COMmercial vehicle Electronic and Telematic Architecture

Programme Name:	**Telematics Application Programme**
Sector:	**Road Transport**
Project Number:	**TR 4005**
Project Acronym:	**COMETA**
Project Name	**COMmercial vehicle Electronic and Telematic Architecture**
Deliverable Type:	**Public (PU)**

Deliverable Number:	**D6.4**
Contractual Date of Delivery:	**10.02.2000**
Actual Date of Delivery:	**09.02.2000**
Title of Deliverable:	**Guidelines and recommendations for trucks manufacturers and solutions providers regarding on-board systems integrated architecture(s) specifications.**
Work-Package:	**WP6**
Nature of the Deliverable:	**Report**
Author(s):	**Guido Manescotto, Efisio Marongiu, Giovanni Ruberti, Dick Mans, Peter Van der Perre, Jacques Claude Rennesson, Catherine Guinan, Toufik Cherief**
Project technical manager:	**Jean André Lasserre (AFT/IFTIM)**
Tel:, Fax:	**Tel: +33 3 44 66 37 88, Fax: +33 3 44 66 37 60**
E-mail:	**mbouchat@aft-iftim.asso.fr ikrebs@aft-iftim.asso.fr**

Abstract: An overview about the COMETA user needs, about the tools available to implement the interfaces defined by the COMETA system architecture and about the currently expanding technological areas is given. In a second part of the document a substantial number of guidelines and recommendations for truck manufacturers and solution providers are given.

Keyword list: truck manufacturer, solution provider, guidelines, recommendations, integrated architecture specification, expanding technologies, user needs.

EXECUTIVE SUMMARY

The first aim of work-package 6 is the consolidation and finalisation of the COMETA system architecture. The second aim comprises:

a) the presentation of the system architecture
b) the identification of potential standardisation and harmonisation fields
c) the description of guidelines and recommendations for the potential users of the system architecture (freight and fleet management, truck manufacturers and solution providers).

This is one of two documents describing guidelines and recommendations for the potential users of the COMETA system architecture, namely for the truck manufacturers and solution providers.

The first chapter gives an overview about the user needs that were collected in interviews with fleet-managers, drivers, authorities and consignors/consignees, during the first phase of the project.

The second chapter gives an overview about the tools (e.g. technologies) that are currently available to implement the interfaces described by the COMETA system architecture.

The third chapter focuses on the new technologies, which evolution is probably of major importance for the development of telematics systems for on-board vehicles; these technologies concern:

- mobile communications,
- in-vehicle networks, vehicle electrical architecture,
- new types of onboard computers.

The fourth chapter is intended to present a limited number of substantial recommendations for truck manufacturers and solutions providers, regards the following aspects:

- Functional aspects
- Information aspects
- Physical aspects
- Standardisation aspects
- MMI aspects
- Cost aspects.

Table of contents

1. THE COMETA USER NEEDS

1.1 INTRODUCTION

Determining on-board system architecture for road transport vehicles must be based on specific knowledge of user needs in order to take the users into account. This approach allows to avoid the reaching of theoretical results, which are to far away from the market requirements. According to this specification one of the first steps of COMETA has been the identification of such needs, and prior to that, the precise definition who the users are.

Within COMETA a distinction has been made between "direct" and "indirect"[1] users of on-board computers for freight and fleet management. Direct users have been the main target of the user needs investigation carried out in WP 2 of the project and reflected in the COMETA deliverable D2.
They are:

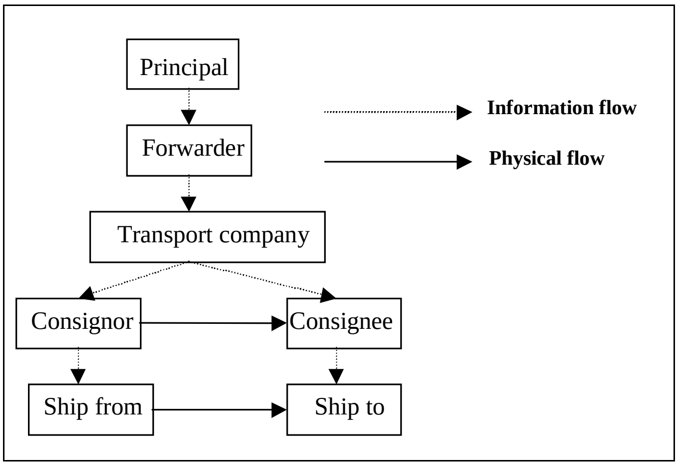
- transport companies

- commercial partners
  - consignor – contractual – (an individual or organisation that prepares a bill of lading by which a carrier is directed to transport goods from one location to another)
  - consignee (the party such as mentioned in the transport document by whom the goods, cargo or containers are to be received and accepted)
  - principal (an individual or organisation that requests certain tasks to be performed - by a contractor - against a relevant form of remuneration, when relevant stipulated in a contract)
  - forwarder (the party arranging the carriage of goods including connected services and/or associated formalities on behalf of a shipper or consignee. The forwarder is often contracted by the consignor or the consignee, depending on which terms of contract apply in the business relation between them)
  - ship from – operational -
  - ship to
  - drivers (the person driving the truck and operating the on-board system)

- public authorities (public bodies, high level ministries and local authorities involved or related to the transport process).

[1] Naturally the main "indirect" users are:
- OBC manufacturers
- truck manufacturers.

Figure below illustrate the roles and importance of these user groups.



Relationship between transport company and main commercial partners

In order to identify and define user needs, COMETA has produced a series of questionnaires, investigation tools destined to the actors of the business whose needs and requirements influenced the actual design of the systems architecture. These actors were fleet managers, drivers, and commercial partners (i.e. principal, consignor, and consignee).

Another questionnaire was then produced for system providers, so as to identify existing technical solutions/tools and to be able to anticipate later evolutions.

The aforementioned questionnaires were submitted to and validated by both the consortium partners and the sponsoring partners.

The identified COMETA user needs have been here grouped according to the following common objectives:

- social regulations enforcement and observance by drivers through the use of an electronic tachograph
- positioning, navigation and route optimisation
- operational and commercial management during trip, missions management
- documents management
- cargo management
- communication management and solutions optimisation
- automatic identification and tracking and tracing
- vehicle mechanics monitoring and control
- ensure and support safety and security
- provide driver comfort,

These are described in the following paragraphs. A detailed list of the user needs currently addressed by COMETA is available in COMETA Deliverable D6.1.

1.2 USER NEEDS

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. This kind of requirement addresses to manufacturers.

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.

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.

This is a requirement for solution providers: software, digital maps, telematic services.

Operational and commercial management during trip, Missions management

Here can be find conditions addressing the provision and process of all necessary information to allow a driver to execute required missions and tasks through real time exchanges with appropriate partners (fleet manager, but also commercial partners), addressing to 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.

This will be performed in different ways by fleet drivers or chartered drivers, but it will require appropriate on-board software and communication channels and protocols from solutions providers.

Documents management

These user needs, beyond the regulatory aspects that will require from authorities conditions 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.

The case of one man companies or chartered drivers

This category could be more demanding for appropriate software, hardware and communication solutions related to the two above mentioned requirements. The concept of mobile office for this category is made still more stringent when considering that it requires to a support for the management of tenders, offers, quotations, tariffs calculation and invoicing...

Cargo management

These user needs can be seen as ranging from weighting the goods to be carried (directly or through the variation of the vehicle weight), to the exchange and management of bay plans (so as to optimise loading/unloading and evaluation of remaining capacity), through the acquisition and memorisation of cargo characteristics (so as for instance to avoid incompatibilities), then 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.

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 accesses 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).

Automatic identification and tracking and tracing

Here to solutions providers will be asked to allow identification at all levels (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.

Vehicle mechanics monitoring and control

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

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

Ensure and support Safety and Security

These requirements can be divided into intrinsic passive safety specifications, to be followed by on-board system designers so as to avoid driver disturbance or use that could endanger him, and into 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 cover to anti theft assistance and alarm management, up to vehicle immobilisation.

These requirements imply of course appropriate sensors and data recording and transmission, possible telematic server supports.

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

Provide Driver Comfort

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

2. THE AVAILABLE TOOLS

To support the development of the COMETA physical and communication architectures, a technical toolbox containing physical and communication "tools" has been developed. In this chapter the results of this operation is presented according to:

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

2.1 COMMUNICATION TECHNOLOGIES

2.1.1 Protocols standards and visions

<u>WAP</u>
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. It is a initiative started by Unwired Planet, Motorola, Nokia and Ericsson to develop a standard for wireless content delivery on the next generation of mobile communicators.

<u>IMT2000 and the UMTS concept</u>
The ITU (International Telecommunication Union) has defined in the frame of the IMT2000 (International Mobile Telecommunication and its predecessor the FPLMTS (Future Public Land and Mobile System) the requirements for the 3rd generation mobile systems.
IMT2000 will provide wireless access to the global telecommunication through both satellite and terrestrial systems.

<u>FAP</u>
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. The FAP was originally specified by MANNESMANN AUTOCOM and PTV.

<u>Mobile EDI</u>
This proposal is a second attempt in the design and submission of an appropriate standard devoted to cover the «mobile» part of the road freight transport information chain, already using EDIFACT messages between partners.

It includes the first proposal submitted to EDIFACTBOARD, and to CEN TC 278 WG 2, FREIGHT AND FLEET MANAGEMENT, replacing EDIFACT Messages envelope by brackets (envelope management being transferred to the networks…) and proposing an IFTMEM («International Forwarding and Transport Macro Encoded Message») Message structure (with the creation of a «FMS = Fleet Management Segment»…) for functionality's not yet covered by EDIFACT existing Transport Messages.

