MORYNE

Communication System
for public transport

D4.3 & D4.4 - V1.1

Authors: EADS Secure Networks & EUSKALTEL

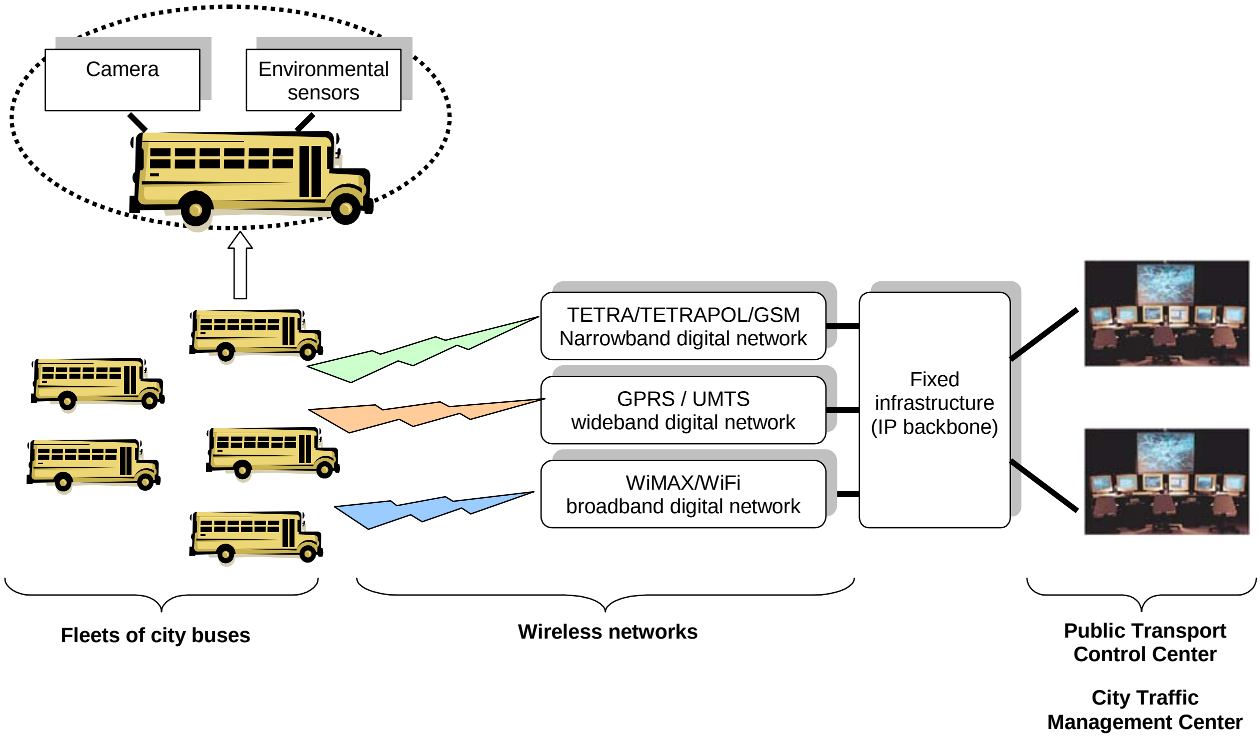
Dec. 2007

1 Overview and context

The MORYNE project is a European Commission funded project that proposes solutions to improve the traffic management of public transport vehicles in urban and sub-urban areas. More specifically, MORYNE proposes that the Public Transport Control Centre (PTCC) and City Traffic Management Centre (CTMC) be able to retrieve at any time the information collected by mobile sensors (e.g. cameras and environmental sensors) embedded on fleets of public transport vehicles (buses) by means of a smart Communication System.

This paper describes this Communication System.

The communication between each bus and the PTCC / CTMC is performed by means of a fixed infrastructure (e.g. IP backbone) and a set of wireless networks. These wireless networks consist of all those available in an urban/suburban European area, i.e. typically a narrowband digital network (e.g. TETRAPOL or TETRA public safety oriented network, or GSM) , a GPRS or UMTS data cell network, and a WiFi or WiMAX-based broadband network. The Communication System transmits data through the most convenient radio network depending on the characteristics of the data to send, on the features of the available radio networks and on the location of the bus.



