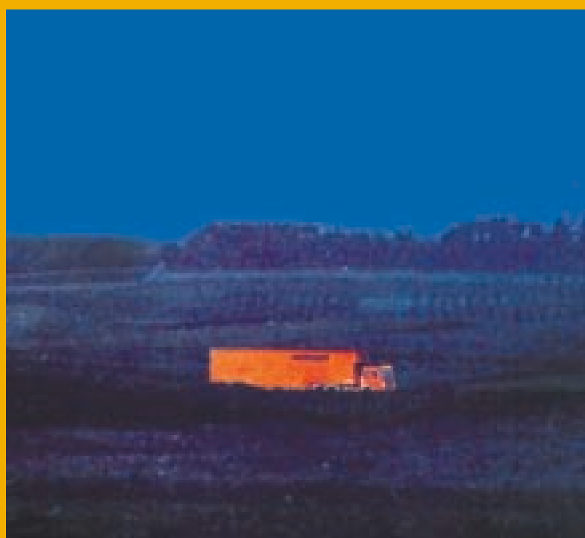
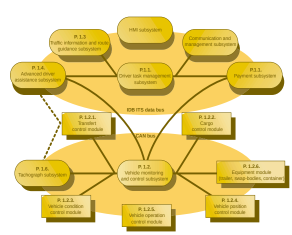
Handbook for truck manufacturers and solution providers





TRANSPORT TRANSPORT TELEMATICS APPLICATIONS

COMETA

COMmercial vehicle Electronic and Telematic Architecture

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1 - INTRODUCTION

Over the last few years on-board systems technology for commercial vehicles has been rapidly developing. Automatic vehicle location, mobile communications and computers have provided fleet managers with the means to control and monitor their fleets effectively. With positioning/navigation systems, on-board communications, on-board computers, and a wide variety of monitoring systems/devices, fleet managers and drivers have access to a big amount of information and have the opportunity of improving the performances of their companies.
To date, trucking companies can choose from hundreds of different on-board telematics applications; most of these systems have their own computer chip, their own input device, their own display, their own method of storing information and their own software.

Furthermore, as widely verified in the COMETA project, further proliferation of on-board telematics systems is expected in the coming years. Some of these applications will be requested by commercial fleet operators, while others might be imposed by (supra) national governments. Some will be required to incorporate multimodal functionality, some to allow for infrastructures and traffic management. Moreover, shippers may also request them to be used by goods carriers.

Given all of these interested parties, as well as the individual interests of telematics suppliers, who each have their own product market standards, and truck manufacturers who have to host the whole devices on-board, there is a real danger of incompatible and/or overlapping on-board systems.
In particular the risk of such proliferation mainly concerns problems of compatibility and ergonomics of on-board equipment on vehicles, and of course the risk of costs multiplication.

This report provides guidelines and recommendations for truck manufacturers and system/solution providers in the field of on-board telematics for commercial vehicles. It is designed to help these two main actors to be close to the market and to meet the users needs. In particular truck manufacturers and system/solution providers should read this handbook because the document:
gives the results of the users needs analysis carried out within COMETA together with some HMI aspects description;
describes the COMETA system architecture (functional and control, physical and communication, information and management architecture) and the key scenarios to which it is related (a "maximal one" corresponding to the hypothesis of "mobile office" for independent or chartered drivers, and a "minimal" one corresponding to large fleet drivers behaviour; gives some useful descriptions of the relationships between the electronic tachograph and the on-board computer;
synthesises the main issues related to the debate "fixed versus handheld OBCs";

introduces some interesting information about the transparency in data exchange and the standardisation matters.

Chapter 2 describes the COMETA project in general and shows how to find the key results and other relevant information.

Chapter 3 describes the results of the user needs analysis carried out within COMETA.

Chapter 4 gives a brief description of the functional, physical, information & communication architecture developed in the context of COMETA.

Chapter 5 provides a description of the actual status of the telematics market for commercial vehicles, based on a survey carried out within COMETA at the European level involving 55 systems.

Chapter 6 and chapter 7 are devoted to the future trends in the field of in-vehicle telematics for commercial vehicles. They give a description of some technologies whose recent and future evolution is likely to be of major importance for the development of the telematics systems for commercial vehicles as well as a list of indications of where the industry and market are headed in the coming years. The main key-drivers described in these chapters intend to give the tools for understanding the future possible scenarios, that is how the telematics commercial vehicle will evolve in the near future.

Chapter 8 finally gives some synthetic general recommendation to truck manufacturers and system/ solution providers.

2 - WHAT IS COMETA ?

About the COMETA project

In the coming years, as the 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 stem mainly from problems of interoperability and ergonomics of on-board systems on trucks, and the multiplication of costs. The COMETA project has been initiated to answer these concerns by defining and designing modular associations of various on-board performed functions so as to allow for their interface within a global transport telematic system. This has resulted in an on-board information systems architecture.

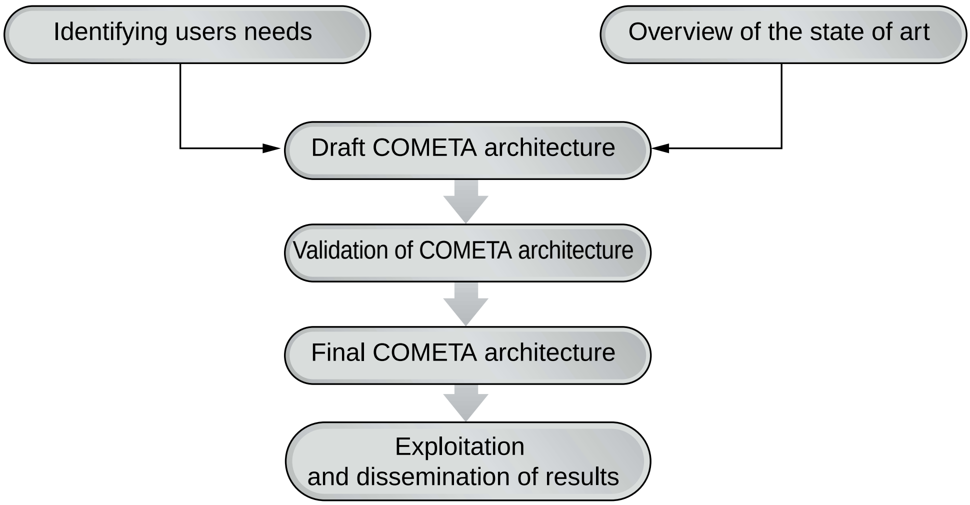
The main objectives

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 been undertaken over for two years (1998-2000). The methodology is shown in figure 1.