2.1.2 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. According to the European political plans, it is going to replace the traditional VHF radio broadcast in a few years.

RDS/TMC

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

2.1.3 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 Apple Computer’s 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. Since then the PCMCIA has grown to include more than 400 member companies, which produce a wide range of add-in functions (PC cards) for mobile computers. The most advanced of these functions are being implemented using the CardBus technology.

RS232

RS is supposed to stand for Recommended Standards for serial communications. Nevertheless the RS232 is more an industry default than a standard. Fortunately, this standard (as the RS485) has been widely used for the implementations, to have become fairly consistent. Even though it is not a standard like IEEE-1394, it is good enough to allow for reliable implementation.

2.1.4 Medium and long-ranged 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 more and more used in other industrial applications.

RS485

RS is supposed to stand for Recommended Standards for serial communications. Nevertheless the RS485 is more an industry default than a standard. Fortunately, this standard (as the RS232) has been widely used for the implementations, to have become fairly consistent. Even though it is not a standard like IEEE-1394, it is good enough to allow for reliable implementation.

J1708

In-vehicle computer networks are used to transfer information over a serial link, between control modules, sensors and the outside world.
In The USA the trucking industry uses only the J 1708 standard defining those parameters of the serial link that primarily relate to hardware and basic software compatibility such us interface requirements, system protocol and message format. The serial data link is based on the EIA RS 485 standard.

J1587

This standard precisely defines all messages and parameters ranged 128 to 255 in the J1708.

2.1.5 Short-range wireless connectivity

IrDA

The Infrared Data Associations is an international organisation that was founded 1993 to create and promote interoperable, low cost infrared data interconnection standards that support a point-to-point user model. The standards support a broad range of appliances, computing and communications devices. IrDA has over 150 members drawn from major hardware, systems, software, peripherals, component, and communications manufacturers, cable and telephone companies, automobile and service providers.

BLUETOOTH

The Bluetooth technology is a result of a 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. It is based on a low-cost, short-range radio link and facilitates ad hoc connections for stationary and mobile communication environments.

DSRC

Dedicated Short Range Communication provide a means of communicating between vehicles and road beacons. This technology which has been developed to support the Electronic Fee Collection is today stabilised at the normative level, and its deployment is already ensured in France by the nearest introduction of TIS "Télépéage Inter Sociétés".

2.1.6 Medium and long-ranged wireless connectivity

2.1.6.1 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 since expanded into land, mobile and aeronautical communications its functions which operate a global satellite system used by independent service providers to offer an extensive range of voice and multimedia communications.

ORBCOM

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 world-wide geographic coverage.

IRIDIUM

The IRIDIUM system is a satellite-based wireless personal communications network based on a constellation of 66 interconnected LEO (Low Earth Orbit) satellites. The system allow for voice, paging, fax or data communications.

2.1.6.2 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.

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.

Mobitex wireless network technology is more and more recognised as an international data communication standard although it is operational in a limited number of countries. In the following European countries a network is available: Belgium, Finland, The Netherlands, Norway, Poland, Sweden and the United Kingdom.

Mobitex was developed in 1984 by Eritel for the Swedish Telecommunication Administration. Today, Mobitex is managed by the Mobitex Operators Association (MOA), which controls its specifications. The network infrastructure is manufactured by Ericsson Mobile Data Design AB.

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.

Trunked radio is a concept that involves both (digital) speech and data transmission.

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.

Developed by ETSI, the European Telecommunications Standards Institute, TETRA is the result of a massive co-operative effort between major manufacturers, regulators, operators and user groups.

2.2 POSITIONING SYSTEMS

NAVSTAR GPS
The NAVSTAR Global Positioning System (GPS) is a whole of twenty-four satellites which orbit around the earth. Launched and maintained by the US Department of Defence (DoD) these satellites send continuous signals to the surface enabling a receiver to determine its position.

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
There is strong support within the European community for a precision source of world-wide navigation and timing that is not under the sole control of the U.S. government. This concept is the Global Navigation Satellite System (GNSS).

This system uses NAVSTAR and GLONASS and other geo-stationary satellites to provide positioning, along with other components to improve accuracy and provide fast warning of problems.

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, the system itself is the leading two way mobile communications and vehicle positioning system via satellite dedicated to the transportation business and specially to enhancing the productivity of fleet management.

2.3 PORTABLE STORAGE MEDIA

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

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

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.

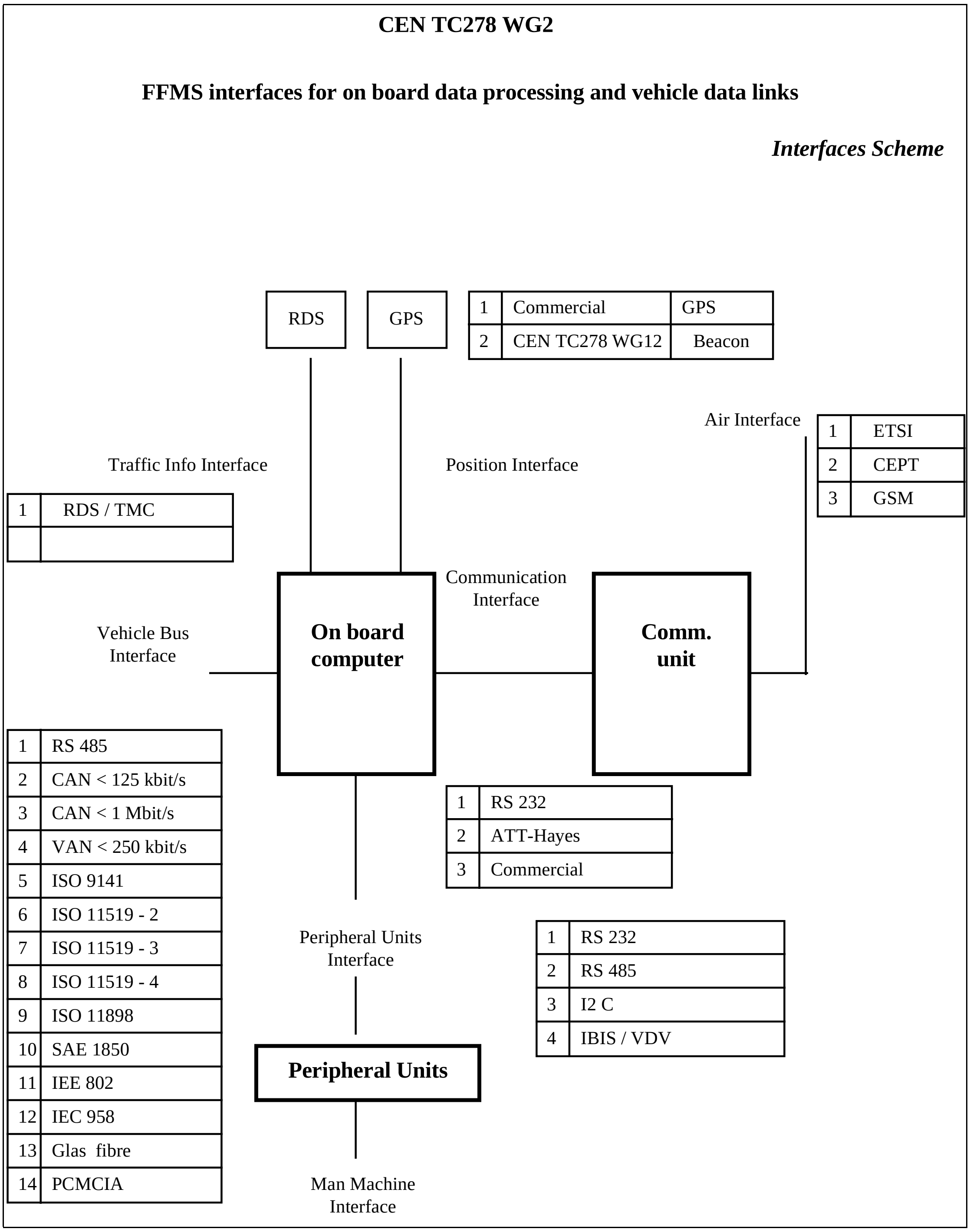
2.4 OTHER

Electronic signature processing
Several methods can be used to sign documents electronically from simple ones (scanned images of a handwritten signatures in a word processing documents) to advanced ones (digital signatures using public-key cryptography).
Although currently there is no agreed definition for it, an electronic signature may be defined as the electronic equivalent to a manual signature placed over an electronic document.

Electronic signatures allow people receiving data via the Net:
- To determine the origin of the data (identity the sender)
- To check if the data was modified during the transmission (integrity of the data).

The transmitted data is accompanied by a certificate, issued by the provider of service of certification which make it possible to the recipient to be ensured of the identity of the signatory.

2.5 MAPPING OF TECHNOLOGY TO INTERFACE



	PERIPHERAL INTERFACE	VEHICLE BUS INTERFACE	POSITION INTERFACE	TRAFFIC INFORMATION INTERFACE	AIR INTERFACE
RDS/TMC				✓	
DAB				✓	
RS232	✓				
USB	✓	✓			
Firewire (IEEE 1394)	✓	✓			
CardBus (PCMCIA)	✓				
CAN		✓			
J1708		✓			
RS485	✓	✓			
IrDA	✓				✓
Bluetooth	✓				✓
Euteltracs			✓		✓
INMARSAT					✓
ORBCOMM					✓
IRIDIUM					✓
GSM (GPRS, EDGE)			✓		✓
UMTS					✓
TETRA					✓
Mobitex					✓
Trunked radio					✓
GPS			✓		
GLONASS			✓		
GNSS			✓		
DSRC					✓

3. 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 telematic 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)

3.1 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; radio and cellular 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 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.