Characteristics:

TETRAPOL: 2 kbps uplink / 2 kbps downlink

UMTS: 384 kbps uplink / 1800 kbps downlink

WiFi: 2000 kbps uplink / 2000 kbps downlink

2 Today status

At the time this document is written, the Communication System exists. Its components have been tested separately, they have been integrated together. However, tests still have to be carried out in Jan. 08 to prove it is fully operational.

3 Communication System features

Various radio communication systems - PMR (TETRAPOL), UMTS/GPRS/EDGE and WiMAX/WiFi - are used in the frame of the MORYNE project. This non-exhaustive choice was made because of their heterogeneity in terms of characteristics, Pros and Cons, and also simply because of the experience of the entities involved in the project. But the local sensing and processing unit in the vehicle works independently of the underlying actual radio system used for transmission; it is not bothered with controlling the radio modem and managing the radio transmission itself. The same applies for the Public Transport Control Centre and the City Traffic Management Centre, which transparently transmit/receive data, whichever the communication network is used.

<u>FEATURES</u>

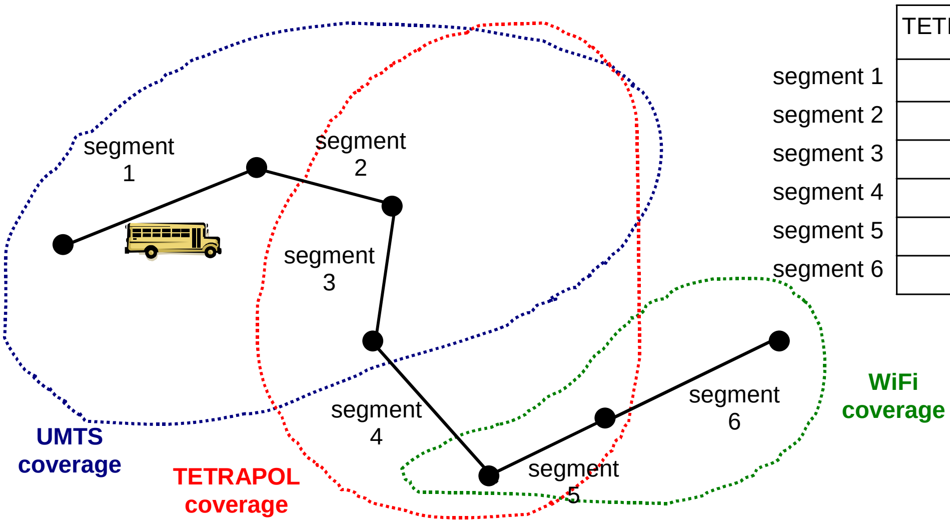
The MORYNE Communication System hides the different radio systems used by the on-board softwares to communicate with the ground softwares. It also manages them intelligently and provides high level transmission services. It is able to manage low data rate traffic (a few bytes used to transmit environmental sensors' data) as well as high data rate traffic (videos, pictures). But, the data rate depends on the underlying radio communication network: For instance, if it provides a maximum of 100 kbps with a lowest delay of 3 sec. then the Communication System will not do better than 100 kbps of bandwidth with 3 sec. of delay.

This ability to actually send different kinds of data and others not through the Communication System depends on several factors:

- the set of available radio communication networks at the location of the bus
- the availability of these radio communication networks at that time (e.g., in case of congestion, the UMTS network is hardly usable)
- the type of information to send (e.g. videos will be sent through wideband and broadband networks, but not through narrowband networks)

<u>example:</u>

Let's take an imaginary set of 3 infrastructure radio communication networks (TETRAPOL, UMTS and WiFi) through which a bus is driving. Its path is made of segments, separated by bus stops clearly identified for each bus when starting its route. The bus is configured with the set of available networks depending on the bus segment.