Figure 1: Methodology of the COMETA project



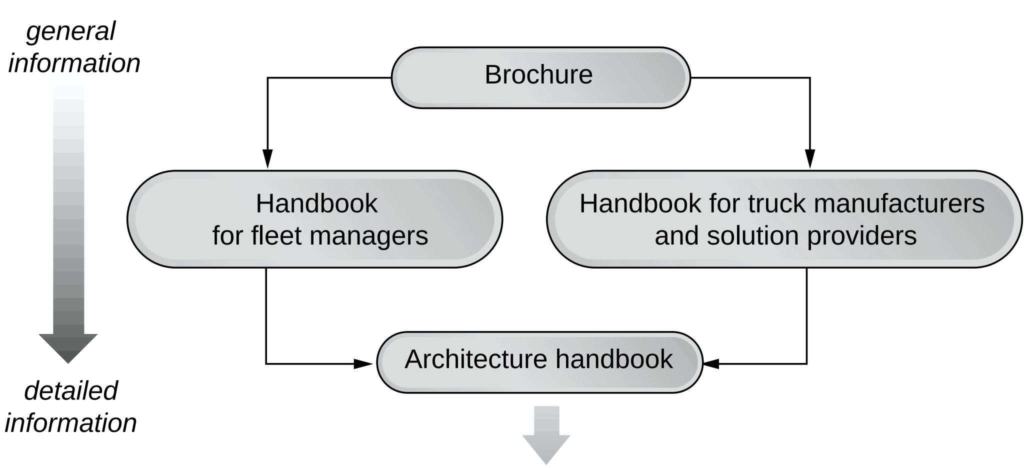
As figure 1 shows, the consortium has carried out the following activities:

- Precise identification of the needs of users through audits and questionnaires;
- Review of existing tools and solutions and their integration potential;
- Design of a 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 a 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

3 - THE USERS NEEDS ADDRESSED BY COMETA AND HMI ASPECTS

3.1 - The users needs

The system architecture hypothesised in COMETA is an integrated one. It has been based on an intensive investigation of the requirements that users of on-board computers have and we recommend to take into account the work carried out by the COMETA consortium in order to be close to the market.

A complete and detailed list of user needs examined in the context of COMETA is available on the website of the project at the following address www.cometa-project.com

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The COMETA project has carried out an extensive user needs analysis and validated it through "Pilots", in order to find out what functionality support the users expect from the COMETA system architecture, or what kind of generic requirement they expressed. In this context various types of "direct" users can be distinguished:

- transport companies
- commercial partners
  - consignor (contractual)
  - consignee
  - principal
  - forwarder
  - ship from (operational)
  - ship to
- drivers
- public authorities
- road operator
- intermodal transport operator
- service provider

The COMETA user needs have been related to:

1 - Commercial Consumers such as fleet managers, one man companies or drivers being chartered by other road transport operators either through time based contracts or for spot operations.
2 - Local Authorities or High Level Ministries, Companies providing, using ITS, Operators applying the ITS, Companies developing and producing ITS.

All these users have various needs, depending upon their role in the transport chain, the products transported, the region in which the transport is carried out, etc. In order to present the user needs in an orderly way, these user needs have been grouped according to common objectives:

1 social regulations enforcement and observance by drivers through the use of an electronic tachograph,
2 operational and commercial management during trip, missions management,
3 ensure and support safety and security,
4 vehicle mechanics monitoring and control,
5 automatic identification and tracking and tracing,
6 positioning, navigation and route optimisation,
7 communication management and solutions optimisation,
8 cargo management,

9 documents management,
10 provide driver comfort.

These groups, and their hierarchy, are the result of the combination of operational points of views, commercial points of views, of data process and exchanges related to the driver, the vehicle, the cargo, the trips, the tasks and orders to be executed and monitored. They are the result of the confluence of management requirements, functional requirements and more supporting technical requirements.

As far as the electronic tachograph has been the triggering event for COMETA it is not surprising to find this first with a broadened view.

Second, requirement related to the performance of his tasks by the driver, which can be seen as a strategic requirement for transport operators.

Just behind have been deliberately grouped different requirements addressing safety and security from various points of views, it means simultaneously that fleet manager are willing to benefit from potential new opportunities, but that they are willing too to avoid any new type of additional risks.

Next are found two quite different types of requirements, vehicle mechanics monitoring and control, Automatic identification and tracking and tracing which gathers a combination of important functional requirements and requirements addressing technologies to support them.
Both can be seen as direct supporting technologies to strategic tasks performance.

Quite various requirements addressing supports for positioning, navigation and route optimisation present a particular case, as far as positioning is seen as a rather important (and even prior) area, but navigation a less important one. So, considering the first aspect, this group should be higher ranked, considering the second one, lower ranked.

Then are found more technical requirements in the area of communication management and its optimisation, dedicated requirements to physical handling and monitoring of cargo to be carried, then carried, electronic documents management and exchanges.

Last, users have nevertheless thought of driver comfort that could or should be improved…

In the remainder of this chapter, these groups will be described in more detail and, beyond a generic requirement for modularity and interoperability expressed regarding the architecture to be designed, some standardisation requirements will be already tabled.

Social regulations enforcement and observance by drivers, through the use of an electronic tachograph.

What is required here is of course that appropriate information should be permanently recorded and made available to Authorities without any possible questioning upon its relevance and integrity, at any moment and even without stopping the vehicle.

Beyond, this information should be made available to the Driver and Fleet manager whenever appropriate or necessary, matched with other relevant information such as vehicle position, supported by means which facilitates and optimise its provision when relevant.

Nearly all users are interested here, though mainly fleet operators, drivers and authorities. Since there is a trend to consider principal and/or freight forwarder responsibility in transport, it might be that orders cannot be executed without risk of regulation infringement. In this case also principals and/or freight forwarders are interested.

Operational and commercial management during trip, tasks management.

Here can be found conditions addressing the provision and process of all necessary information to allow a driver to execute required tasks through real-time exchanges with appropriate partners (fleet manager, but also commercial partners), also addressing the process and transmission of any kind of status report to the same partners, either automatically or with human intervention, so as to facilitate, anticipate and speed up freight, fleet and drivers management on the ground side.

Fleet drivers or chartered drivers will perform this in different ways, but it will require appropriate on-board software, communication channels and protocols from solutions providers.

Ensure and support Safety and Security.

These requirements can take two forms:
1 - Intrinsic passive safety specifications, to be followed by on-board system designers in order to avoid driver disturbance or use that could endanger him.
2 - Active safety ones, providing assistance to the driver.

This assistance will cover quite different expectations such as driving assistance (vehicle operation control), driver physical condition evaluation, emergency situation management support, etc.
It will also cover e.g. anti theft assistance, alarm management, and vehicle immobilisation.

These requirements imply appropriate sensors and data recording and transmission, and possibly support of telematic service providers.

Authorities could, in the future, implement road checks for this kind of information or even a dedicated global system.

Vehicle mechanics monitoring and control.

These are requirements that aim to ensure that vehicles have been and will be properly maintained. Between two maintenance operations, first the driver, then if necessary the fleet manager and/or any remote support, will be warned and/or in case of any dysfunction, can access, more or less automatically, continuously stored parameters.

These User Needs are of course expressed by all drivers and fleet managers, but will be satisfied by vehicle manufacturers, solution providers and telematics service providers.

Authorities could, in the future, implement road checks for this kind of information.

Automatic identification and tracking and tracing.

Here too, solutions providers will be asked to allow identification at all levels (e.g. cargo, documents, vehicle, driver, equipment) and appropriate linkages when and where required: loading, unloading, trailers shifting, during trips, during gate in/gate out procedures on terminals, for fee collection (without stopping the vehicle for these three possible applications), etc.

Automatic transmission should be facilitated and creation and allocation of new Ids by the driver should be supported.

Positioning, navigation and route optimisation.

From a minimal positioning requirement up to highly sophisticated possible navigation systems, using digital maps and interfaced with traffic, weather and infrastructure real time information, these User Needs are aiming at the provision of best or alternative trips conditions and at more reactivity and anticipation for Drivers, by themselves or through dialogues with commercial partners or third parties.

Communication management and solutions optimisation.

Solutions providers (network operators and related software providers, telematics servers) are here strongly appealed.

The offers should allow voice and data (from free text to EDI/EDIFACT, via macros messages) communication associated with automatic identification, positioning, authentication, content protection, openness or flexible access from/to various parties, including other vehicles or equipment, roadside, etc.

They should allow from short range to world wide communication, with rather "generic" tools (radio, phone, fax) or more dedicated ones (beacons, transponders, radio tags).