3.2 IN VEHICLE NETWORKS – VEHICLE ELECTRICAL ARCHITECTURE

In vehicle network architecture will represent a crucial point for the future developments of the on-board telematic systems and, in particular, for their integration with the vehicle and its productive process. The kilometers 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 may 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 to propose 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 telematic on-board systems development will be strictly connected in the next years.

3.3 NEW TYPES OF ON-BOARD COMPUTERS

New types of on-board computers have recently appeared on the market which look like real PC. 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 color display and it make 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 functionalities.

This computer is powered by the Windows CE operating system which has been designed for portable and hand-held computers. The philosophy of 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 meant that for building a new device, only the needed pieces are picked and choosed; 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.

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

4. GUIDELINES AND RECOMMENDATIONS

4.1 INTRODUCTION

The COMETA project is initiated to answer the strong concern regarding the potentially growing proliferation of on-board systems for commercial vehicles. Some of these systems are offered by the market and some are imposed by authorities.

The objective of COMETA was to define and design modular associations of various on-board performed functions, allowing for efficient interfacing within a global transport telematic system.

To this aim a first architecture predesign has been identified to simulate its implementation with different fleet operators already equipped with partial dedicated devices.

The architecture predesign has been reconsidered after the simulations; all the needed adaptations, improvements and strengthening of weak points have been identified; all kind of necessary parallel actions and recommendations have been made, in order to speed up the concretisation of an board systems architecture(s) modular, interoperable and cost effective.

The outputs of these operations has been consolidated in various documents addressed to systems architecture designers and users, fleet operators, truck manufacturers and solution providers.

The contents of this deliverable and of this chapter in particular, are intended to present a limited number of substantial recommendations for trucks manufacturers and solutions providers regarding on-board systems integrated architecture(s) specifications.

4.2 GUIDELINES AND RECOMMENDATIONS

4.2.1 Functional aspects

QUESTION CODE: **1**

What functional aspects do we recommend to take into account ?

ANSWER

A wide range of functions have been identified as important as a result of the user needs analysis and validation work packages. These functions have been grouped into three large functional areas:

1. Manage business transactions: This area contains all the functions that interact directly with the client. Essentially, these functions obtain transport orders from the client, provide him with all necessary status information regarding the order and finalise the handling of the order in the form of invoicing and payment.
2. Prepare vehicle, driver, equipment and cargo: This area contains all the functions that are necessary to prepare the resources (vehicle, driver, cargo and equipment) required to execute transport orders (and any tasks unrelated to transport orders) as well as the functionality to prepare trips, routes and load plans. Preparation of resources includes of checking their availability, making early reservations and converting these reservations into bookings at the moment that transport orders have finally been received.
3. Perform and control vehicle, driver, cargo and equipment operations: This area contains all the functions required during the actual execution of transport orders (and any tasks unrelated to transport orders). Functions clearly within the domain of freight and fleet management include the monitoring of cargo and equipment as well as of the progress of tasks. But other functions that are closely related have been elaborated as well because of their close link to freight and fleet management. These include compliance with regulations, management of traffic and route guidance information, provision of access to comfort services, the monitoring of vehicle and driver, provision of emergency calls and advanced driver assistance.

COMETA recommends to carefully consider the functionality of functional area 3 for any implementation. It suffices in the case of fleet drivers assuming that all the direct (commercial) contacts with the client (area 1) as well as the preparation of resources and calculation of trips, routes and load plans (area 2) will be handled by the fleet manager. This is possible as area 3 feeds the fleet manager will all relevant data ensuring that the fleet manager has the up to date information that is necessary to fulfil areas 1 and 2.

Whether functional areas 1 and 2 should be carried out on board depends on the specific situation of the driver. Clearly, the entire functionality is necessarily on-board in the case of independent or chartered drivers. In the case of fleet drivers, area 2 should first be considered for installation on-board as it allows a great deal of flexibility to handle new transport orders or other tasks ordered by the fleet manager. As a second step, area 1 is also useful to be carried out on board for reasons of flexibility. Clearly, it also has the potential to accelerate payments. Availability on-board of functional areas 1 and 2 also allows drivers to act as a part of a larger fleet (adhering to specific procedures) as well as independent or chartered drivers.

As an important final remark, we would like to stress that the functionality of areas 1 and 2 does not necessarily have to be installed on board for drivers to have access to it. The services can also be provided by server (service provider) acting as a “virtual fleet manager”.

Below, the main functions in each functional area are described in greater detail.

<u>MANAGE BUSINESS TRANSACTIONS</u>

The most important functional elements are:

- to acquire transport orders by preparing transport offers in response to transport opportunities or by indicating the availability of excess capacity
- to provide the client with status information as agreed in the transport order or in response to a specific request
- to handle all administrative aspects of the order vis a vis the client in the form of invoices and payment.

Negotiate transport orders
This function is responsible for the commercial interface between an independent (or chartered) driver and a (potentially) contracting party (consignor, consignee, principle or forwarder). The function also looks over the order book and sends - when needed - transport capacity availability advises or transport opportunity requests to potential customers. As such it basically handles transport orders. The function delegates the necessary preparation of resources (checking of availability and early reservations) such as documents, vehicle, driver, equipment, cargo, accessories and other transport modes to another function. It will also rely on this function to book the resources when a transport order has finally been received. Once the commercial negotiation is finalised, the function hands over further activity to the functions in charge of performing and controlling the vehicle, driver, cargo and equipment operations. The closure of the order from an administrative point of view plus invoicing and payments are also handled by a separate function.

Administrate business transactions
This function is responsible for the administrative operations of an independent (or chartered) driver. As such it prepares and sends invoices to customers and waits for payment.

PREPARE VEHICLE, DRIVER, EQUIPMENT AND CARGO

The function will essentially prepare resources (by checking their availability and status, by making early reservations if suitable and by booking the resources when the transport order has finally been received) such as documents, the vehicle, driver, equipment, cargo, accessories and any other transport mode involved in executing the order. Upon reception of the transport order, the function will also be triggered to transform the order into specific tasks, including the detailed trip(s) to be made for executing the order as well as the route and the load plan to be followed.

Prepare resources
This function groups all necessary functionality to ensure a independent (or chartered) driver that his vehicle, driver, equipment, cargo and accessories are ready to help perform a transport order. The most important elements are that:

- the necessary statutory, commercial and operational documents are available on board the vehicle
- the vehicle's maintenance situation and the driver's driving time records as well as the cargo, equipment and accessories availability and status allow to perform the task
- liaison with any other transport mode needed to perform the task.

The functions include early reservations for resources to avoid that conflicting tasks or transport orders are unconsciously accepted at a later stage.

Prepare trips, routes and load plans
This function prepares the trip, route and load plan for a confirmed transport order. It obtains route information and information on environmental conditions, such as traffic, weather, pollution, etc. from a supporting function. It also has the responsibility for providing information about the transport of hazardous goods when required. The function shall obtain the information through communication with the route information providing function.

PERFORM AND CONTROL VEHICLE, DRIVER, CARGO AND EQUIPMENT OPERATIONS

The most important elements helping to perform operations are:

- support to check whether loaded or unloaded cargo corresponds to the transport order
- support to comply with regulations, the provision of driver assistance functions and access to comfort services and support for payment operations.

The most important elements helping to monitor operations are:

- the monitoring of any relevant vehicle, driver, cargo and equipment parameters including storage of relevant parameter values for future use
- warnings if certain thresholds are exceeded
- support for monitoring the progress of transport orders and other accepted tasks.

Check whether cargo conforms to transport order
This function helps to ensure that the loaded and unloaded goods correspond to the goods that are described in the corresponding transport order. The function is triggered by the driver at the start of loading or unloading operations. The function will ensure that there is a match between the unique identifiers that are marked on the loaded and unloaded goods and those that are stored in the corresponding driver task instruction. If this is not the case, this will be stored in the vehicle, driver, cargo and equipment data store.

Comply with regulations
The function typically allows the authorities to check the compliance of the driver with the European Union's social regulations as well as the availability on board of statutory documents required for executing the transport order.

Provide advanced driver assistance
The main functionality is:

- the monitoring of visibility conditions for the driver (darkness and glaring)
- longitudinal dynamic control such as for supporting parking, intelligent speed adaptation, adaptive cruise control, stop & go and anti-collision emergency braking, speed enforcement and vehicle platooning
- lateral dynamic control such as for supporting parking, lane and road keeping, lane change, reserved lanes I/O, overtaking and stop & go
- automated driving
- miscellaneous functions such as the provision of road regulations, the provision of floating car data, support for tracking stolen vehicles and the detection of law violations.

Provide access to comfort services
This function provides driver comfort by providing telephony services as well as access to information and entertainment services. The function is triggered by a request of the driver.

Manage traffic and route guidance information
This function supports the driver in providing traffic, weather and pollution information as well as in finding the shortest, quickest or cheapest route from any origin to any destination taking into account any of this information. The function is either triggered by a request from another function or directly by the driver.

Support payment operations
The function provides support for road based or area based tolling as well as for any service that requires payment support.

Monitor vehicle
The first function supports a wide range of other functions that request the current vehicle position from it whilst the second function essentially collects and stores engine and maintenance related data.

Monitor driver
The function receives the social regulations data and supports warnings to the driver as well as (if relevant) to the fleet manager. It also monitors the physical status of the driver such as driver fatigue. Finally, it supports the monitoring of driver expenses as well as driving behaviour evaluation and training.

Monitor cargo
This function will monitor and store the status of the cargo and warn the driver and - if relevant – the fleet manager if any dangerous situation arises.