	TETRAPOL	UMTS	WiFi
segment 1		X	
segment 2		X	
segment 3	X	X	
segment 4	X		
segment 5	X		X
segment 6			X

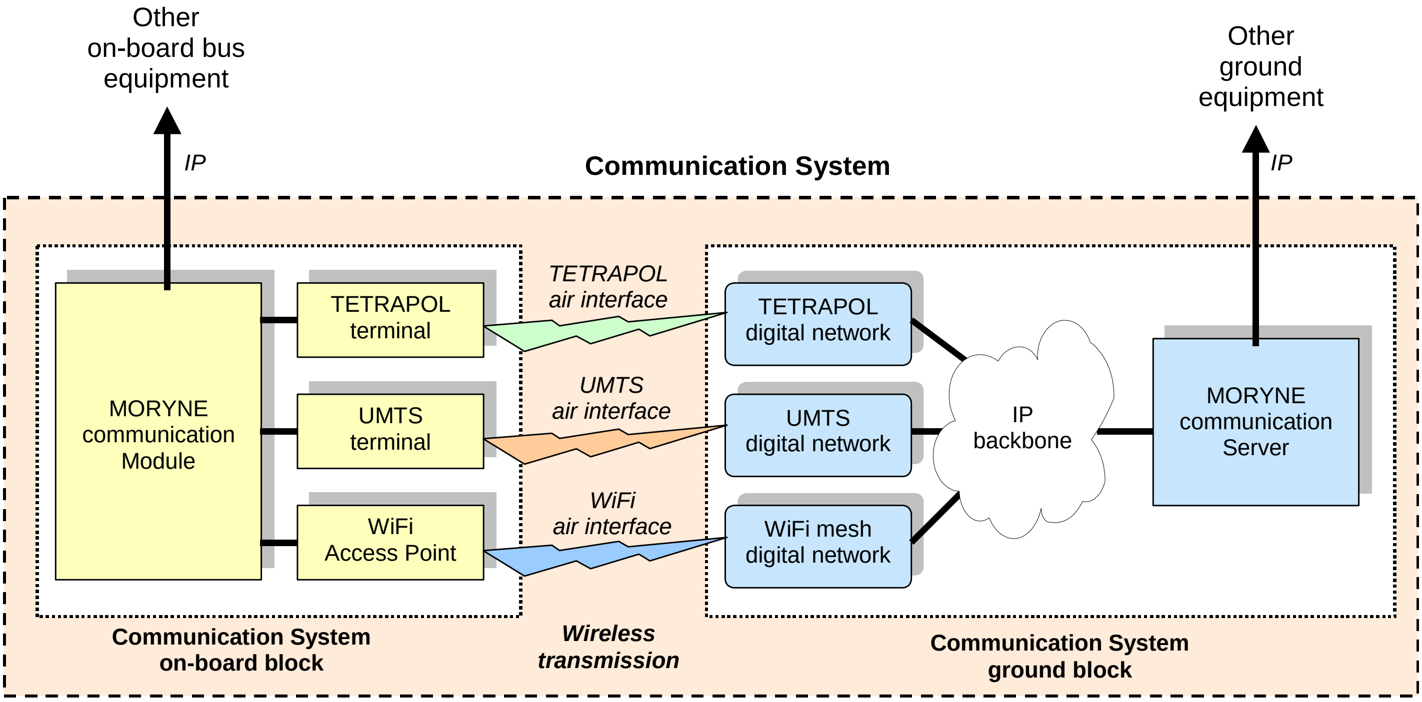
When driving along its route, the bus will alternatively select the proper radio communication network depending on its location. For instance, along the segment 3, TETRAPOL and UMTS are available, and so short data will be sent through TETRAPOL (event if it would work through UMTS) and pictures and videos will be sent through UMTS.

There is no detection of whether the communication networks are actually available. So, in case one communication network is not actually available, whereas it should be considering the table described above, then there is no automatic switch to the another communication network.