They should allow for "on line" applications or downloading of software. The involvement of "clients" varies, according to the degree of integration of the physical movement of goods within

their complete supply or delivery chain management (e.g. just in time).

Cargo management.

This User Need can consist of one or more of the following functions: weighing the goods to be carried (directly or through the variation of the vehicle weight), the exchange and management of bay plans (so as to optimise loading/unloading and evaluation of remaining capacity), the acquisition and memorisation of cargo characteristics (so as for instance to avoid incompatibilities), and the continuous monitoring of these characteristics and stowage and transport conditions.

It can imply the triggering of alarms, automatic messaging or even remote corrective actions.

Industry is of course expected, by all kind of transport operators, to provide appropriate solutions, which should require minimum intervention from the driver.

Authorities are required to facilitate their inspections through the implementation of weight in motion systems.

Documents management.

These User Needs, beyond the regulatory aspect that is required by Authorities' demand for a "paperless transport" and/or checks without stopping the vehicle, address more specific legal and formal dimensions of formatted document exchanges, storage, modification, printing, electronic signature "on" them or on a substitute.

Solution providers are concerned when considering processing and printing these documents, when considering the protection of data, or opposed, the possibility to modify some of them, when considering the securing of proofs of delivery and electronic signature.

These kind of solutions are of course welcomed, if not eagerly requested, by the "clients" involved (and responsible) at a given moment in document management.

Provide Driver Comfort.

Comfort is here understood in a very broad way, as far as it addresses HMI requirements related to matters like the provision of visual or acoustic information (and multilingual information), to the automatic customisation of the driver environment, his access to entertainment services.

The case of one man companies or chartered drivers
This category could be more demanding for appropriate software, hardware and communication solutions related to operational and commercial management, documents management. The concept of Mobile Office for this category is made still more stringent when considering that it requires too a support for the management of tenders, offers, quotations, tariffs calculation and invoicing...

3.2 - HMI aspects

Based on the users needs analysis, which is the basis for the COMETA on-board system architecture and the results of a driver survey carried out in COMETA, some recommendations can be given with respect to the interaction between the driver and the on-board systems of the vehicle. The driver is the most important user of on-board systems. Most of these recommendations are related to safety and user-friendliness of the on-board systems.

A complete detailed description of the HMI aspects is included in the deliverable D6.4. A synthesis of such aspects is given here in the form of short general recommendations.

- Information and communication systems of every kind, which are installed in commercial vehicles, shall not need two-hands operation, not even for a moment, nor require visual attention from the driver, which must be reduced to a minimum during the trip, info and communication systems being installed in a place where the turning away of the driver's eyes from what is happening on the road is as small as possible.

- The on-board system shall not lead to an operating insecure vehicle by the appropriate usage of information technology facilities, as well as their partial or total breakdown: primary driving task must be managed by the driver on his own at any time. • The on-board system shall not lead to disturbance of other on-board system functions or of the vehicle itself.

• Long and repeating sequences of actions need to be avoided and information to the driver should be presented in time and in appropriate portions, i.e. route guidance information shall be presented in time in order to give the driver the time to react accordingly.

• Operating instructions should include an explanation about potential dangers and system limitations, as well as a note saying, that vehicle information systems shall 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 by using.

• Inputs using the keyboard should be reduced to a minimum, or they should only be possible when the vehicle is not in motion, or be allowed to use no-hand systems, i.e. include facilities operated by voice commands instead of manual ones, which means to be used by the driver during the trip such as appropriate (microphone based inputs) and acoustic outputs of incoming messages and information or on-board produced process results. • On-board incoming information and messages – both in written and voice mode – should be delivered in the native language of the user, even when driving abroad or if a foreign partner generates messages.

• In a maximal situation, the information the driver could read should be presented on 2 screens at least. If one display is used this should be positioned in front of the driver and if two displays are needed, the second display should be positioned on the dashboard in front of the passenger. One of these screens 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 to appear only in "normal" mode, with the detailed site or street names appearing only at request.

• 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. The push buttons controlling the "management" of tachograph data and alarm presentation could be located there, making it possible for the driver to use without taking his hands off the wheel. • In an advanced situation, a computer-generated voice will announce incoming messages and alarms, above and beyond visual presentation. The driver will be able to trigger announcement of incoming messages by means of a push button located in the steering wheel.

• The luminosity of the display should be reduced automatically while driving or should be modified at the drivers initiative.

• The keyboard controlling the communication and on-board screen management functions (use of the on-board applications) could be placed within the driver's reach, for instance in the armrest on the right side of the seat (for Continental Europe). Its functioning must be locked (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 reverse cameras are dedicated and located high up on both sides of the cab.

Further useful information can be found in the document "European statement of principles on Human Machine Interface for in-vehicle information and communication systems" from the Task force HMI [12/05/98]. Relevant principles can be found there summarising safety aspects to be considered for the Human Machine Interface for in-vehicle information and communication systems. 32 principles are given, divided into 6 categories: overall design, installation, information presentation, interaction with displays and controls, system behaviour and information about the system.

A second important source of information is the document "Human Machine Interface Guidelines" [Code project, January 1998] in which some useful recommendations can be given regarding HMI with respect to the development of on-board telematics applications.

Finally, based on the description of the HMI architecture of the SAVE prototype system (used to monitor driver status and perform an emergency manoeuvre if necessary or requested by the driver) in the document "Deliverable 9.1" [SAVE project, August 1998] other recommendations are given.

4 - SYSTEM ARCHITECTURE

Based on the users needs analysis, COMETA has defined a "System Architecture", which consists of the following components:

- A functional and control architecture, describing the functions and sub-functions of an information technology system (ITS) in a hierarchical manner.

- A physical and communication architecture, describing the grouping of functions into physical units (or even application packages already available on the market) and the communication channels between them.

- An information and management architecture, describing the data needed for the ITS and their inter-relationships.

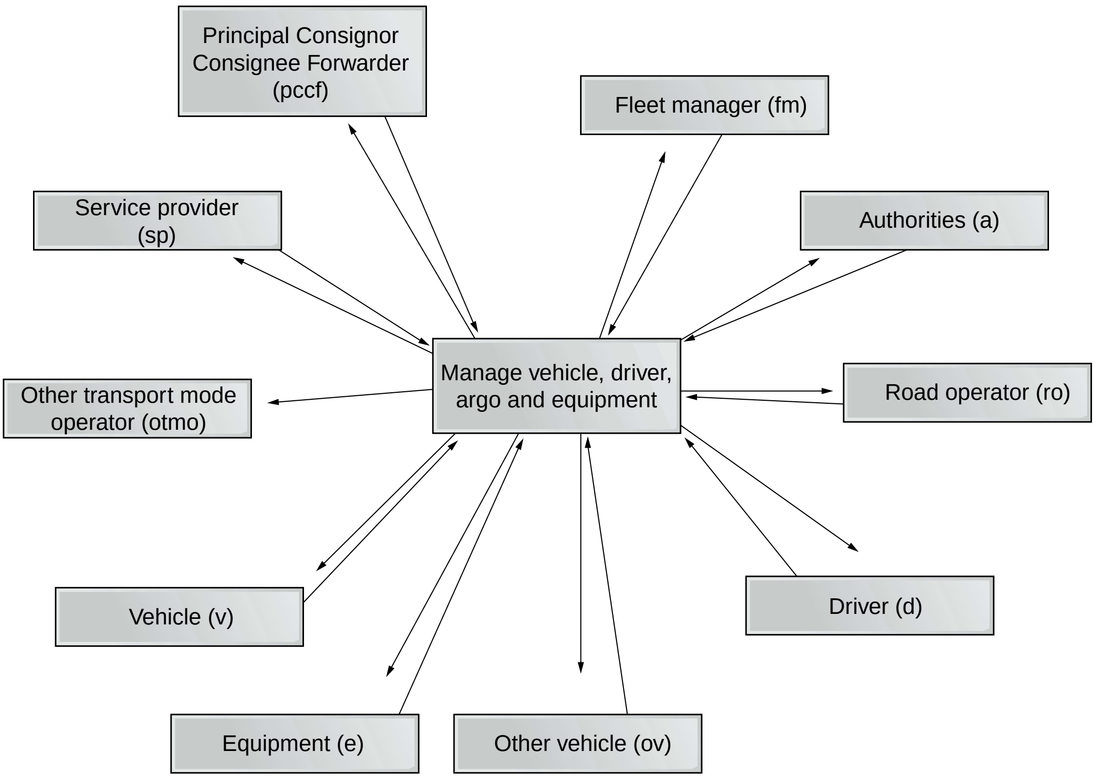
A complete and detailed description of the COMETA architecture is available on the web site of the project at the following address :
www.cometa-project.com

