Marian OZIEWICZ[1]

EUROPEAN DIGITAL RADIO PROJECTS
FOR TRANSPORT TELEMATIC SYSTEMS

The digital radio broadcasting systems will play the fundamental role in the Transport and Travel Information (TTI) systems. European Commission have recognised the use of the Digital Audio Broadcasting (DAB) system and its interactive counterpart MEMO as a carrier for TTI and especially the Traffic Message Channel (TMC) and approved its implementation. In presentation the main programmes relating applications of digital radio for TTI are presented.

EUROPEJSKIE PROJEKTY CYFROWEJ RADIOFONII DLA
TELEMATYCZNYCH SYSTEMÓW W TRANSPORCIE

Systemy cyfrowej radiofonii będą stanowić istotny element systemów informacji transportowej i drogowej. Komisja Europejska uznała użyteczność cyfrowej radiofonii DAB oraz interaktywnej jego wersji MEMO jako perspektywicznego nośnika komunikatów TTI, w szczególności tzw. kanału TMC i aprobowała program prac nad jego implementacją. W referacie krótko opisane są podstawowe programy dotyczące zastosowań radiofonii cyfrowej dla TTI. W szczególności ukazano zastosowania systemu DAB dla TTI z perspektywy Unii Europejskiej. Plany Komisji Europejskiej dotyczące programu Galileo oraz europejskiej sieci zarządzania ruchem i informacji drogowej również zostały krótko zaznaczone.

1. INTRODUCTION
EU RADIO PROJECTS ON TELEMATIC FOR TRANSPORT

Within the European Commission EC two directorate sections have specific concern with TTI technology:

DG VII – A2, the Section of Transport, International Relations and Trans European Transport Networks and Infrastructures with concern for pilot projects and implementations associated with Euro-Regional Projects:

- CENTRICO - traffic management and user information services, cross border traffic (France, Germany, Belgium, Netherlands + UK)
- CORVETTE - (Austria, Bavaria, Italy)
- SERTI   - (Spain, France, Germany, Italy)
- VIKING   - (Denmark, Finland, Norway, Sweden, Germany)

DG XIII – C6, the Section for Telecommunications, Information Market and Exploitation of Research Telematics Applications for Transport and Environment, e.g. Project

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[1] Institute of Telecommunications, Wrocław Branch, Swojczycka 38, 51-501 Wrocław, mozi@il.wroc.pl

FORCE (standards); Project ESCORTIS (implementation related public transport information, car parking status, timetable information)

The significance of Transport and Travel Information (TTI) within European countries with the aim of enhancing safety and mobility on European roads was early recognised and first standardised in the middle of 1980s. As a wireless carrier allowing to transmit Traffic Message Channel (TMC) [2] information was first appointed Radio Data System (RDS) – digital subchannel accompanying FM transmission. RDS-TMC announcements [2,3] could be presented on the alphanumeric display of RDS receivers.

The European Commission, in line with the resolutions of the European Conference of Ministers of Transport and, in 1997, the Council of the European Union (EU) approved the EC proposal to implement RDS-TMC services, as a priority action [1].

Meantime the wholly digital powerful Digital Radio Broadcasting (DAB) system was created within EU EUREKA 147 DAB Project [4,5]. Its application for Multimodal Information Systems was early recognised [6]. The DAB system is appointed as the next generation European radio system and now is progressively introduced in developed European countries. Introduction of the return channel via GSM or UMTS systems to DAB was a theme of the EU AC 054 MEMO Project (Multimedia Environment for Mobiles) [7,8].

Both projects have been strongly supported from beginning by European Broadcasting Union (EBU) joining European public broadcasters. Later the WorldDAB Forum – organisation of international institutions – has taken up the task of DAB promotion and development including DAB applications.

In 1991 started consortium ERTICO – European Road Transport Telematic Implementation Coordination Organisation – UE co-ordinator for European telematic projects. It is a private-public organisation with the support of the EC. The aim of ERTICO is to boost development of European intelligent transportation activities, provide co-ordination service to ensure a higher degree of harmonisation between the numerous national transport telematics projects. It is especially important along pan-European corridors.