4 Communication System architecture

The Communication System is made of 2 main blocks:

- The Communication System on-board block: It is located on the bus side. It is made of a Communication Module associated with several peripherals acting as telecommunication terminals. For MORYNE, these terminals consist of a TETRAPOL terminal, a UMTS terminal and a WiFi Access Point.
- The Communication System ground block: It is made of a Communication Server and a set of radio communication infrastructures, allowing the Communication Module peripherals to communicate with the Communication Server. For MORYNE, these networks consist of a private owned TETRAPOL network, a public UMTS network and a WiFi mesh network.


Other
on-board bus
equipment
Other
ground
equipment
IP
IP
Communication System
MORYNE
communication
Module
TETRAPOL
terminal
UMTS
terminal
WiFi
Access Point
TETRAPOL
air interface
UMTS
air interface
WiFi
air interface
TETRAPOL
digital network
UMTS
digital network
WiFi mesh
digital network
IP
backbone
MORYNE
communication
Server
Communication System
on-board block
Wireless
transmission
Communication System
ground block

5 Communication System elements

5.1 MORYNE Communication Module and Server

The MORYNE communication module is a PC with the following characteristics:

- P4 / 3 GHz CPU.
- At least 512 MB RAM.
- At least 120 GB Hard disk .
- LAN (Ethernet 10/100).
- At least one serial port (RS-232 connection) for the TETRAPOL terminal
- At least one USB port for the UMTS Module on the Board segment
- Windows XP SP2

The MORYNE communication server is a PC with the following characteristics:

- P4 / 3 GHz CPU.
- At least 512 MB RAM.
- At least 120 GB Hard disk.
- LAN (Ethernet 10/100).
- Windows XP SP2 (including Internet Explorer).

These PC embed the MODEX product from EADS which was initially develop to simplify the development of applications communicating through TETRAPOL, and which is now enhanced in MORYNE through other radio communication networks, and with an even more simple access procedure.

5.2 TETRAPOL terminal and network

Several types of TETRAPOL terminal are available, depending on their use: handset (for pedestrians), mobile (for cars)… For MORYNE, as transfers of data are planned with no voice communications, special terminal used for buses would be the most convenient. They don't have any human-machine interface, just a serial connector.

However, in the frame of the demonstration, the actual provided equipment will be a TETRAPOL handset. Its ergonomics makes it more suited for human, even if not useful for the project. It provides data services (SMS and IP transfers) and also voice services.

A TETRAPOL network is a radio communication network offering Professional Mobile Radio services (essentially voice oriented) to public safety users as well as for public transports. As this network is narrowband, data rate is very poor compared to UMTS or WiFi but it offers reliability and ciphering features which make it attractive.

See more on: http://www.eads.net/1024/en/businet/defence/dcs/solutions/pmr/pmr.html

The architecture retained for the demonstration is light, compared to a full network with switches and base stations. It is made of a Projectable Telecommunication Network (PTN)

Transit cases:

- Complies with MIL STD 810F or GAM EG13 standards
- Weight less than 65 kg - made of composites - transportable by ground, sea and air

Dimensions (D x L x H in mm):

- 800 x 750 x 710 active transit cases - 800 x 600 x 700 transport transit cases

Temperature:

- Operating: –15/+55°C, storage: –33/+70°C

Watertightness and airtightness:

- IP54 operating - IP65 storage and transport

Power:

- 220V AC or option 110V AC - battery backup. Complies with EMC MIL STD 461 E.
- Complies with EN60950 standard for electric security aspects

Network interfaces:

- Analogue: PSTN, E&M (RONTRON, 50 Hz) and radio networks
- Digital: ISDN (T0/S0; T2/S2), E1 (G703/G704) and Ethernet Radio
- Frequencies: 380/430 and 440/490 MHz
- TETRAPOL air interface; FDMA channel access; 12.5 KHz channel bandwidth, 10 MHz duplex spacing

5.3 UMTS terminal and network

The ZadaCOM 3G+ UMTS modem provides global wireless access to the internet on HSDPA (High Speed Downlink Packet Access) capable UMTS networks. With speeds up to 1.8Mbps down (an enhanced version with 3,6Mbps is available mid 2007) and 384kbps up, users will have access to wireless connectivity similar to or cable modems.