Monitor equipment
The function supports requests from other functions to provide the current position of the vehicle equipment. It also responds to requests from other functions on the current status of the equipment, for instance on its availability and status (driven kilometres, registered temperatures, maintenance record, etc.).

Monitor progress of tasks
This function helps to ensure that the driver will comply with task instructions including the necessary feedback and reporting. The function will maintain a queue of on going and foreseen tasks and support the driver by providing early warnings for requested feedback.

Provide emergency call
This function initiates emergency calls to any relevant party and follows up the emergency by waiting for an acknowledgement of the call as well as for advice and a description of planned support actions.

Support electronic signature
This function initiates the collection of electronic signatures; it is triggered by a request for an electronic signature by any other function.

4.2.2 Information and management aspects

QUESTION CODE: **2**

What information and management aspects do we recommend to take into account ?

ANSWER

For the information architecture an entity relationship diagram is used to visualise the entities that are present in the on-board data-base and the cardinality of the relationships between them. In the final implementation (the on-board data-base stored e.g. on a hard-disk) an entity is represented by an entry (the so called record) in a so called table. Each record is a pre-defined array of alpha-numerical or numerical values of fixed length. Each table is an array of records of a specified type. A record corresponds to the physical representation of an entity.

Informational clusters

Depending on the functionality implemented in the on-board computer system a number of entities (data-base records and consequently tables) may be either merged with each other, or may be completely absent in a possible implementation.

The data entities modelled in the entity relationship diagram may be sub-divided ad-hoc into the following informational clusters, which could be regarded as being modular components of the database. Each cluster is managed by a specific application layer. Hereby the following application layers can be identified:

1) Management of commercial information
   Principal (Forwarder)/Consignor/Consignee, Transport order (opportunity), Transport order status (includes Proof/notice of pick-up/delivery), Offer (quotation), Invoice, Rate/Tariff, Cargo, Logistic unit.
2) Management of electronic documents
   Driver document, Vehicle document, Equipment document, Cargo document, Transport order.
3) Management of operational information
   3a) Monitoring of operational statuses
   Driver status, Vehicle status, Cargo status, Equipment status, Accessory status.
   3b) Management of loading/unloading information
   Vehicle, Equipment (trailer), Load plan, Cargo, Logistic unit.
   3c) Management of tasks order/task
   Tasks order, Task, Task report, Landmark.
   3d) Management of additional information
   Re-usable equipment report, Driver expense.

4) Management of road information
   Landmark, Route, Road (segment).
5) Management of resource information
   Driver, Vehicle, Equipment (e.g. trailer), Accessory

As can be seen from this sub-division, certain entities may be administrated by different data management layers like e.g. "Landmark" which is controlled by "Management of mission order/task" and by "Management of road information". This means that certain fields out of a landmark-record are relevant for the respective first cluster, while others are relevant for the respective second.

Another example is the "Transport order" which is both, commercial information and (with a look to the future) an electronic document; for this reason it is administrated by the management application layer "Management of commercial information" and by "Management of electronic documents".

Life-cycle of the information

As mentioned before, a record is a physical representation of a database entity. For a system developer it is extremely important to have some information about the so called "life-cycle" of a record, meaning the time (or event) when a record is created and the time (or event) when it is deleted or (more common) when it is archived. The information and management architecture description presented as part of the COMETA system architecture includes this kind of information.

Physical considerations

Generally in COMETA we differentiate between the driver doing acquisition of transport orders and administration himself (independent driver) and a driver who is directly employed by the transport company and "only" takes care about the driving (fleet driver).

A minimum database for the fleet driver consists of the tables "Mission order", "Task", "Landmark" and "Principal (Forwarder)/Consignor/Consignee" (with minimum information about the contact person). To reduce the number of database tables (e.g. if a copy of the principal (forwarder)/consignor/consignee table cannot or does not need to be stored on-board) "Landmark" and "Principal (Forwarder)/ Consignor/ Consignee" may be merged into a single, simple table.

The "Equipment" table stores the characteristics of the equipment (if e.g. a new trailer is attached to the traction engine); these characteristics include the dimensions of the loading space; the same applies for the "Vehicle" table (for the vehicle). Theoretically the traction engine (vehicle) may transport a trailer from point A to point B, a second trailer from point B to point C etc. Each of these trailers may require an own loading plan for the logistic units; if no trailer is meant, then the loading plan refers to the loading space of the vehicle.

A load plan is determined before the trip (if the "Logistic unit" information is available). The "Load plan" contains the information about the order of the logistic units to be loaded/unloaded.

The fully extended "Principal (Forwarder)/ Consignor/ Consignee" table together with "Transport order", "Transport order status", "Offer (quotation)", "Invoice" are present only in the case of an independent driver who manages the commercial information himself.

Additional remarks

The eventuality that the driver may carry the on-board computer with him (when exchanging vehicles with another driver) is not taken into consideration by the data model presented.
A "Tour" is a "Mission order" containing only trips. A "Trip" is a special kind of task, where a destination is given. The relationship between "Task" and "Route" exists only if the task to be carried out is a trip.

A trip is a journey from point A to point B. For simplicity reasons the starting point is either the home-base or the last point B, so each "Trip" references only one "Landmark", which may be any kind of stop (e.g. pick-up, delivery, ferry, border). Logically a new trip starts as soon as the "Tour" (mission order) with all the "Trips" (tasks) information is downloaded to the on-board computer system or as soon as a "Trip" (task) is accomplished. A "Tour" (mission order) is accomplished as soon as its last "Trip" (task) is accomplished.

The so called "Path" or "Route" cannot be reflected directly by an entity, but is the result of a database query (a so called view) and is described by a list of links. The resulting vector of the database query "determine the path/route for trip1" or more specifically "determine all road segments to be driven for trip 1 and order the list by the sequence number" could look like the following

$$Path / Route = \begin{pmatrix} trip1 & segment22 & 1 \\ trip1 & segment30 & 2 \\ trip1 & segment35 & 3 \end{pmatrix}$$

meaning that first a road segment identified by the ID 22 has to be driven, then a road segment with the ID 30 and last road segment 35.

4.2.3 Physical aspects

QUESTION CODE: **3**

What physical aspects do we recommend to take into account ?

ANSWER

PHYSICAL ARCHITECTURE: «FREIGHT FLEET, VEHICLE, DRIVER, CARGO, EQUIPMENT SYSTEM» WITHIN FREIGHT AND FLEET MANAGEMENT SYSTEMS

This section provides a description of the Physical Architecture which forms part of the COMETA System Architecture.

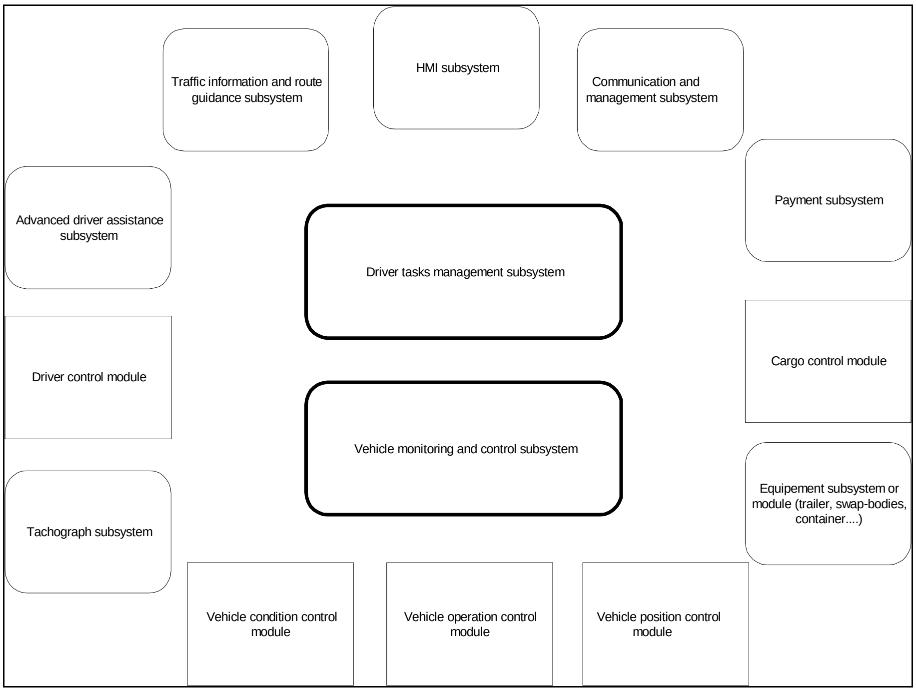
A Physical Architecture defines and describes the way in which the constituents of the Functional Architecture can be brought together into groups to form physical entities. The main characteristics of these entities are firstly that they provide one or more services required by the user needs, and secondly that they can be created. This creation process may involve physical things such as roadside structures and various forms of equipment, non-physical things 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 (high level and low level functions, data flows to / from / between them and Terminators) 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.

This section considers the Physical Architecture as a series of "example Systems".

This approach has been adopted because there are many ways in which a Physical Architecture can be produced from a Functional Architecture. The purpose of these "example Systems" is to illustrate examples of products that could be produced to fulfil some of the COMETA user needs. The description of each System includes details of the parts of the Functional Architecture (Functions, Data Flows and Data Stores) that it includes, as well as providing information on what the System can provide.

THE CONCEPT



Freight, Fleet, Driver/Vehicle/Cargo/Equipment system: The Concept

Static view

This COMETA System provides, either for large freight fleet or for independent or chartered drivers, a Freight Fleet, Vehicle, Driver, Cargo, Equipment System, when these four entities are combined so as to perform operational or commercial road freight transport activities, even involving other transport modes, in a given infrastructures management and public regulatory environment. It does mean that it is not limited to on board information management but that it aims to the integration of these four entities in a wider intelligent transport system.