ERTICO with its offices in Brussels brings together industry, public and private infrastructure operators (mainly road authorities and motorway companies), public authorities and users. In 1999 during conference in Budapest [10] representatives of ERTICO presented proposals on TMC service database organisation for Central Europe countries.

Among other projects ERTICO promoted
- GSM-based ITS services within GATS Forum (GATS – the Global Automotive Telematics Standard),
- DIAMONDS project for DAB-based Multimedia ITS Applications.

The possibility of using different carriers for transmitting ITS services (RDS, GSM, DAB) has led to idea of introducing the protocol for carrier-independent format of ITS messages. The adequate project supported by EBU and ERTICO was named TPEG (Transport Protocol Expert Group).

2. ITS – INTELLIGENT TRANSPORT SERVICES

Intelligent Transport Services (ITS) include:
- Traffic and travel information (TTI)
- Breakdown and emergency messages
- Real-time route guidance

- Fleet management and information services
- Navigation systems

Transport telematics (Intelligent Transport Systems) should insure:
- relevant to an individual customer needs information
- the European –wide services in native language of user

The TTI system includes infrastructure:
- data collection systems [11]
- data exchange system (DATEX standard [12])
- location referencing tables [13]
- Traffic Information Centres
- Traffic management centre

Broadcast Traffic and Travelling Information services and applications are introduced to deliver data to other ITS services and satisfy customer need for accurate and regularly updated information. The basis of activity on TTI services are rules internationally worked out for:

- Events codes list
 It is constant list involving 1200 event types

- Location database
  Location database [3] includes updated location codes assigning characteristic points (oil stations, bridges,...) together with its parameters along autoroutes. Practical organisation of database consists of few stages [10]:
  - working up general concept (regional locations; along pan-European corridors, along road classes)
  - bilateral agreements on coding cross-border locations
  - central base organisation
  - regional database for Central and East European Countries
  - inclusion to UE ERTICO database

Authorities included in database organisation:
- on national level: road authorities, police, regional authority
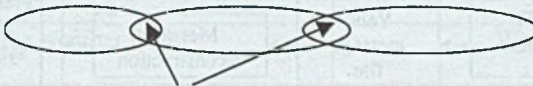
co-ordination: Ministry of Infrastructure / Ministry of Internal Affairs

- on EU level: bilateral agreements on coding cross-border locations

There is EU Member Countries commitment that basic TTI information should be free of charge across Europe [10].

3.   GENERAL CONCEPT OF TTI SYSTEMS FOR TRANSPORT

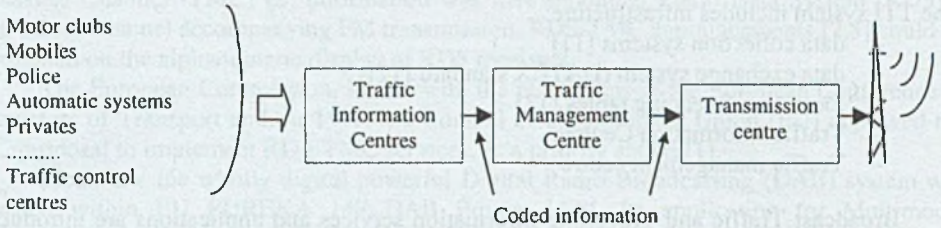General scheme of data collection and transmitting in Transport and Travel Information system is presented on Fig.1:

Motor clubs
Mobiles
Police
Automatic systems
Privates
....
Traffic control
centres

Traffic Information Centres

Traffic Management Centre

Transmission centre

Coded information

Fig.1. Data collection for TTI system

Data processing on DAB transmitter site is presented on Fig.2:

