on the outcome of the pilots, one system will be chosen.

6.1.4 - Test phase (optional)

In this phase the on-board system will be tested by using a test plan.

6.1.5 - Go/no-go decision phase

In this phase, the go/no-go decision has to be made. This means deciding whether or not to invest in such a system considering the short, medium and long term. It should be noted that the decision should be taken not only at the economic level, performing a return on investment simulation as shown in § 3.3, but also taking into account competitive fields.

6.1.6 - Implementation phase

The implementation of on-board systems can be very complicated, depending on the complexity of the organisation, the configuration and the requirements of the introduced on-board system with regard to already implemented tools.

6.1.7 - Exploitation phase

Once the on-board system is successfully installed and in use, certain aspects need to be monitored in order to make sure the system continues to function properly in the future.

Appendix 1

The COMETA architecture consists of three key architectural views:

- A functional and control architecture
- An information and management architecture
- A physical and communication architecture

These three architectural views will be described here in more detail. A complete description of the COMETA architecture can be found in the available documents at the COMETA website, as indicated in the "roadmap to COMETA results" in chapter 1.

Functional and control architecture

Based on the user needs analysis, the main functionality to be supported on-board were identified as follows:

- Manage business transactions
  - Negotiate transport orders
  - Administrate business transactions
- Prepare vehicle, driver, equipment and cargo
  - Prepare resources (prepare documents, prepare vehicle, prepare driver, prepare cargo space, prepare equipment, prepare accessories, prepare other transport modes)
  - Prepare trips, routes and load plans (ask for a new task order, process and read a new task order, check client profile and constraints, prepare trip/routes, prepare load plan)
- Perform and control vehicle, driver, cargo and equipment operations
  - Manage tasks and transport orders (manage tasks and transport order contents and modifications, check whether cargo and or equipment conforms to transport order, create a new transport unit)
  - Comply with regulations (comply with social regulations, comply with other regulations)
  - Provide advanced driver assistance (provide visual support, provide longitudinal control, provide lateral control, provide automated driving support, miscellaneous telematics functions)
  - Provide access to comfort services
  - Manage traffic and route guidance information
  - Support payment operations (perform EFC transactions, support billing services)
  - Monitor vehicle (monitor vehicle position, monitor vehicle status and operation)
  - Monitor driver (monitor social regulations status, monitor physical status, monitor driver expenses, monitor driving behaviour)
  - Monitor cargo
  - Monitor equipment (monitor equipment position, monitor equipment status)
  - Monitor progress of tasks (monitor and report on operational task, monitor and provide proof of execution of transport order)
  - Manage emergency calls

These processes as well as the relevant information and control flows between them were described and documented in the form of diagrams for easy reference.

Information and management architecture

To keep the diagrams describing the functional and control architecture as simple as possible, only one database was used: the Vehicle, Driver, Cargo and Equipment database. This was done, because the focus of functional and control architecture lies not primarily on the data, but more on the processes. Therefore information and management architecture is needed to complement the functional and control architecture. By definition, information architecture describes the data needed by an Information Technology System (ITS) and the interrelationships between the different data-blocks. Generally, for large quantities of data a database is utilised to store all the information. In these cases (like for COMETA) the information architecture describes the structure of the database using (for example) entity relationship diagrams.
As the central part of the information architecture, the entities of this common database were described in a data dictionary. An entity-relation diagram was used to visualise the entities and the nature of the relationships between them. These entities are building blocks for establishing an on-board database.

The key entities in the COMETA information architecture are:

- Driver
- Vehicle
- Accessory
- Equipment
- Cargo
- Task order
- Task
- Task report
- Route
- Road segment
- Landmark
- Principal (Forwarder)/Consignor/Consignee
- Transport order
- Transport order status
- Offer (quotation)
- Invoice
- Load plan

In cases where a database comes under the management of different applications, the responsibility for the availability and accuracy of the entire system database must be defined. This is the task of management architecture.
As part of the management architecture, the different entities described in the information architecture are grouped into information clusters, according to their use. The data access modalities (reading and writing access) for the functions described in the functional and control architecture are given in a table and the life cycle of the information is described.

Physical and communication architecture

The physical and communication architecture distinguishes between the following subsystems:

- The driver's task management subsystem: supports execution, monitoring, reporting of tasks required from a driver by his fleet manager or directly by another partner
- The vehicle monitoring and control subsystem: provides internal support to the driver, automatically or on request, in order to prepare, execute, monitor and report on any operation; this subsystem also groups different modules supporting driver control, vehicle operations and control as well as cargo control
- Five other associated subsystems including traffic information and route guidance, advanced driver assistance, payment, digital tachograph and autonomous equipment

In the medium to long term, COMETA expects these systems will be fully integrated.