Road freight transport is a very heterogeneous activity. Truckload or pickup / delivery on one side and large fleet or one man company on another side, will e.g. require different features of the system. COMETA has considered two major scenarios: the first one could be seen as a "maximal" one, corresponding to a concept and hypothesis of "mobile office" for independent or chartered drivers. The second one could be seen as a "minimal" one, corresponding to large fleet drivers behaviour.

The COMETA architecture has been developed to support the two above mentioned key scenarios. In the following paragraphs we give the description of the most complex situation (the independent or chartered driver scenario), the less complex one being a sub-set of this latter.

4.1 - COMETA context diagram

Figure 3: COMETA context diagram



In the following diagrams "f" will mean "from," "t" will mean "to," "terminators" or other functions.

Examples :

- fd : from driver
- td : to driver
- ffm : from fleet manager
- ta : to authorities
- totmo : to other transport modes.

Data flows written in capital letters (for instance To Driver) are placeholders for several data flows that are not presented here for reasons of clarity.

A terminator is an external entity to the COMETA system(s) architecture, with which this system(s) architecture will have to exchange information and that will trigger the performance of functions, or will be asked to as the result of the performance of one given function.

Authorities (a)
Authorities are public bodies, high level ministries and local authorities involved with or related to the transport process, often in a law enforcement role. Examples are police, customs agency, social regulations authority.

Driver (d)
The driver is the person that drives the truck and operates the on-board freight and fleet management system. Messages are received from and sent to a driver through peripheral equipment such as display, printer, keyboard, barcode scanner and other peripheral device.

Equipment (e):
This term has been imported from the EDI/EDIFACT area where, in transport messages, it means "a transport unit unable to move by itself" but possibly autonomous : trailer, semi-trailer, swap body, pallet.

Fleet manager (fm)
The fleet manager is the main interlocutor for drivers who are working as a part of a transport fleet. The fleet manager is responsible for generating sufficient transport orders and ensuring optimal use of fleet resources when executing these orders. To do so, he will communicate in various ways with all relevant parties including drivers.

Other vehicles (ov)
Other vehicles are vehicles that are travelling within a relevant range (in the same area or on the same stretch of road) of the vehicle concerned by the COMETA architecture either because they are likely to physically cross or because they are an interesting source or target of information exchange for instance supporting cooperative driving.

Other transport mode operator (otmo)
Operators of other transport modes are responsible for performing freight transports on modes different from roads. Examples are rail, inland waterways and sea transport.

Principal, consignor, consignee, forwarder (pccf)
Principal, consignor, consignee and forwarder have been grouped into a single terminator within COMETA as all are possible interlocutors for independent (or chartered) drivers. Precise definitions are as follows:

- principal: an individual or organisation that requests a transport order to be performed (by a contractor) against a relevant form of remuneration, when relevant stipulated in a contract (it is a generic term for the entity that orders a transport; examples are the consignor, consignee, freight forwarder or any third party),

- consignor or shipper: an individual or organisation that prepares a bill of lading by which a carrier is directed to transport goods from one location to another (based on ELA),

- consignee: the party such as mentioned in the transport document by whom the goods, cargo or containers are to be received and accepted (based on ELA),

- forwarder: the party arranging the carriage of goods including connected services and/or associated formalities on behalf of a shipper or consignee (ELA); the forwarder is often contracted by the principal, the consignor or the consignee, depending on which terms of contract apply in the business relation between them.

Road operator (ro)
Road operators are responsible for the provision of safe roads on which vehicles can travel efficiently. Increasingly, road operators are levying tolls for the use of their infrastructure either to recover road construction and maintenance costs (for instance in build, operate and transfer or BOT arrangements) or to better manage demand (also known as road pricing).

Service provider (sp)
Today, there are a number of service providers offering different kinds of services and this number will increase in the near future. Examples are:

- traffic information service providers (using e.g. RDS/TMC or DAB as a communication medium),
- freight information service providers (using e.g. the WWW as a communication medium),
- automatic billing service providers.

Vehicle (v)
The vehicle terminator is foremost a collection of relevant sensors. These sensors are used to capture measurements for:
- temperature,
- pressure,
- speed,
- tiredness,
- anti-theft,
- etc.

4.2 - Functional and control architecture

A functional and control architecture shows the key processes that are to be performed by a system as well as any information and control relationships between these processes.

Based on the user needs analysis, COMETA has defined three important areas of functionality that need to be supported on-board. The three areas mentioned above are composed of functions, each of them corresponding to one (or more than one) users needs. The precise correspondence between user needs and functions is indicated in the documents downloadable from the web site of the project.
The main functionality to be supported on-board were identified as follows:

- Manage business transactions
  - Negotiate transport orders
  - Administrate business transactions

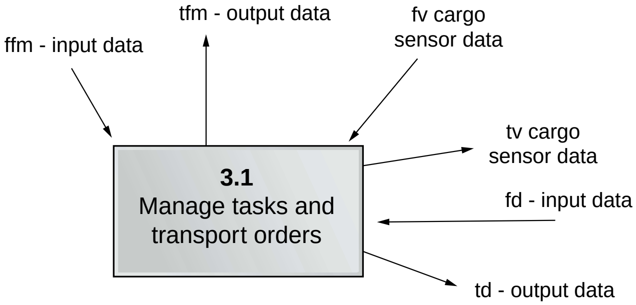
- Prepare vehicle, driver, equipment and cargo
  - Prepare resources (Prepare documents, Prepare vehicle, Prepare driver, Prepare cargo space, Prepare equipment, Prepare accessories, Prepare other transport mode)
  - Prepare trips, routes and load plans (Ask for a new task order, Process and read a new task order, Check client profile and constraints, Prepare trip/routes, Prepare load plan)