Coded TTI message

DAB server

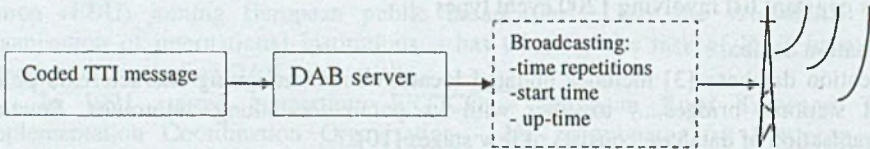Broadcasting:
-time repetitions
-start time
- up-time

Fig.2. Data processing on DAB transmitter site

On DAB receiver site decoding process looks like in Fig.3:

Location database

Tuner + DAB decoder

TTI decoder

Valid message file

Message reconstruction

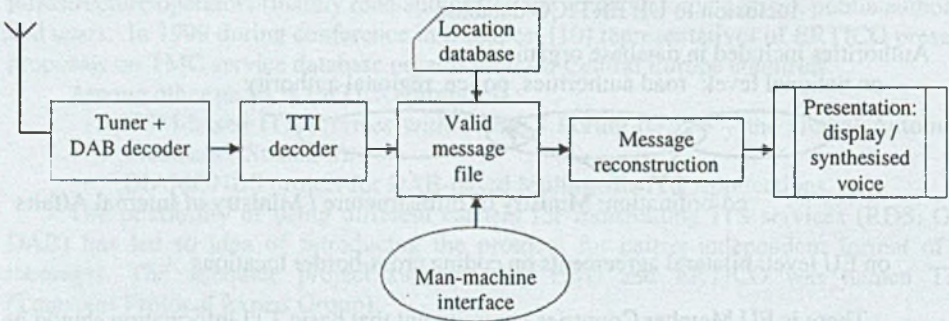Presentation: display / synthesised voice

Man-machine interface

Fig.3. TTI messages processing on receiver site

Actual receivers, because of technical limits, can present about 60 types of synthesised messages. Location databases can be carried on CD-ROM'S and up-dated through DAB system, or on smart cards.

4. DAB SYSTEM

The first in the world fully digital radio standard system DAB (Digital Audio Broadcasting) is European standard [4] and is expected to be the world standard. System DAB will replace fully actual system FM in about 10 years.

The basic frequency block in DAB system has 1.5 MHz and can contain up to 6 different programmes plus additional multimedia applications. Different DAB transmitters can work on the same carrier frequency - if the same program is emitted – and thus the frequency spectrum is saved in this system.

The DAB features of special use for ITS applications:

1. for emergency situations
- Announcement feature
  Announcement support contains information on types of voice announcements, which can interrupt service and links to other services, which share the same interruption privileges (clusters). These announcement types include:

Table 1

Announcement types of meaning for TTI information

DAB feature	WorldDAB comment
Alarm	Situations like: nuclear fallout or war
Road traffic flash	Information about problems on road
Transport flash	Public transport: schedules of buses, ferries, planes or trains
Warning / service	Incidents as: disruption of power or water supplies
News flash	News bulletin
Area weather flash	Weather bulletin
Event announcement	Information about commercial, cultural or public events
Special event	Information on unscheduled or previously unforeseen events

- Emergency Warning System feature:
  The EWS feature allows spoken messages to be transmitted in encoded form. This method of issuing emergency warnings is restricted to a closed user group possessing special receivers and is not intended for general alarm announcements.
- TMC message

In earlier versions of system DAB the TTI message have had to be encoded according to the Alert C protocol. The Module 1 in WorldDAB Forum actual works on DAB-TMC future standard more suited for DAB system capacity

2. for information directed to closed group of users
- Conditional Access – feature allowing realisation of the pan-European payment systems through the chip-card distribution.

The broadcast DAB system was proposed for "Multimodal Information System in The Traffic Network of the Federal Republic of Germany" – proposal for a leading project within the BMBF-Initiative "Mobility in Conurbations" [5].