The System is physically distributed, consisting in :

- Driver Tasks Management Sub-system,

  Which supports the execution, monitoring, reporting of tasks required from a driver by his Fleet Manager or directly by another "partner" such as Principal, Freight Forwarder, Consignor, Consignee, Infrastructure Managers, Authorities, or the performance of which will be helped by the same, or by dedicated Telematic Services Providers.
- Vehicle Monitoring and Control Sub-system,

  Which provides an internal support to the driver, providing automatically or on request information, so as to prepare, execute, monitor and report on any operation involving the four above mentioned components.

  This Sub-system gathers the following Modules:
  - Driver control
  - Vehicle operation control
  - Vehicle condition control
  - Vehicle position control
  - Cargo control
  - Equipment module.

- Equipment Sub-system, in the "Autonomous" scenario, where one will find nearly the equivalent of the "Vehicle Monitoring and Control Sub-system" mentioned here above, without, of course, a driver control module.
- Tachograph Sub-system, which captures, stores and protect information related to driver compliance with social regulation and others related to vehicle operation. This tachograph could be seen as a sensor like others used for data capture, but its legal status and the fact that it allows (beyond appropriate handling by the driver) for direct access from authorities, requires to consider it as a Sub-system as such.
- Advanced Driver Assistance Sub-system, which gathers driving helps which will be found in any "intelligent vehicle", but with the addition of vehicle platooning functions more dedicated to freight vehicles.
- Payment Sub-system, which allows automatic electronic fee collection for various services (even without stopping the vehicle) and manages related procedures.
- Traffic Information and Route Guidance Sub-system, which provides another kind of help to the driver, from simple appropriate information up to a complete automatic navigation system receiving possibly instructions from the infrastructures.
- Communication management Sub-system, which covers a possible wide range of solutions, from voice mobile phone or fax to a multiprotocol, multistandards, multinetworks (from short range to satellite, from infrared to INTERNET and UMTS) communication platform.
- HMI Sub-system which provides, beyond all what can be already imagined through the above descriptions, interfaces such as display, keyboard, voice recognition and process, printer, bar code and smart card readers / writers, printer.
- Entertainment Sub-system, which will be found too in any "intelligent vehicle", be it TV or INTERNET or other medium, but which will not be addressed here.

Dynamic view

The "concept" means here that the combination of these Sub-systems and modules may vary, of course, according to companies profiles and transport activities specificity, but it means too and most, that, beyond technical evolutions to be expected in the coming years (COMETA Physical Architecture have not been "dated") the combination will depend on two major factors :

- Important on board information processing or simple terminal, all what can be remote processed, being processed that way with permanent communication.
- Progress (as far as relevant and cost/efficiency justified) towards a complete integration of these Sub-systems, which can be seen today as a group of separated building blocks, due to state of art, but, too, due to vehicle manufacturers and authorities present requirements.

Beyond the possible evolution of the "Generic Intelligent Vehicle" in the future, which consideration is left to KAREN, these perspectives will be briefly considered, added to the particular point of the "Intelligent Autonomous Equipment" mentioned above and added to the consideration of the impact of emerging possible "virtual fleet managers", that is to say telematic services provided to drivers by third parties, through standardised applications interfaces.

A focus will be made, nevertheless, on what can be seen as a transitory phase allowed by standardisation of vehicles internal data buses.

Therefore, after a brief reminder of what can be seen as a starting solution, the "concept" will be developed on the basis of shortest term, or even on going, evolution.

SUB-SYSTEMS

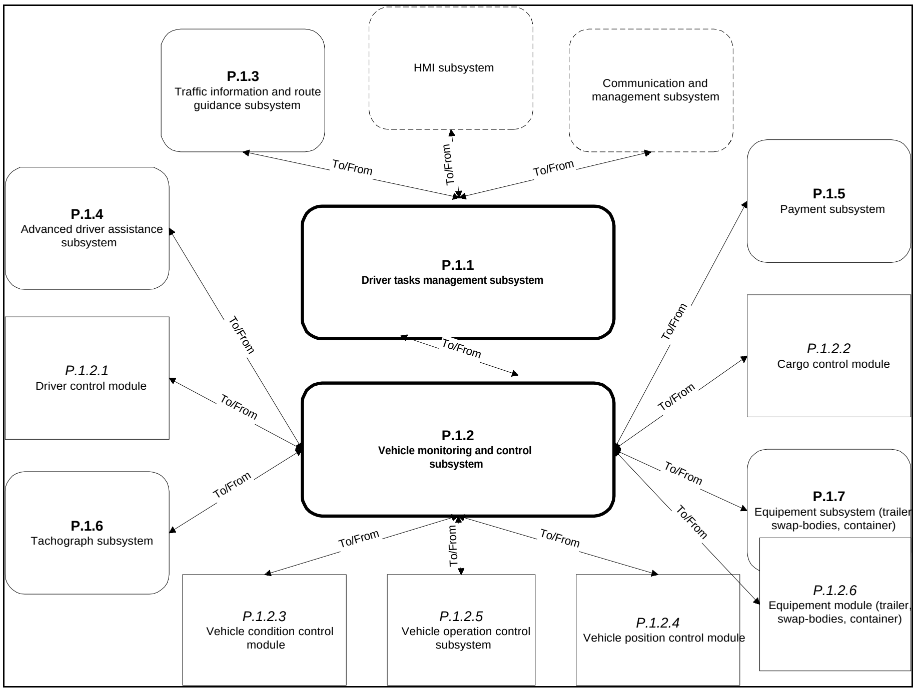
The Freight Fleet Vehicle, Driver, Cargo, Equipment System consists of (possibly, if the Equipment is autonomous) seven Sub-systems.

They provide a demonstration of the different functionality within the management system, an illustration of how :

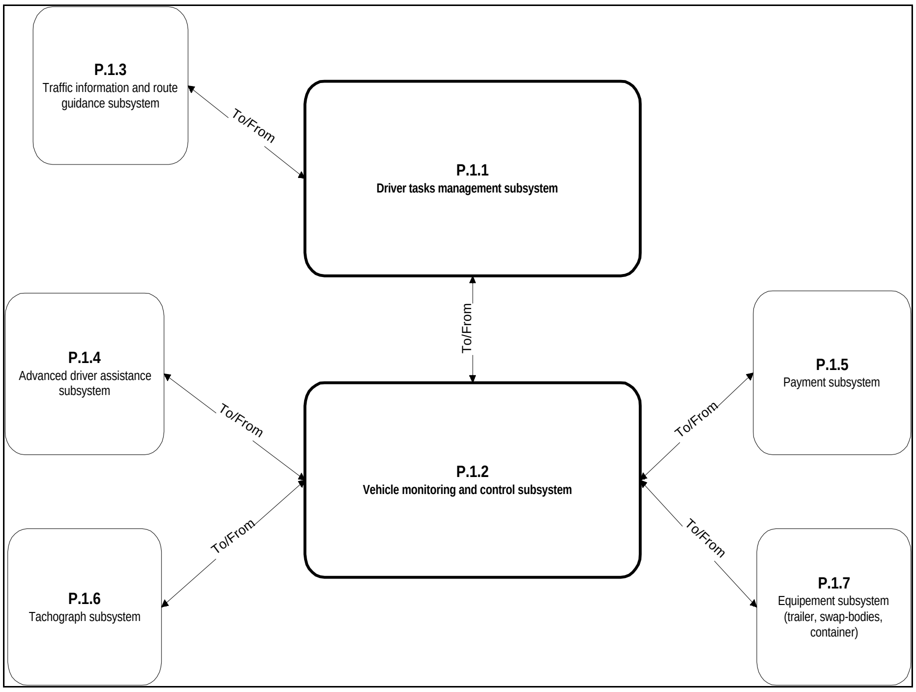
- an independent or chartered driver would use this system to be physically close to its customers (and Authorities), in this case the customers are represented by the "Principal" actor be it Consignor, Consignee, freight forwarder.
- A fleet driver would use this system to be close to his fleet manager, even if he could be allowed to exchange with other partners, including, too, Authorities.

The Subsystems are described hereafter. They are also shown in the following figures, together with their relationships to each other and the terminators.

First through a short term global internal view then selected at the sub systems level next, one by one.



Freight, Fleet, Driver/Vehicle/Cargo/Equipment: The short term global internal view



Freight, Fleet, Driver/Vehicle/Cargo/Equipment system: The subsystems diagram

The subsystems diagram represented here the "major" components of the on board systems Physical Architecture.

Driver tasks management Sub-system gathers all hardware (even a removable one) and software that will be operated by the driver or directly triggered by partners or by the vehicle monitoring and control Sub-system, so as to perform adapt or modify and stop the performance of any kind of task. It could have been subdivided into more specific modules (leaving aside the HMI and communication aspects) according to the type of support to be provided to tasks preparation and performance. These modules should mainly be software modules and possibly related data bases. These potential modules can be implicitly identified "behind" the data flows.

Nevertheless, this subsystem will have a "privileged interlocutor" with a more or less sophisticated traffic information and route guidance Sub-system, able to "operate" on its own.

Vehicle monitoring and control Sub-system is tied to the vehicle and is supposed to play an orchestra leader role in receiving, storing, selecting, processing and emitting all relevant information. It is supposed to be permanently interfaced with 4 other more or less autonomous Sub-systems : Advanced driver assistance Sub-system, Tachograph Sub-system, Payment Sub-system, Equipment Sub-system (in the "autonomous" scenario).

Opposed to the Driver tasks management Sub-system, the specificity of its potential hard and soft components allowed and even required a subdivision in appropriate modules which will be reviewed as such.