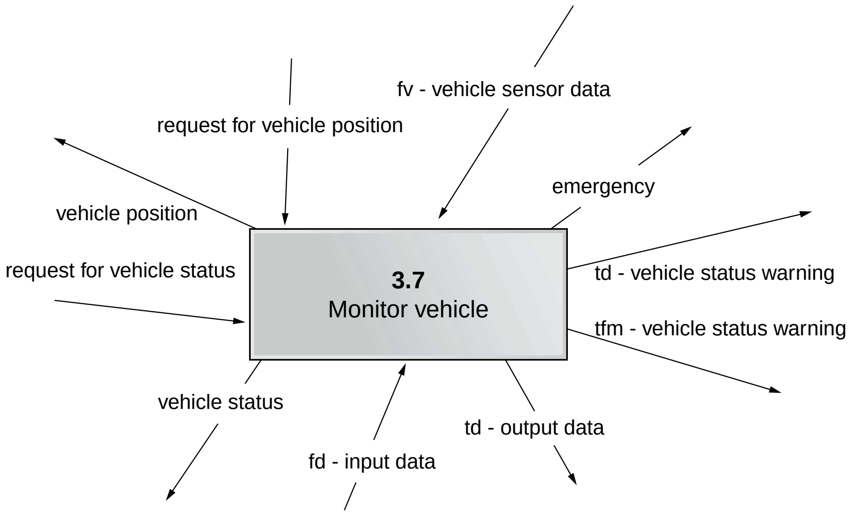
- Perform and control vehicle, driver, cargo and equipment operations
  - Manage tasks and transport orders (Manage tasks and transport order contents and modifications, Check whether cargo and or equipment conforms to transport order, Create a new transport unit)
  - Comply with regulations (Comply with social regulations, Comply with other regulations)
  - Provide advanced driver assistance (Provide vision 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 prove transport order execution)
  - Manage emergency calls

These processes as well as the relevant information and control flows between them were properly described and documented in the form of diagrams for easy reference.
As an example, we describe below the simplified modular processes of three functions related to some areas of functionality "Perform and control vehicle, driver, cargo and equipment operations".

Manage tasks and transport orders

The function gives rules to the driver so as to execute the allocated task or tasks, after the preparation phase and to report and react accordingly, particularly in case of modifications felt as necessary or decided by the fleet manager. In the case where the tasks are associated with the execution of a transport order, the reaction may be to warn about discrepancies, or, if permitted, to accept an additional transport unit after its identification.



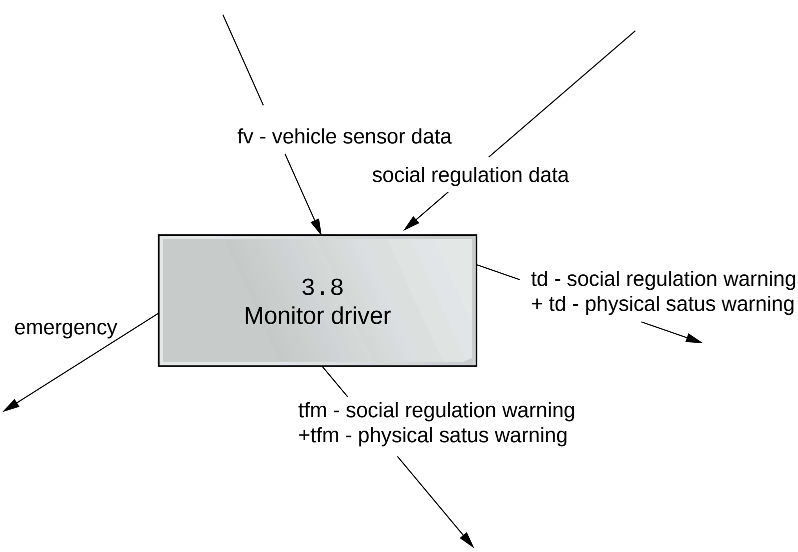


Monitor vehicle

This function supports a wide range of other functions that request the current vehicle position from it and also collects and stores engine and maintenance related data.

Monitor driver

This function monitors the driver's social regulations status, his physical status, driver expenses and the driving behaviour.



4.3 - Physical and communication architecture

A physical architecture defines and describes the way in which the constituents of the functional architecture can be brought together into groups to form physical entities. The main characteristics of these entities are firstly that they provide one or more services required by the User Needs, and secondly that they can be created. This creation process may involve physical elements such as roadside structures and various forms of equipment, non-physical elements such as software, or a combination of the two.

So, a physical architecture will define and describe how the functionality created in the COMETA Functional Architecture can be grouped to form Systems that can be produced. These Systems will use components that are produced from hardware, software, or a mixture of the two. Through their inclusion of parts of the Functional Architecture, these Systems will of course be able to satisfy some or all of the requirements of the COMETA user needs.

From the actual situation, in which the above mentioned systems can be considered isolated, COMETA expects that there will be first a "short term evolution scenario", then a "transitory phase" and then, in the medium to long term, a "high integration scenario". These development dynamics are described below.

The actual situation

The following basic systems can be found more or less today: an on-board computer for freight fleet management, a tachograph made "digital" through an ad-hoc interface, perhaps a navigation system, some advanced driver assistance, an engine computer, an EFC device. The level of integration of such systems (both among them and with the vehicle) is very low.

The short term evolution scenario
It is obvious that truck manufacturers and solution providers are already designing more "intelligent" architectures and that fleet managers or independent drivers, have in mind more comprehensive on board integrated systems.
So this phase takes into account that some combination of sub-systems and modules will exist for the beginning of years 2000.

In this phase, the physical and communication architecture developed in COMETA distinguishes between the following sub-systems:

- The driver task management sub-system: supports execution, monitoring, reporting of tasks required from a driver by his fleet manager or directly by another partner
- The vehicle monitoring and control sub-system:

The transitory phase

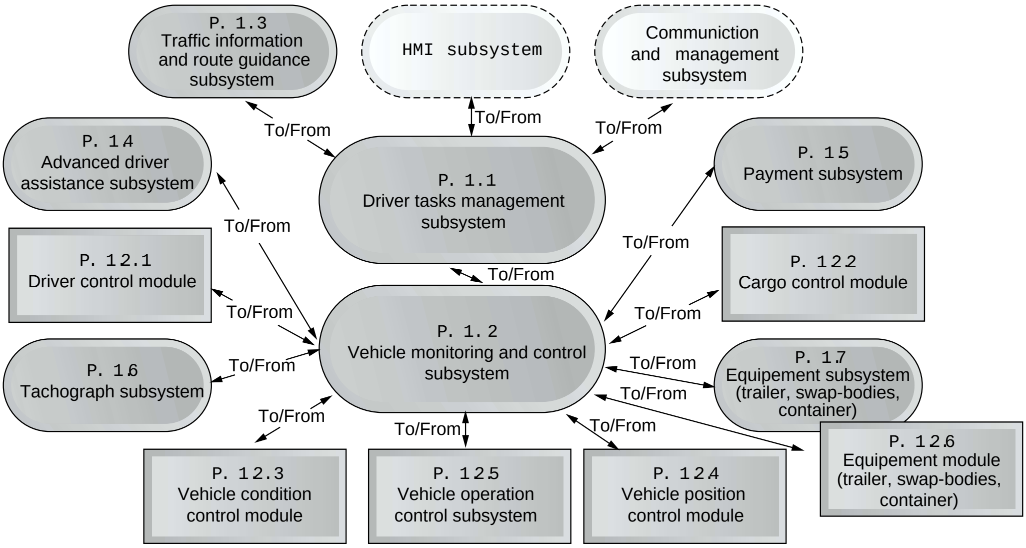
provides internal support to the driver, automatically or on request, in order to prepare, execute, monitor and report any operation; this sub-system also groups different modules supporting driver control, vehicle operations and control as well as cargo control • Five other associated sub-systems including traffic information and route guidance, advanced driver assistance, payment, the digital tachograph and autonomous equipment

The digital tachograph is "only" a sub-system, as far as if it captures and stores information, additional processes are required from an on-board computer (or at the home base by appropriate application) to allow for a more intelligent interpretation of its content by the driver (or the fleet manager) and the matching with other information.

In this phase there will be two on-board networks for the interconnection of the different functionalities. The level of integration increases with respect to the previous situation.