Appendix 2

To support the development of a COMETA-based system, a technical toolbox containing physical and communication 'tools' has been developed. In this appendix, the results of this operation are presented according to:

- communication technologies
- positioning systems
- portable storage media
- other tools.

Communication technologies

Protocols standards and visions

WAP
The Wireless Application Protocol (WAP) is an open, global specification that empowers mobile users with wireless devices to easily access and interact with information and services instantly.

IMT2000 and the UMTS concept
The ITU (International Telecommunication Union) has defined the requirements for the 3rd generation of mobile systems in the framework of the IMT2000 (International Mobile Telecommunication) and its predecessor the FPLMTS (Future Public Land and Mobile System).

FAP
The FAP (Fleet Application Protocol) is an open interface for home-based fleet related applications, supporting provider independent, modular, interoperable and extendable solutions for fleet managers.

Mobile EDI
This proposal is a second attempt in the design and submission of an appropriate standard devoted to covering the 'mobile' part of the road freight transport information chain, already using EDIFACT messages between partners.

Traffic information services

DAB

DAB (Digital Audio Broadcast) is a technology that was developed within the EUREKA 147 project. Originally it was planned as an audio-broadcast system, but as a multimedia tool, it is more and more used for data-broadcast purposes.

RDS/TMC

RDS-TMC ('Radio Data System - Traffic Message Channel') is a system of collection, collation and broadcasting of traffic-related data according to a European standard.

Short-range wired connectivity

USB

This communication interface represents a new connection standard agreed by different prominent industry players like Microsoft, Intel and Compaq. The USB (Universal Serial Bus) will functionally replace the parallel and the standard serial interface (RS232).

FireWire (IEEE 1394)

The FireWire is an Apple Computer version of a new standard, IEEE 1394 High Performance Serial Bus, to connect devices to a personal computer.
IEEE 1394 implementations are expected to replace and consolidate the standard serial and parallel interfaces, including Centronic parallel, RS232-C and SCSI.

CardBus (PCMCIA)

The Personal Computer Memory Card International Association (PCMCIA) was established in 1991 to standardise a particular form of add-in cards for mobile computers.

RS232

RS stands for Recommended Standards for serial communications. Nevertheless the RS232 is more an industry default than a standard. Fortunately, this standard (like the RS485) has been widely used for implementations and has become fairly consistent.

Medium and long-range wired connectivity

CAN

CAN stands for Controller Area Network and was originally developed by Bosch for applications in the automotive industry. Because of the large availability of CAN controllers from several manufacturers, CAN is being used more and more in other industrial applications.

RS485

RS stands for Recommended Standards for serial communications. Nevertheless the RS485 is more an industry default than a standard. Fortunately, this standard (like the RS232) has been widely used for implementations and has become fairly consistent.

Short-range wireless connectivity

IrDA

The Infrared Data Association is an international organisation that was founded in 1993 to create and promote interoperable, low cost infrared data interconnection standards that support a point-to-point user model.

BLUETOOTH

The Bluetooth technology is a result of co-operation between the leaders in the telecommunications and computer industries. It is a proposed radio frequency (RF) specification for short-range, point-to-multiple-point voice and data transfer.

DSRC

Dedicated Short Range Communication provides a means of communicating between vehicles and road beacons. This technology which has been developed to support Electronic Fee Collection is today stabilised at the normative level.

Medium and long-ranged wireless connectivity

Satellite

INMARSAT

Founded in 1979 to support the maritime industry by means of satellite communications, INMARSAT (INternational MARitime SATellite organisation) began service in 1982. Currently INMARSAT has expanded its functions into land, mobile and aeronautical and operates a global satellite system used by independent service providers to offer an extensive range of voice and multimedia communications.

ORBCOMM

The ORBCOMM system offers global wireless data and messaging communications services. The system is based on the LEO satellites (LEO: Low Earth Orbiting) constellation to provide worldwide geographic coverage.

EUTELTRACS

Launched in Europe in 1992 by EUTELSAT (the network operator of EUTELTRACS in Europe) and ALCATEL QUALCOMM (the joint venture between QUALCOMM, the American system developer and ALCATEL, the European manufacturer of telecommunication systems), EUTELTRACS is the leading two way mobile communications and vehicle positioning system via satellite dedicated to the transportation business and especially to enhancing the productivity of fleet management.