This Sub-systems level (and the underlying Modules) should not be directly mapped to Functions, as far as if some Functions could be easily "followed" within a Sub-system, some, such as, for instance, compliance with regulations other than social ones (which may be related to Driver, Vehicle, Cargo, Equipment) or provision of emergency call, may be performed in many different ways and involve different Sub-systems and / or Modules.

SUB-SYSTEMS DESCRIPTION

P1.1 Driver Tasks Management Sub-system

This Sub-system provides all the functionality so as to receive, execute, monitor, make report, send reports of tasks required from a driver by his Fleet Manager in the fleet driver scenario or manage orders directly with another “partner” such as Principal, Freight Forwarder, Consignor, Consignee, for the independent or chartered driver and “translate” them into the same kind of tasks.

This Sub-system provides for both, functionality for the management of information from/to Infrastructure Managers, Authorities, or from dedicated Telematic Services Providers.

P1.2 Vehicle Monitoring and Control Sub-system

This Sub-system must be seen as an internal support to the driver (or directly to other terminators such as Fleet Managers, Emergency Services, Maintenance Services, etc.) providing automatically, or on request, permanently captured information, so as to prepare, execute, monitor and report on any operation involving, beyond the driver himself, the vehicle, the cargo or the equipment.

P1.3 Traffic Information and Route Guidance Sub-system

This Sub-system provides and possibly manages, traffic Information and Route Guidance, as an help to the driver, from simple appropriate information up to a complete automatic navigation system receiving possibly instructions from the infrastructure

It is clear that very different information could be provided by very different Services Providers (and even, for some of them by Fleet Manager or even Authorities). It is clear that it could be rather “raw” information or highly processed one.

P1.4 Advanced Driver Assistance Sub-system

From KAREN project: "*This System provides all kinds of facilities for Advanced Driving Assistance. It is based on similar Systems that exist or are under development in different countries and particularly as part of the European Commission 4th Telematics Application Programme (4FP). In this System both the standard components (like engine, brakes, dash-board, sensors etc.) and the ADAS equipment (like radar, cameras, automatic controls, telematic equipment etc.) are considered as part of the vehicle*".

So seen by COMETA, this subsystem provides driver with advanced assistance, which gathers driving helps which will be found in any "intelligent vehicle", but with the addition of vehicle platooning functions more dedicated to freight vehicles.

P1.5 Payment Sub-system

This subsystem is responsible for automatic electronic fee collection payment for various services, even without stopping the vehicle, and manages related procedures.

Payment Sub-system is here a very generic approach, as far as it may cover a range of different services, such as Electronic Toll Collection, ECO Points, Road Pricing, Fuel, Hotel, Restaurant, Garage, INTERNET Services, from DSRC to wide range communication, using or not smart cards, electronic purse concept or not.

P1.6 Tachograph Sub-system

This sub-system captures, stores and protect information related to driver compliance with social regulation and others related to vehicle operation. It receives inputs from the driver (on occurrences) and from vehicle sensors (on a permanent basis). It has its own HMI, for the time being, and its content can be accessed (without any modification possibility) by the Driver, the Fleet Manager and, of course, Authorities.

The Tachograph Sub-system is of course represented here in its basic configuration, where it is handled by the Driver and accessed by Authorities. Value addition is brought to the Systems Architecture, through its use as a data capture tool by the “Vehicle Monitoring and Control Sub-system”, so as to allow for various processes.

We know that, for the time being the Tachograph Sub-system may be directly interfaced with a Communication solution, so as to provide the Fleet Manager with information without Driver intervention.

P1.7 Equipment Sub- system:

This Sub-system, in the “Autonomous” Equipment scenario, provides nearly the equivalent of the “Vehicle Monitoring and Control Sub-system” mentioned here above, without, of course, a driver control module.

4.2.4 Standardisation aspects

QUESTION CODE: **4**

What kind of standardisation aspects do we recommend to take into account ?

ANSWER

Mobile EDI messages in general

As can be seen in COMETA deliverables D6.1 and D6.2, when coming to physical and communication architecture, the need for standardised messages becomes stringent.
Tasks and Tasks reports, status reporting, Transport Orders (to which among others transport opportunity and offer could be added), are necessary conditions for the design of a solution based on this systems architecture.

Integration of new information structures in messages, to reduce the importance of „other information“ flows

Beyond the above statement, automated dialogues between home-based applications and on-board ones require the creation of "ad hoc" messages containing free text zones and/or messages 5 (questions/information from the home-base to the mobile unit) and 6 (questions/information from the mobile unit to the home-base) in the present EDITRANSPORT list, which could be seen as "miscellaneous" for the time being.

Integration 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 and cargo information)

This can be seen as precise cases or alternatives to the above mentioned issues.

The system should allow for automatic addition of various kind of more technical information within operational messages. This aspect is already addressed in standardisation area, considering a first proposal called "MDTP" ("Micropross Data Transfer Protocol).

An ISO "ad hoc" Group is drafting a standardisation proposal (ISO CD 16844) divided in 9 parts:

- Part 1: Connectors.
- Part 2: Recording unit – Electrical interface.
- Part 3: Recording unit – Speed and distance sensor interface.
- Part 4: Recording unit – Check and calibration interface.
- Part 5: Recording unit – download interface.
- Part 6: CAN interface.
- Part 7: Secured CAN interface.
- Part 8: Diagnostics.
- Part 9: Parameters definitions.

This document had a first voting circulation (ISO DIS) at the end of 1999; the result is not yet available.

Beyond that, it is necessary to consider the content of the "Technical Annex" of the new regulation addressing the electronic tachograph, to be mandatorily adopted at European level, not only to start the count down of the future introduction date of this tachograph (2001 / 2002?), but also and most here to analyse the possible consequences on the On Board System(s) Architecture and possible standardisation requirements beyond the regulatory stipulations.

Unfortunately, when this Deliverable is written, this annex has not yet been adopted.

More interoperability and integration between sub-systems (control modules)

This point has been illustrated by the low level, transitory and high level scenarios described in COMETA deliverable D6.1.

The most important development in the domain of "Interfaces for on board data processing and vehicle data links" is now expected from the AMIC initiative (gathering all cars and trucks manufacturers) and the ITS Data Bus FORUM, a private industrial initiative (mainly from the USA), of which we know very little up to now…

During a presentation in TORONTO 6th ITS World Congress, where one could understand that this development was just starting (and to last some two years) and that "Special Interest Groups" will be gathered, COMETA representative asked if one could be convened for trucks applications and was answered to positively.

Nevertheless one should remind that it is foreseen that the networking of On Board Systems will mean a minimum of two interfaced Data Buses as described in Del 6.1, which means that enhancement are expected too on CAN bus or from WORLDFIP, a standard proposed by CEN TC 278 WG3 for Public transport vehicles.

It is clear that any progress in that direction will make the whole system more user friendly, cost efficient and cheaper. It is clear too, that it will make it safer to operate.

Considering HMI aspects: Harmonisation between support devices

It seems difficult to imagine standardised HMI, whoever the truck manufacturer or solution provider is. Nevertheless, according to the fact that fleet will remain often heterogeneous and that the couple driver/vehicle will be more and more dissociated in the future, efforts should be made towards HMI harmonisation.

Happily, one may think that these efforts could be facilitated by a general trend in information processing tools.

Compatibility and interoperability of sub-systems (in terms of control modules and physical components) from different manufacturers

This issue could be considered as a redundant one after the above mentioned. But it needs to be considered that such a “transitory” period could still last many years and that therefore fast and practicable solutions are urgently needed.
The FLEETMAP project funded by the European Commission for example is promoting a communication protocol called FAP (Fleet Application Protocol) located at the interface between the in-house fleet-management applications and a communication server called FPS (Fleet Protocol Server), which manages the communication with the on-board units and the service provider(s) or even third parties. The FAP/FPS solution allows to use and combine different on-board units and communication mediums.
FLEETMAP is currently developing a FAP certification concept for fleet-management software and initiating the standardisation process of the FAP.

Importance of the evolution of hardware and software

Up to now on-board systems were sold with their “proprietary” software. Nevertheless the wide spreading of e.g. Windows CE, JAVA and INTERNET based solutions show a trend towards modularity, interoperability and consequently open systems.

Importance of the evolution of communication solutions

Regards external communication high transfer-rate solutions such as GPRS and EDGE are expected in the coming years; it is obvious that this will encourage real-time transmission of a consistent amount of information. This could simultaneously encourage opposed perspectives: the mobile office with many communicating applications as well as the simple communication and information terminal.
For internal communication, much is expected from on going work addressing either wired networks (IDB/CAN) or radio ones (BLUETOOTH).

Importance of the global integration approach, through the role of integrators and telematic services providers

The concept of virtual fleet manager, which is presented in COMETA deliverable D6.1, is already entering the market either promoted by communication providers (e.g. WEBRASKA from ALCATEL) or promoted by car/truck manufacturers (e.g. diagnosis and remedy support, emergency support). The wide spreading and increased comprehensiveness of these offers will wipe off the borders between the modalities of usage of on-board systems by SME's (with e.g. a maximum of 50 vehicles) and by big companies with large fleets.

Possible impact of new public/private relationships

The introduction of the electronic tachograph, possibly followed by developments of other regulations enforcement measures in the field of safety checks, could provide the basis for a new common usage (and implementation acceleration) of on-board systems and of an equivalent of the American CVISN (Commercial Vehicle Information System Network).

Consideration of longer term hypothesis: the automatic vehicle, automatic highways and the autonomous intelligent equipment

Beyond the immediate perspective of vehicle platooning, investigation should be started, so as to be prepared to maximise the benefits of having vehicles and equipment managed as industrial production units more and more automated. This will mean adapted "intelligent" infrastructures.