The first network will be related to the telematics functions (i.e. it is a kind of multimedia bus) and its main aim is to circulate, to all the on-board modules, the information coming from (or going to) outside the vehicle (via the communication media like RDS, GSM, DAB, DSRC etc.). This bus has provisions to check the integrity of the data and to avoid misuse.

Figure 4: Vehicle, Driver, Cargo, Equipment: The short term global internal view



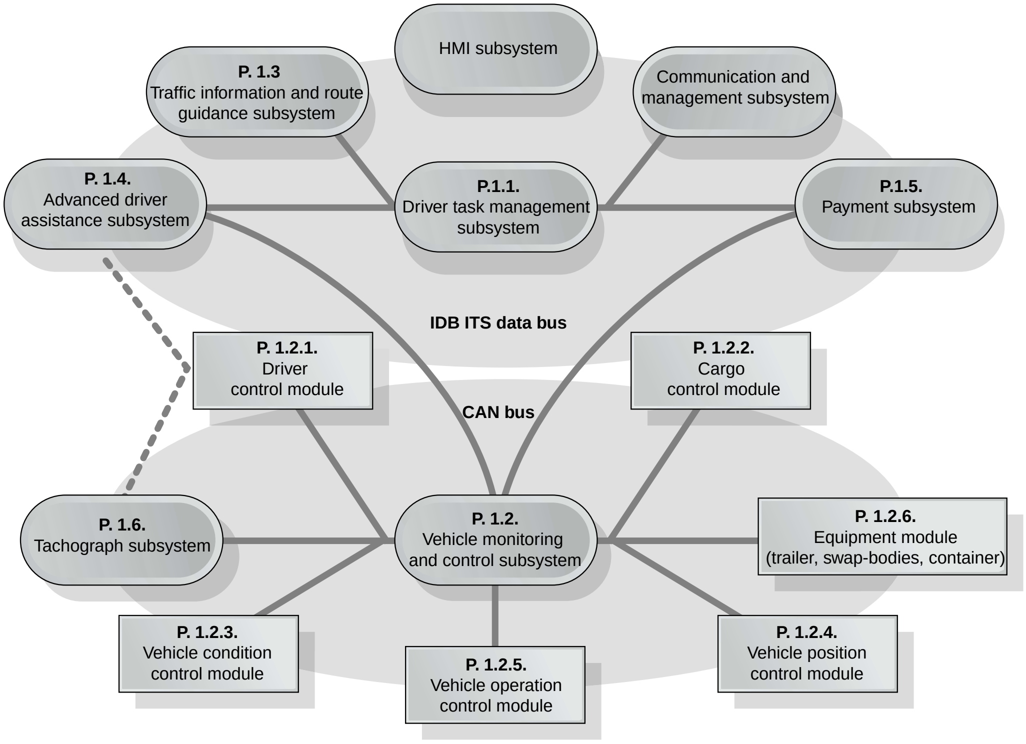
The second network is a kind of vehicle control bus that, depending on the required function, guarantees a suitable level of dependability. In real applications it can be split in two or more lines to assure safety critical operations.

The distribution of Sub-systems and Modules between the two data buses is built on the assumption that some will be more external communication and telematics oriented and other will remain more internal communication oriented. It means that, if, of course, there will be efficient interfacing between the two networks, which could make discussions upon their "borders" rather irrelevant, it can be imagined that the most "communicating" Sub-systems or Modules, will belong to the IDB.

Even if advanced driver assistance Sub-system and Driver control Module will get more integrated.

Even if Cargo control Module will become more and more "autonomously communicating" (images, Automatic Identification, "Messages" on the unit itself through high density bar codes or radio tags).

Figure 5: COMETA "transitory phase"



The "high integration scenario"

If we consider the high integration scenario to be expected between years 2005 and 2010, we are entering a more twilight zone. Compared to the starting situation (and even the transitory phase), beyond a possible stage where one could find only one data bus (as in present air planes), sub-systems will become less and less physically distinguished. They will be more and more interpenetrated, even if a major functional distinction will still be made between "Driver tasks management sub-system" and "Vehicle monitoring and control sub-system".

Described data flows will remain relevant, but will be input/output from software modules within a much more integrated global data processing.

What can be pushed forwards as a key example of integration justification, is the tachograph case: it is clear that software solutions will replace the present hardware ones used to protect the integrity of social regulations data.
Reasons for having a separate sub-system will become irrelevant.

Besides, it may be expected that social regulations enforcement will become only a part of a more global safety / security inspection by authorities. Last, this high integration scenario does not give borders to the respective "roles" of an on board implemented computer and an interfaced handheld or removable one that could be attached to the driver according to given transport activities (e.g. Pick up and delivery as shown presently by UPS or FEDEX).

Concerning the debate "embedded versus portable computer", the chapter below gives some more details.

Embedded OBC versus handheld or portable computer

During COMETA investigation a debate has been opened on "implemented OBC versus portable computer", justified by some views that it could be easier to use an "external" computer to be brought into a truck when necessary, rather than to have to design and implement a quite complex system architecture.

Even if COMETA Systems Architecture has been designed so as to allow any kind of implementation of technical solution, any "market package", some pros and cons regarding the choice of OBC solution or "nomad" ones have been considered.

Pros for OBCs :

- The processing unit should be permanently on board the vehicle so as to be automatically polled from outside (remote usage by the home base or another actor or "terminator").
- Lots of data processing will be attached to the vehicle (Tachograph, engine monitoring, driver monitoring, ADAS, etc.), this is a strong argument for the justification of OBC solution.
- Parts (e.g. screen) could be on board and processing unit removable.

Cons for OBC :

- Heavy vehicles offer an hostile environment for mounted devices.
- Information technology changes quite faster than Trucks possible lifetime.
- OBC will always be more expensive than equivalent portable devices.

Pros for portable, removable computers :

- Portable computer will indeed be useful for pick up and delivery activities (scanning of bar codes, electronic signature, etc. . . .),
- Portable computer could be dedicated to given drivers while they change vehicles.
- Many portable computers are already on the market.
- They can be made harder with a large screen.

Cons for portable, removable computers :

- Portable computers have too small screens, are fragile, can be more easily stolen, etc.
- Interfacing a portable computer with the rest of the system will result, each time it is connected, in lengthy initialisation process.
- Having the computer attached to given drivers rather than to vehicles will result in low rate of usage, due to their working time reduction.
- If the computer is not attached to a driver (pool of computers), this could raise other kinds of problems.

Whatever, if COMETA project assumes that there will be a large "amount of intelligence" mounted permanently on board commercial vehicles (one could say, more and more), this does not forbid the use of an additional processing unit interfaced with the rest of the components of a global system architecture.

4.4 - Information and management architecture

To keep diagrams describing the functional and control architecture as simple as possible, only one data-store was used , the Vehicle, Driver, Cargo and Equipment data-store. This was a justified choice, since the focus of a functional and control architecture lies not primarily on the data, but more on the processes. Because of this, an information and management architecture is needed to complement the functional and control architecture.
By definition an information architecture describes the data needed by an Information Technology System and the interrelationships between the different data-blocks. Generally for large quantities of data a database is utilised to store all 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 a management architecture.
As part of the management architecture the different entities described in the information architecture are grouped into informational clusters, according to their usage. The data access modalities (reading and writing access) for the functional and control architecture are given in a table and the life-cycle of the information is described.
The more in-depth defined entities can be found in deliverable D6.1.

4.5 - Standardisation matters

Designing a Systems Architecture was seen as providing a basis for ensuring more modularity and interoperability through the identification of necessary standards at the interfaces of this SA and as far as possible supporting on going standardisation process or starting new ones.