No design is provided for UMTS. MORYNE relies on the public UMTS network.

5.4 WiFi terminal digital network

WiFi mesh is an emerging technology based on WiFi legacy networks and investigation performed around 802.11s standardization process. The standard is not still closed so the provided solutions are proprietary. WiFi Mesh networks are applied to cover dense user cases and implementations that require a dynamic infrastructure providing this way an alternative wireless broadband solution to WiMAX network.

The installation is facilitated since only some of the access points need to be connected wiredly to the ground infrastructure. In this architecture, the wired access point is acting as a gateway for several other access points which act as relays, routing and balancing the traffic wirelessly. The access points, apart from routing the traffic in a mesh-like infrastructure, provide access to end users. Normally 3 to 4 hops are allowed, in order to keep the necessary bandwidth.

The scenario must be analysed in order to select the most suitable solution; the following ones are some of the main characteristics of the MORYNE scenario:

- Vehicular speed
- Video transmission support
    - Data rate
    - Latency
- Location

There has been a technology selection process in Euskaltel, in order to select the most suitable technology (and associated provider/integrator) for Moryne project WiFi Mesh communications infrastructure. Considering the scenario, CISCO is the selected solution for MORYNE project. The WiFi Mesh networks, analogue to legacy ones, could be distributed or centralized.

CISCO provides a solution of the second type, a centralized architecture. This feature provides further capabilities for load balancing, dynamic channel assignment and dynamic power optimisation. Apart from that, it provides vehicular speed (around 130-140km/h) and video transmission support thanks to its proprietary software; "Adaptative Wireless Path Protocol (AWPP)" algorithm; and hardware characteristics.

Following, a quick overview of the equipment required for the demonstration is included:

Mesh AP/Gateway Mesh AP: Cisco Aironet 1500 Series Outdoor AP

This equipment is used to form the mesh infrastructure and it has got double functionality. On the one hand, it is used for the equipment that is used wirelessly and is going to be installed in the street lights (wireless router). On the other hand, it is going to be used as Gateway equipment wired to the ground infrastructure.

Mobile Mesh AP (Vehicular): 3200 Series Wireless and Mobile Router

This is the user equipment, which is capable of attaching dynamically to different points of the fixed architecture formed by the previous equipment while on the move. It is located inside the bus and it provides the possibility of connecting the bus to the WiFi Mesh infrastructure and this way, it makes possible the video transmission through the bus to the ground block.

Home Agent: 3725 Cisco Router

This equipment is part of the structure required for mobility management, offered in Cisco solution using MIP protocol. The mobility management functionality is necessary due to the vehicular speed and the Mobile Mesh AP used to provide this capability. It is part of the ground infrastructure required for the WiFi Mesh Communication network.