4.2.5 MMI aspects

QUESTION CODE: **5**

What kind of MMI aspects do we recommend to take into account ?

ANSWER

GENERAL ASPECTS

Based on the list with 119 final user needs, which is the basis for the COMETA on-board system architecture and the results of a driver survey carried out in COMETA workpackage 2, 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.

- 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 – one only managing simultaneously mobile communication and on-board computer – 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 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.
- 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.
- The information, which the driver must read, should be presented on 2 screens at least. 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 in the steering wheel, making it possible for the driver to use without taking his hands off the wheel.
- 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.

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 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. These principles are related to the following issues:

- How to design and locate information and communication systems in such a way that their use is compatible with the driving task.
- How to present information so as not to impair the driver's visual allocation to the road scene.
- How to design system interaction such that the driver maintains safe control of the vehicle, feels comfortable and confident with the system and is ready to respond to unexpected occurrences.

A detailed description of all principles can be found in the above-mentioned document.

Based on the document "Human Machine Interface Guidelines" [Code project, January 1998] some useful recommendations can be given regarding HMI with respect to the development of on-board telematic applications:

- HMI can be described by 4 different type of interactions: information, warning, advice and control. They all require or imply a direct or indirect form of dialogue of the driver with the system.
- For output to the user, the most frequent channel is the visual one, with the auditory one being increasingly used for applications such as route guidance. Other output channels such as haptic (a device which causes a movement of a limb such as active gas pedal, gives pressure or vibrations) are less used.
- For input the preferred channel is the manual input, being the vocal input in principle interesting but up to now affected by technological problems when working in a noisy environment as in moving vehicles. It should be noted that classically in the car the preferred channel is the haptic one for primary controls (e.g. steering and braking).
- HMI issues should be considered as early as possible during the development of on-board systems.
- Evaluation is important to take HMI issues into account. Using a prototype of the on-board system is essential for this purpose.
- Several evaluation techniques can be used. In the beginning of the project expert evaluations or test sessions with small panels of subjects. Later on prototypes can be evaluated with panels with subjects that are representative for the intended user, simulation test might be very useful. At the end of the project road test need to be carried out, validation can be done using questionnaires, diaries and experimental observations.

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] the following recommendations can be given:

- If human machine interaction with an on-board system occurs extremely infrequently, it cannot be expected that users will be trained. This means that the interactions have to be designed for inexperienced users. This implies:
  - Comprehensive and full text information
  - Avoidance of abbreviated or symbolic information (if not self-explaining)
  - Redundancy of information if possible
  - Feedback to the driver of possible or required driver actions
- In the case the traffic situation might become critical the driver's attention should not be distracted from road scenes. This implies:
  - A focus on acoustic information output
  - Visual display information shall only be used as a redundant source of information
  - Avoidance of complicated or complex human machine interaction tasks
- Interaction of the HMI with the driver becomes necessary in the case of impaired or even critical status of driver's performance or health. This implies:
  - Simple human machine interaction has to be preferred
  - Redundant multi-mode alarm signals to ensure to attract the driver's attention
- With respect to the design of acoustic signals an important distinction has to be made between two type of signals:
  - Alarm tone (e.g. used to attract attention of the driver prior to speech messages)
  - Alertness raising signal (e.g. used to enhance the alertness of drivers at an onset of fatigue)

<u>TECHNOLOGICAL ASPECTS</u>

<u>INPUT</u>

There are a number of different types of input techniques that can be suitable in mobile environments. Which type that is suitable for the different situations depend on such factors as where the focus of the user is most needed, e.g. if the driver has to focus on the road while driving or if he can focus on a screen while at stop.

One thing that should be kept in mind when designing a system and an input interface for a mobile setting is that it should be a very low input and high output. The user should be able to run the system without having to focus to hard on it.

Speech Recognition
The techniques most discussed at the moment are the usage of voice interface and the benefits and drawbacks this type of interface will bring to the mobile environment. The benefits are easy to see when it comes to drivers that have to keep their focus on the road ahead, but the drawbacks might not be as easy to find. Mobile settings are often a bit noisy and the voice recognition systems of today is not equipped to handle the interference noise and are easily disturbed and misinterpret the users commands.

This type of interface might be the most suitable when it is a bit more stabile and got better speech recognition systems implemented then they have today.

Keyboard and mouse
Regular keyboards and mouse is not a type of input devise that is suitable for mobile environments. The only positive effects when using them, for example, in a car is that the user is familiar with them and therefore it might be a shorter "start up" time when first using the system.

The familiarity to a device might also have a negative effect. The user might associate the on-board system with different types of systems. This might lead to that the user associate his work with a different type of work, which has proven to be the case in a Swedish study from 1998. The users, in this case truck drivers, did not like to use the on-board system because they thought of it as a computer and computers was, according to the drivers, something that office workers used and it was not a part of the truck drivers job.

There is however other ways to use the keyboard and the mouse that is more suited for a mobile setting. Often all keys and functions of the mouse and keyboard is not needed for the on-board system and it is then better to re-design it so that it is both more adapted to the usage and to the environment e.g. ergonomic. For example it might be better with a couple simple buttons that are located on the steering wheel or somewhere else that is easy to reach. Those simple buttons combined with a more complex output device might be the best way to make a user friendly, ergonomic and safe input device, that is given the technology of today.

OUTPUT

Screens

Regular display is a very good output device but it requires very much of the users focus. A screen might not be a very safe output device for a mobile setting. If it is to be used in a car or truck, as in our case, it requires that the truck is stopped or driving very slow to let the drivers focus move from driving to the screen without any risks for accidents. Another thing that should be kept in mind is that if there are a screen it will be used, and not only when the truck is standing still. This should be prevented within the system rather than in regulations.

There are however a number of different ways to overcome this problem. A screen that is only usable when the truck has stopped, HUD (Head Up Displays), and other types of specially designed screens. The placement of the screen is also very important. There is a study made by the SNRA (Swedish National Road Administration) together with a number of other countries which shows that the drivers eye focus can not leave the road for more than one second before it starts to become a hazardous situation. If a screen is placed beside the driver he will never be able to use and at the same time drive safely.

Another problem with screens in mobile settings is that they are usually quite small, but the amount of data is very often the same as for common computers. It is easy to imagine how it would be to use Internet or word on a five-inch screen.

Sound

The ear/truck is an environment that already is prepared for voice output since almost every single unit has speakers in them. Today there are many different projects concerned with audio interfaces in mobile settings. Sound output is divided in to at least two types, commands/voice and sounds. The Sounds or soundscapes is what commonly is called sound icons e.g. the windows error message and the new mail notification sound. This is used to build an environment that allows the user to stay focused on his current task and still, without having to shift his focus to the system, knows where in the system he is currently working and if he succeeded or failed with a command. This is a very good way to use for output, when it is combined with a voice output interface it might be the best in many situations.

The voice output reads menus, texts, emails and much more on the request of the user. It sounds futuristic but it is already in use in many prototype cars and systems.

SIGNALLING TECHNIQUES

What type of signalling and communication in technical matters that is used does not matter from a users point o view. There are some aspects that should be considered though such as connection speed, transfer speed, in what areas the communication works and how reliable the transfers are. To make the users use the system, which is often a problem, it takes that these criteria's are fulfilled. No one wants to wait long to connect to a low bandwidth transfer with bad reliability.

RESULTS OF STUDY

A recent study made by Viktoria Institute and several other companies in Sweden showed that the best interface for a car, that is going to be used as a platform for a mobile e-business was a combination of different of the above described interfaces.

The communication is based on a DAB/GSM module. Since there will be relative low input from thew driver e.g. requests and other commands that requires low bandwidth, the GSM phone was enough to use as uplink. The demand on the downlink to the car was much higher. The solution was to use the Digital Radio Broadcast (DAB) protocol so send out Internet with up to two Mb/s to the Vehicle. This technique allowed the vehicle to communicate with high bandwidth while going in up to amazingly fast 500 Km/h. The drivers interface is a combination of three buttons that is attached to the steering wheel e.g. next, previous and enter functions, and a voice and sound output interface. This way the driver can "surf" the web and perform a great number of other different tasks while driving, and he never is forced to take his hands of the steering wheel or the eyes of the road.

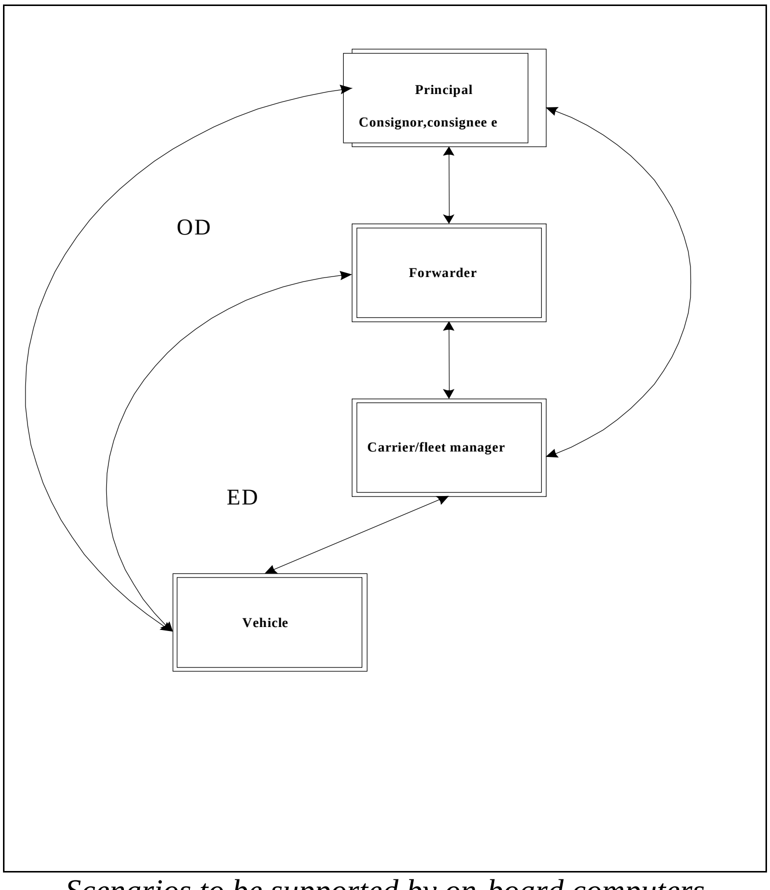
4.2.6 Costs aspects

QUESTION CODE: **6**

What costs aspects do we recommend to take into account?