Terrestrial

GSM

GSM (Global System for Mobile communications), a digital cellular phone technology based on TDMA that is widely deployed in Europe and throughout the world and beyond voice communication offers data and SMS services.

Mobitex

Mobitex is intended for data communication from, to and between mobile units. The network is a nation-wide network of independent components such as base radio stations and area exchanges.

Trunked radio

Among the manufacturers of trunked radio systems are renowned companies such as Alcatel, Bosch/Ascom, Ericsson, Motorola, Nokia, Kenwood and Philips. The providers of these systems are manifold; many telecom companies provide trunked radio services.

TETRA

Trans European Trunked RAdio (TETRA) is a European standard for digital trunked radio that is primarily designed to meet the requirements of the emergency services.

Positioning systems

On-board positioning is acquired by dedicated satellite systems, which send continuous signals to the surface, enabling a receiver to calculate its position.

NAVSTAR GPS
The NAVSTAR Global Positioning System (GPS) is made up of twenty-four satellites, which orbit around the earth. Launched and maintained by the US Department of Defence (DoD).

GLONASS
GLONASS (GLobal Orbiting NAvigation Satellite System) is a Russian constellation of 24 satellites placed in three orbital planes at an altitude of about 25000 km.

GNSS/GALILEO
The European community supports the Global Navigation Satellite System (GNSS), a high precision worldwide navigation and timing system that is not under the sole control of the U.S. government. GNSS will be a global navigation satellite system under civil control. It will consist of 21 or more satellites. According to current planning, GNSS will be fully operational in 2008 at the latest, with signal transmission starting in 2005.

Portable storage media

Radio tag
Also called a transponder, a radio tag allows for the storage of anything from only a few bytes to be used as a simple identifier, up to a complete description or a message related to the unit it is attached to (vehicle, trailer, container, . . .). The information is read (the radio tag may be active or passive to be activated) when passing a beacon at short distance, using high frequency radio. Most recent solutions allow for writing in addition to reading.

PCMCIA PC-cards
PC-Cards are small, credit card sized storage devices. They are used in many portable devices.

Ibuttons
Ibuttons is a 16-mm computer chip, which is Java powered. This can be used for the storage of identification information and other information needing less storage.

Sony's memory stick
Memory Stick:16MB Storage Capacity Ultra-Small, Thin Design Erasure Prevention Switch 10 Pin Connector for High Reliability. It has 20mHZ Clock Speed, 1.5MB/sec Write Speed and 2.45MB/sec Read Speed.

IBM micro drive
This is a very small hard drive with a capacity of either 340 Mb or 170 Mb.

Other tools

Electronic signature processing
Several methods can be used to sign documents electronically from simple ones (scanned images of a hand-written signature in a word processing document) to advanced ones (digital signatures using public-key cryptography).

1 - For the OD (owner driver) scenario costs might be higher because of more advanced systems with more functionality

2 - Examples: trailer automatic identifier: 150 – 200 Euro; printer: 700 – 1200 Euro; etc.

3 - E.g. transport or mission order transmission and related acknowledgement, loading and unloading reporting, consignment and incident data, routine contact, queuing at loading/unloading, changing order, traffic information acquisition and transmission, dynamic route planning, etc. (a list of up to 30 different activities is available).

4 - this explains the importance of function buttons located in the steering wheel, for tachograph data, alarms, and possibly map visualisation.

Cometa deliverables

The following deliverables can be found on COMETA website :
http://www.cometa-project.com

D1.1 Framework report

D1.2 Final report

D2 On-bord systems integrated architecture(s), identification and evaluation of present and future expectable users requirements.

D3 State-of-the-art and short-term perspectives in on-board systems for commercial vehicles.

D4 Predesign of on-board system architecture(s) for commercial vehicles.

D5.1 Review methodology

D5.2 Result of on-board system architecture simulation : results of simulations of a pre-design of COMETA on-board systems integrated architecture(s) by pilots (fleet operators).

D.6.1 Commercial vehicles on-board systems integrated architecture(s) specifications.

D.6.2 Harmonisation and standardisation addressing on-board systems integrated architecture(s) specifications.

D.6.3 Guidelines and recommendations for integrated freight fleet management involving on-board systems integrated architecture(s) specifications.

D.6.4 Guidelines and recommendations for trucks manufacturers and solutions providers regarding on-board systems integrated architecture(s) specifications.

D.7.1 Brochure summarising results and recommendations.

D.7.2 Formalisation of results of standardisations to users, recommendations to solutions providers.

Brochure prepared by AFT - IFTIM - IPTL
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