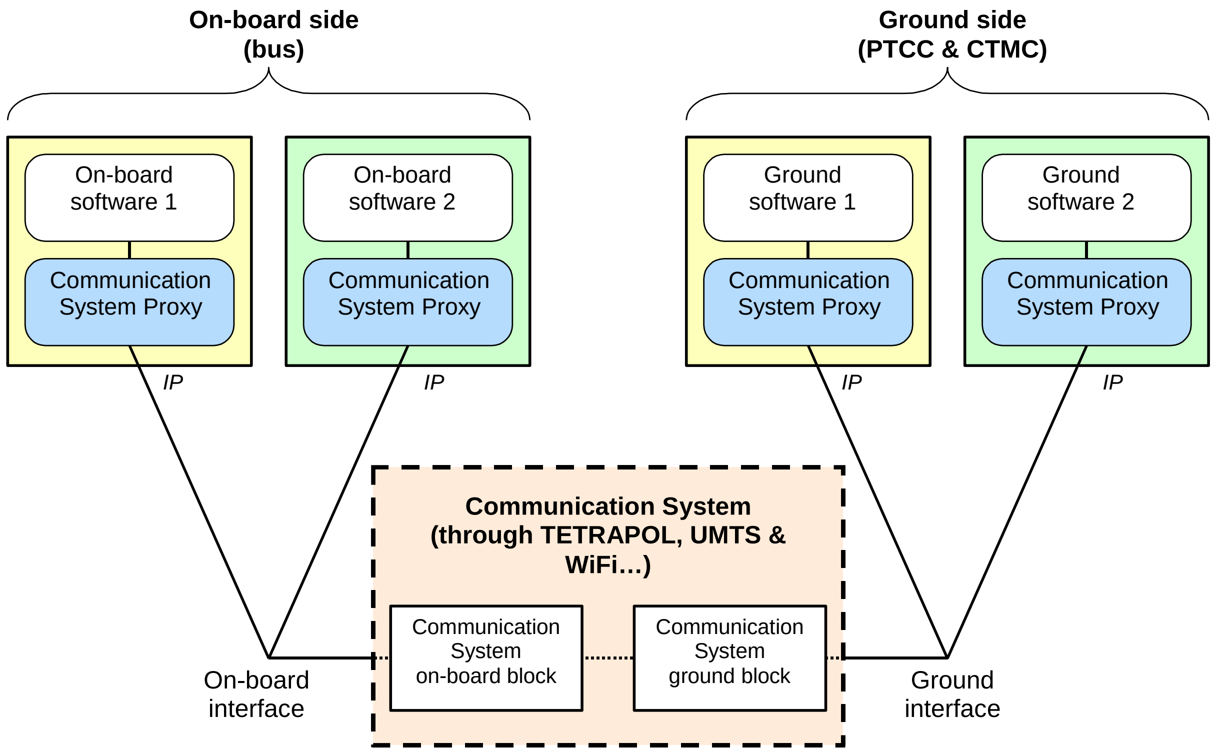
Wireless Controller: Cisco 4402 Wireless LAN Controller

As mentioned before, Cisco provides a centralized architecture and this equipment is responsible of providing this feature. It is going to be located in the ground infrastructure.

5.5 Communication System Proxy

The Communication System behaves as an IP network between the on-board bus equipment and the ground equipment. However, its interface is not strictly speaking IP, in the sense that it does not provide a layer 3 interface as an IP router does.

Both the on-board bus equipment and the ground equipment must embed a piece of software named Communication System Proxy. The Communication System Proxy is an extra component of the Communication System which is provided as a file (DLL Windows or shared Linux library) which must be linked with the on-board softwares and the ground softwares for the Communication System to be operative. These on-board softwares and the ground softwares will communicate to the Communication System through these Communication System Proxies.



Abbreviations

AP	Access Point
AWPP	Adaptative Wireless Path Protocol
CMTC	City Traffic Management Centre
CPU	Central Processing Unit
DLL	Dynamic Link Library
DSL	Digital Serial Link
EADS	European Aeronautic Defence and Space company
EDGE	Enhanced Data rates for GSM Evolution
FDMA	Frequency Duplex Multiple Access
GPRS	General Packet Radio Service
GSM	Global System for Mobile com
HSDPA	High Speed Downlink Packet Access
IP	Internet Protocol
kbps	kilo bit per second
LAN	Local Area Network
MB	Mega Byte (1024x1024)
MODEX	Mobile Data Exchange
MORYNE	Enhancement of public transport efficiency through the use of mobile sensor networks
PC	Portable Computer
PTCC	Public Transport Control Centre
PTN	Projectable Telecommunication Network
RAM	Random Access Memory
SMS	Short Messaging Service
TETRA	Terrestrial Trunked Radio
UMTS	Universal Mobile Terrestrial System
USB	Universal Serial Bus
WiFi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access