The following issues must be mentioned here:

- Mobile EDI, as the need for standardised messages to / from the vehicle becomes stringent.
- Transport Orders, Tasks and Tasks reports, status reporting, etc. are necessary conditions for the design of a solution based on this systems architecture. Integration in these messages of information coming from other sub-systems and modules than driver tasks management sub-system and going to it, such as tachograph information, driver status, vehicle and equipment condition and operation, cargo information, etc. (more details are available in COMETA Del 7.2 and 6.1).
- More transparency between mobile data communication networks and fleet management applications. This can be seen as a complement to data structure and contents standardisation, through messages handling procedures standardisation and a way to solve, on the ground side through application protocol interfacing, the problems raised by the multiplicity of on board systems and communication solutions. This is commonly seen as "Office Interfacing" (idem supra).
- More interoperability and integration between sub-systems, control modules (the BUS of the future).
- Ease of plugging / unplugging of various sub-systems and control modules and physical components in the global system architecture, whatever the market origin.

COMETA has taken into account such issues. As an example, the mobile EDI messages proposed by the French association EDITRANSPORT have been examined. A number of proposals for extensions have been made including driver availability, social regulations, technical data capture and intermodal applications.
The same is true for the Fleet Application Protocol (FAP) that will be submitted to CEN TC 278 WG 2 as a result of the FLEETMAP project, in which extensions such as new services for tour management have been introduced as a result of COMETA. At a more general level, there is a need to more actively involve the transport sector in the development of in-vehicle data buses and related standards based on the COMETA results.

COMETA has gathered strong justifications for standardisation enhancements on one side, will provide interested standardisation body with working tools on the other side, but the field for a unified standardisation process is just opened as some possible solutions can be seen as complementary, alternatives or competing. CEN TC 278 WG2 working group for freight and fleet management in the European standardisation technical committee for road transport and traffic telematics, will consider this.

5 - OVERVIEW OF THE TELEMATICS MARKET FOR COMMERCIAL VEHICLES

A wide range of definitions exist for "telematics". In the context of COMETA the most appropriate appears "the convergence of wireless communications, location technology (generally utilising the Global Positioning System) and in-vehicle electronics, which is a fundamental way for integrating the car/truck into the information age".

According to this definition, one of the core points is that telematics systems must be integrated in some way in the vehicle itself; telematics thus directly relies on networking or vehicle interface technology to allow telematics devices to communicate with one another and with the vehicle.

At its simplest, a telematics system can essentially consist of a GPS receiver and a wireless communication device. This configuration appears widely used in Europe today by those systems mainly implementing security and emergency functions. At an upper level we can find more complex systems with a wider range of applications, which incorporate a navigation system, a multimedia system etc. Such systems can also, by accessing the vehicle's bus, incorporate other vehicle control functions.
Finally, at the highest level, we find on-board integrated systems for driver/vehicle/freight/fleet management. These systems contain in general an on-board computer, a GPS receiver and antenna, a wireless communication system and an interface to the vehicle data bus. Various driver interfaces are located in the cab, such as screens, keyboard etc., and various on-board sensors systems are located in the vehicle, which allow monitoring of whether the trailer is loaded/unloaded, doors open/close etc. These systems allow a fleet dispatcher to automatically exchange data and messages with the vehicle; in some cases the data-messages are exchanged through private communication links and pass through a service centre operated by a service provider. In other cases data and messages are accessed through the internet.

These advanced systems offer the possibility of implementing a wide range of functions and can be quite complex; some of them rely on many of the same functions as the passenger vehicle telematics market, some other are specific for the commercial vehicle telematics market.

The most important users of telematics devices and services in the commercial vehicle market are the commercial vehicles operated by fleets. This is because:

- larger commercial fleets have the resources for implementing a telematics system;
- larger fleets have more complex logistical, reporting, maintenance etc. issues to address;
- a larger amount of functions is implemented by larger fleets and a higher need of optimisation of such functions is necessary.

However, on-board telematics systems are also becoming more and more attractive for smaller fleets and a number of specific applications are appearing on the market for individual companies.
Sophisticated telematics systems for commercial vehicles are mainly addressed to the large long-haul trucking companies. This segment, dominated by the heavy vehicles, is probably the best developed market world-wide today. The market composed of light and medium trucks that operate at metropolitan or regional level doesn't appear as important as the previous one today. Anyway it represents an interesting developing market for the next future.

Referring to the long-haul trucking sector, various companies that provide location-based communications, information and services exist today. These service providers can be grouped in three categories:

- trucking communication and information service providers that sell proprietary telematics systems for fleets to be installed on-board and communication software to be installed on the fleet's computer system. These companies provide communications and information services through service centres or private communication links;
- providers of trucking communication and information systems that sell proprietary telematics systems for fleets to be installed on-board and communication software to be installed on the fleet's computer system, but which generally don't provide services;
- providers of internet-based (especially in the USA) trucking communication and information systems and services, which sell proprietary telematics devices for fleets that are installed on-board and operate home-based centres which are accessed by fleets over the internet.

The commercial vehicle telematics market appears quite different with respect to the passenger vehicle market. While the producers of passengers vehicle telematics devices are moving towards the adoption of industry standards, the commercial vehicle telematics industry is dominated by proprietary systems. Both telematics systems industry and truck manufacturers have undertaken efforts for developing proprietary systems.

The result of such an evolution is that the market appears fragmented today and this situation will probably remain unchanged in the very near future. A survey carried out in the context of COMETA at European level, based on the analysis of 55 systems, has demonstrated that the number and type of the devices (especially communication devices) that compose the on-board systems are expected to increase in the short-term and their proliferation will represent a risk in the medium-term. Furthermore both the amount of software installed and the number of functions implemented by the systems is rapidly increasing. A crucial aspect concerns the level of integration, which seems very low, both with the vehicle and between the electronic devices.

6 - FUTURE TRENDS IN COMMERCIAL VEHICLE TELEMATICS

This chapter presents the synthetic results of a survey carried out within COMETA involving 55 European systems. More details regarding this survey can be found in Deliverable 3.

6.1 - Expanding areas and new technologies

The following paragraphs describe some technologies whose recent and future evolution is probably of major importance for the development of the telematics systems for commercial vehicles; these technologies concern:

mobile communications

in-vehicle networks – vehicle electrical architecture, and

new types of on-board computers (Auto PC & Windows CE – AutoJava API)

6.2 - Mobile communications

The ability to quickly collect, process and disseminate data and information is fast becoming a necessity in the truck business and is almost as important as the necessity of rapidly pick up and deliver freight. A number of new mobile communication providers are actually entering in the trucking market. Data transmission, voice transmission, internet connections, private networks and radio devices, etc. are the applications that benefit of the mobile communications development.

An important evolution is in progress concerning satellite communications. We can estimate that approximately 500 new low-earth orbit (LEO) and high orbit satellite (usually called geo-stationary) for mobile communications will be put into orbit in the next 5 years.

On the ground another technology for mobile communications is rapidly expanding; cellular radio systems are offering new communication devices and services to the trucking industry.

These evolutions made the choice of a mobile communication system more difficult but they also offer innovative products at lower prices.

Into this wide context, recent developments concern a new generation of communication systems named UMTS (Universal Mobile Telecommunication System) in Europe and IMT2000 (International Mobile Communication 2000) at the world-wide level. Both UMTS (based on an evolution of existing networks such as GSM, RNIS etc.) and IMT2000 will offer mobile communication systems for efficient multimedia services. In this field an important role will be probably played by the development of transfer protocols for mobile systems. Two techniques can be mentioned here, ATM (Asynchronous Transfer Mode) and IP (Internet Protocol), which will probably be widely used for mobile communications and access to multimedia services.