ANSWER

The following figure leads to the identification of the two basic scenarios that allow for the definition of on-board systems costs. It shows that a consignor can present a transport opportunity to a forwarder, who can forward it to a transport company. Another possibility is that order will be directly sent to an on-board computer of an independent driver. Finally another solution which should be convenient for both scenarios will consist on a driver (owner or employee driver) using a service provider.



Scenarios to be supported by on-board computers

The considered basic scenarios are based on the following figures:
- Employee-driver (ED)
- Owner-driver (OD)

For the employee-driver most tasks related to freight and fleet management are performed at the home-base of the company.

For the owner-driver his truck is his office and functionality, which is for the employee-driver carried out at the home-base, has to be carried out in the truck. This means that the owner-driver demands additional functionality from the on-board systems compared to the employee-driver.

Remark : for the driver using a service provider (either owner or employee driver), most tasks related to freight and fleet management, could be performed by a third party information provider like the VISEGO system (Vehicle Information System) from TRACE-IT in the Netherlands, WEBRASKA from France and freight exchange information providers like Teleroute.

Because the focus of COMETA is the on-board systems, only systems directly related to the gathering and processing of data from the vehicle are described, like mobile data communication systems and some freight and fleet management systems.

HARDWARE AND SOFTWARE COSTS

For each of the above mentioned scenarios the main hardware and software costs categories are summarised in the following table:

	ED	OD	SD
Investment costs for hardware and software	x	x	
Installation costs for hardware	x	x	x
Maintenance costs for hardware and software	x	x	
Operational costs (technical, organisational)	x	x	x
Costs for application software	x	x	
Communication costs	x		x
Training costs	x	x	x

Hardware and software costs of current systems by scenario

Hardware and software costs are categorised in investment costs, installation costs and maintenance costs. An overview of all these elements has been described in the COMETA deliverable D4.

In general:

- installation costs vary of course with the quantity and complexity of the hardware and software to be installed. For all the above basic scenarios the installation costs has to be paid and will vary from one day for the most simple scenario (using a service provider) up to a week for the more complex scenario (owner driver)
- the maintenance costs for hardware are usually 10 % of the hardware investment costs per year. For the maintenance of the software suppliers will calculate usually an amount that's twice this percentage, because of the complexity of the software bugs. A common trend in software maintenance is to include the maintenance and new releases in the initial software prices.
- communication costs are a combination of fixed subscription costs and variable transmission costs. The subscription that gives the lowest overall communication costs should be chosen.

<u>OTHER COSTS</u>

Until now mainly communication costs, hardware and software costs regarding the commercial vehicle and the home-base are considered. These costs relate to the technical aspect of the implementation of the COMETA architecture. But there are also other costs, related to for example technical, organisational and commercial aspects.

Technical costs
Costs related to the technical aspect of on-board systems are: specification costs, programming costs, integration costs and installation costs. Technical costs are also the costs related to unsuccessful messages send, costs related to the breakdown of an on-board system, caused by errors in messages and additional costs, related to the demanded level of security.

Organisational costs
Another important aspect is the organisational costs. Typical organisational costs are costs related to training and support, consultancy costs, costs related to changes in organisational structure, workload or organisation of work, costs related to changes in time spent on daily activities or on (administrative) paperwork.

Commercial costs
Costs related to the commercial aspect are: costs related to the level of supply of information to the customer and to changes in customer satisfaction and costs related to changes in competitive advantage or company's image.

Miscellaneous costs
Other costs related to investments in IT-equipment are: finance costs for the purchase of the on-board system and possible failure costs.

<u>COST DEVELOPMENTS</u>

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

If there is a lack of competition in a certain market, because of the existence of propriety systems and no common agreed standards prices are expected to remain stable. This is still the case with the market of on-board computers.

The use of common components by various subsystems (e.g. 1 screen, 1 keyboard, etc.) is a way to lower the total costs of on-board systems. Also the breakdown costs, the costs of replacing parts of the system could become lower, because fewer components are used. This could be the case for peripheral equipment, like a printer, a keyboard or a screen

Products that are in the beginning only installed in the most expensive models for high prices can become popular. Examples are airbags and airco. The products can become standard equipment in the market of smaller passenger cars and prices will drop down a lot. This could be the case for autonomous navigation systems in the coming years. At this moment these systems are mainly offered for more expensive models, but if the systems become popular prices can drop considerably.

If installation of certain on-board systems could become plug and play, like the installation of hardware components to a standard PC, installation and instruction costs could be lowered. This could be the case for sensors, if they could be connected to a common bus in the commercial vehicle.

Sensors could also be installed by the truck manufacturer, instead of installed afterwards by putting in several cables in the vehicle and prepare the dashboard for connecting on-board components.

The developments of on-board systems with more and more functionality instead of on-board systems which are only built to carry out one function could be a reason that on-board computers are used by a much greater part of the vehicles, thus resulting in higher sales, economy of scale and drop in prices.

If on-board systems are widely used in other areas than commercial vehicles prices of these on-board systems could drop down. This could be the case for data capture devices like smart cards read/write devices or peripheral equipment, like a certain type of screen. Prices of special on-board peripheral equipment will stay higher than prices of peripheral equipment used at home and in the office. But because components which are mass-produced for the equipment used in the office, are also used for the equipment used in the vehicle prices will become lower.

European laws oblige some systems. One important device that will be available within a few years is the digital tachograph, which will replace the analogue tachograph. The digital tachograph will be obliged for new vehicles in Europe. The information that will be recorded by the digital tachograph can be used as input by the on-board computer. Because the digital tachograph is not yet available on the market the costs of the digital tachograph are also not yet available. However indications show that the price of a basic digital tachograph should be comparable with the price of a (paper) analogue tachograph.

Software

If systems have to be tailor-made instead of the usage of standard systems costs will be considerable higher. An example is the market of home-base software. If the standard systems that are offered aren't sufficient enough, a lot of additional costs have to be made to adjust these systems.

The development of standards for certain systems in a market can be one of the factors that lead to mass production. This can cause prices to go down and also instruction costs going down. The development of new types of on-board computers like AutoPC can lead to a standard operating system for passenger cars and commercial vehicles.

A service provider can provide services, which in that case don't have to be carried out by the systems. This mean that software can be less complex, or that less hardware is necessary to perform the same task. An example is the possibility to make a service provider responsible for the collection of the data from the on-board computers of the vehicles and to get access to this information via Internet. The service provider offers the requested information in the right format. In this way less expensive software is needed at the home-base to make use of information from on-board computers. Especially for smaller fleets this can be an interesting option. The service provider benefits from economics of scale, part of these benefits go to the end user, the transport company

Data communication

The development of more competition in the data communication market have made the prices dropping down. An example is the market of cellular communication, GSM. In the case of one or two operators prices are in most cases higher than with more operators. The second operator sets his prices according to the prices of the first operator. The prices of the first operator are usually high, because there are no competitors at that moment and the most customers are high volume business customers. When there are three or more operators on the market, these operators will set their prices also according to their costs and not only according to the prices of the competitors. Price differentiation will be an important tool to compete. New markets have to be found by the new operators. The small market of only business customers is not sufficient; the mass consumer market of personal communication has to be reached. This will change the structure and characteristics of the users and the market. The market will change from a low volume, high profit market to a high volume, low profit market. Value added services are becoming more and more important.

On the market of satellite systems also new satellite systems are available or will be available in the coming years. Because of this increasing competition costs for satellite systems are also declining.

On-board systems that are integrated or related to other systems can improve their market share if the usage of the systems to which they are related improves. Costs for location/position devices can become lower if the usage and number of systems to which they can be connected becomes higher. Most location/position devices are sold in combination with the on-board systems that uses the position information, e.g. a navigation system, or offered as an option from the mobile communication system.

The COMETA architecture for commercial vehicles contributes to the developments of more standardisation, modular approach, multi-functionality and integration by truck manufacturers.

5. CONCLUSIONS

The first phase of the COMETA project was characterised by an intensive investigation of the requirements that users of on-board computers have. These requirements were the basis for the following phase, where a first draft of a system architecture was developed.

The first draft of the system architecture was validated by means of existing systems, that are in use at the premises of the fleet managers, which are associated to the project as so called pilots.

The knowledge accumulated during the validation phase substantially contributed to the ameliorating of the COMETA system architecture, which (after a number of modifications and extensions) became the final COMETA system architecture.

Finally, the purpose of this document is to give recommendations and guidelines to solution providers and truck manufacturers regards the on-board system integrated architecture specification of COMETA.

The system architecture hypothesised in COMETA is an integrated one, but reality is (currently) far away from this optimal situation. It is almost impossible 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.

The future depends on the capacity/willingness that these three main actors work on common standards of interoperability.