6.2.1 - In-vehicle networks – Vehicle electrical architecture

In-vehicle network architecture will represent a crucial point for the future developments of the on-board telematics systems and, in particular, for their integration with the vehicle and its productive process. The kilometres of wiring in yesterday vehicles have been replaced by computer networks.
Electrical architectures of today's vehicles has evolved from stand alone systems with little exchange of information to distributed systems where several units communicate and exchange information on "multiplex" buses. These systems use common communication protocols. Some of the most frequently used protocols in-vehicles are: ISO14229 (Diagnose Application protocol), J1939 (protocol structure for heavy vehicles), CAN (the major "low-level" protocol used in European vehicles today) etc.

Much work is currently going on at European level and in international organisations to standardise in-vehicle communication.

The above-mentioned networks have been used only for primary vehicle function control up until now. More sophisticated user functions like navigation, e-mail, etc. are now being added. These mobile and multi-media functions should not interfere with the safety of the vehicle. Two opposite technologies will probably develop in the future.

One solution for this problem is the use of a separate bus, for example a high-speed optical bus. This multi-media bus is preferably an open system to which laptops, cameras, printers, and other various devices may be connected.

The second solution is a system in which safety-critical communication and mobile multi-media communication can safely co-exist in the same bus.

This is a field to which telematics on-board systems development will be strictly connected in the next years.

6.2.2 - New types of on-board computers

New types of on-board computers have recently appeared on the market which look like real PCs. One of the most known is Auto PC. This palm PC will fit into any car because its size is that of a car CD player. It contains a CD player, a radio, a colour display and makes it possible (while driving) to:

- send and receive e-mail
- find information on the internet
- use voice commands
- navigate to a specific address
- operate a cellular phone
- etc.

The most important feature of this computer is that it has the ability of adding both new components and new software programs after purchase to increase its functionality.

This computer is powered by the Windows CE operating system which has been designed for portable and hand-held computers. The philosophy underlying Windows CE is that it is a foundation of software building blocks that could be assembled in many different ways to create new devices. This means that for building a new device, only the needed pieces are picked and chosen; therefore the size of the software is consistent with the size of the device.

Windows CE uses a subset of the Microsoft Win32 application programming interface (API) that is used on Windows-based desktop and server computers. Developers can use the same development tools, such as the Microsoft Visual C++ or Microsoft Visual Basic development system, and communications protocols to create applications for Windows CE-powered devices.

One of the most promising opponents to the Microsoft Auto PC & Windows CE is the Sun -AutoJava API for automotive applications. The AutoJava API represents a platform independent software framework for the development of solutions for mobile multi-media applications. APIs for car navigation, audio/video controls for in-vehicle entertainment, remote diagnostic capabilities, voice recognition, AC/climate control interfaces, wireless communications etc, can be realised with AutoJava.

A third actor of this panorama is Symbian EPOC. This latter is an operating system, application framework and application suite optimised for the needs of wireless information devices such as smartphones and communicators, and for handheld, battery-powered, computers. EPOC also includes connectivity software for synchronisation with data on PCs and servers.

These new technologies will probably intensively influence the development of on-board telematics systems in the near future, both for cars and trucks.

6.3 - Key-drivers for the future

The emergence of the telematics technologies offers new opportunities both to truck manufacturers and system providers, which operate in a market whose general trend is toward open systems that can take advantage of the myriad new communication, location, infotainment etc. devices/services coming on the market itself. This paragraph gives a short list (in the form of bullet points) of indications of where the industry and market are heading in the coming years. The main key-drivers described below intend to give the tools for understanding the future possible scenarios, that is how the telematics commercial vehicle market (which is still dominated by proprietary systems and services) will evolve during the next future:

- the commercial vehicle telematics market growth is driven by new or improved services, not devices;
- the biggest source of OEMs revenues are the telematics services, not devices; anyway telematics revenue don't climb too quickly;
- industry standards efforts succeed, but more work is needed;
- the telematics systems demand is driven by concerns about, safety, theft, efficient vehicle/driver/fleet/freight management;
- industry succeed in overcoming safety concerns through the development of integrated devices with simple interfaces;
- the long-haul trucking sector remains a key vehicle telematics segment;
- larger for-hire fleets have more resources and needs, which can be satisfied through telematics systems;
- a growth of the market for smaller fleets is likely possible, depending on new internet-based technology and services and their lower start-up costs;
- portable devices would appeal to smaller fleets and short-haul fleets that rely on rental units;
- new products and services appear on the market and take advantage of the new technologies;
- important steps are carried out towards the development of more integrated telematics systems (integration with the vehicle and among devices);
- open data buses could offer new opportunities;
- an important growth is expected in location-based wireless fleet-management services;
- many non-traditional firms enter the commercial vehicle telematics industry: non-automotive software firms, internet firms, non automotive wireless communication firms, etc.;
- industry alliances proliferate.

7 - INDUSTRY ALLIANCES

The system architecture developed in COMETA is an integrated one. It has been based on an intensive investigation of the requirements that users of on-board computers have and we recommend to take into account the work carried out by the COMETA consortium in order to be close to the market. It is difficult to predict when such a system will be available, since a number of standardisation efforts are necessary to promote its development. An important role in this context will be played by the computer industry, by the electronic industry for automotive applications and by the telecommunication industry.

The computer industry will be directly involved in the evolution of hardware devices and software for more integrated on-board systems. The automotive industry will be responsible for the evolution of the electronic architecture of the vehicle and, in particular, for the development and installation of multimedia bus on the vehicles (preferably open systems to which laptops, cameras, printers, and other various devices may be connected). The telecommunication industry will play a major role for the development of mobile communication systems for efficient multimedia services.

Our main recommendation is that in the future these three main actors work on common standards of interoperability.

Taking into account the diverse nature of the technologies needed for developing telematics systems for the automotive sector, the traditional division between automakers, automotive components and systems suppliers, customer electronic firms, communication firms, IT companies etc. seems a major obstacle to the development of the above mentioned common standard of interoperability.

For this reason we give below a brief list of possible typologies of agreements among actors of the telematics market:

- relationships between producers of telematics devices and key providers of GPS location technology, wireless technology, voice recognition technology, etc.;
- agreements between automotive electronics firms and computer software firms;
- agreements between mapping software and database firms and navigation system producers;
- agreements among diverse technology firms to develop integrated telematics devices, such as the many companies working with Intel to develop Car PC devices and applications;
- agreements between automotive interior firms and automotive telematics companies to incorporate telematics devices and networking into interior modules;
- relationships between telecommunication equipment firms and OEMs or automotive suppliers;
- relationships between "content" providers and OEMs or automotive infotainment equipment firms;
- relationships between automakers and telecommunications service providers for in-vehicle wireless services;
- agreements between customer service providers and either automakers or device firms to provide call centres for telematics services;
- relationships between OEMs and internet portals or service providers to offer a variety of web-based telematics services.

8 - FINAL RECOMMENDATIONS

This document concludes giving the following synthetic recommendations to truck manufacturers and system/ solution providers:

- Consider the list of user needs
- their detailed content and grouped hierarchy
- Consider available tools and expanding areas
- new types of OBCs
- communication technologies
- in vehicle networks
- positionning systems, etc.
- Consider the architecture output
- functional and control aspects
- information and management aspects
- physical and communication aspects
- Consider standardisation issues
- Consider HMI aspects
- Consider costs aspects.

With respect to the last point (cost aspects), not treated in this handbook, we recommend to take into account the COMETA document D7.3.2 "Handbook for fleet managers", in which costs/benefits aspects are addressed. The most relevant cost elements are mentioned there 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 administrative, safety, quality of service, flexibility aspects.

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.

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