4.1. SYSTEM MEMO

European project AC054 MEMO (Multimedia Environment for Mobiles) [6,7,14] represents a convenient system for implementation the 'information on demand' services for portable and mobile reception. The DAB 'radio highway' concept complemented by MEMO's return channel will offer wide possibility for access of information. Information for wide publicity as well as specialised data for closed circles of users:
- unidirectional info for mobile: an audio, local info data including TTI, Internet pages
MEMO system will allow accessing TTI multimedia information from both the regional, national and pan-European sources including both terrestrial and planned satellite transmission systems. One MEMO (and DAB) receiver is ready for terrestrial or satellite reception. It can thus work for pan-European TTI projects without violating the local program reception.

4.2. SMART-CARDS AND PAYMENT METHOD FOR TTI SERVICES

In Europe only basic ALERT-C ITS services are supposed to be cost-free. Additional services including updated location code database and event database coded in the user's language are expected to be paid. User needs to acquire a series of databases covering the areas in which he will travel. In the cross-border areas different country service providers can supply the data. The databases are expected to be distributed in the form of smart cards. The cards will be supplied by a variety of providers, formatted to appropriate standards using data derived from national databases. In order to ensure that a quality of service is maintained it is imperative for cards to have an expiry date, guaranteeing that out-of-date cards are no longer usable [9]. Because the whole payment process includes different sites (service providers, card providers, users) and possibly from different states – standardisation process in this field necessities the international co-operation.

5. PROJEKT DIAMOND: DAB BASED ITS SERVICES AND PRODUCTS

In 1998 ERTICO created EC project on the DAB system application for ITS services. The basis for using DAB as a carrier for ITS follows the specific advantages of DAB:

- Digital transmission
  System DAB is the first in the world completely digital radio system. This feature allows for multimedia files transmission according to Multimedia Object Transfer protocol. Examples of such objects are files with digital maps, pictures, voice comments, slow video.
- Mobile reception
  Digital transmission during mobile reception is impaired by multipath propagation. The construction of system DAB allows for avoiding this problem.
- Roll-out of DAB infrastructure EU member countries
  System DAB is implemented in Sweden, United Kingdom and few lands in Germany. But far reaching preparations for its implementation are processed in all developed EU Member Countries. DAB is European standard and is supposed to be World standard.
- Multimedia applications for future products
  Digital system of DAB and subchannels PAD (Programme Associated Data) and NPAD (Non-Programme Associated Data) together with protocol MOT (Multimedia Object Transfer) guarantee different possibilities of multimedia applications transmission.
- Combined with GPS
  Car navigation systems demand on one side the precise on-line position information and, on another side, the on-line updated digital map information. Up-dating is realised with the help of DAB system.

Particularly suited to ITS services are applications:

- Pre-trip information
- Route guidance
- Dynamic navigation
- Tourist and weather navigation
- Filtered information for the trip to public transport information
- Digital maps updates
- Software upgrades
- Broadcast websites
- Fleet management

ITS services based on traffic and travel information messages databases allow:
- basic ITS services for car receivers
  - text information: parking, alternative routes (dynamic traffic information)
  - synthesised messages
  - filter of information through TII (Transmitter Identification Information)
  - display of road maps, alternative routes, actual positioning, basic navigation on level of TII
  - billing functions like payment and subscriptions
- adding GPS
  - navigation with CD-ROM or regional map down-loaded over the air
  - updating digital maps
  - dynamic navigation with actual traffic pattern
  - dGPS
- MEMO = DAB + GSM
  - Easy billing (pay per use)

- DAB+GSM+GPS
  - General information services (hotels, restaurant, point of interest,...)

ITS in Poland demands organising multimedia applications centre for DAB [15,16] and DRM (Digital Radio Mondiale) systems [17].

6. PROJECT TPEG

TPEG (Transport Protocol Experts Group) is a project with the aim to prepare a medium-to-long alternative for TTI services. It should provide significant improvements in terms of range of services, market opportunities and suitability for decoders of different levels of functionality and complexity.

The work of TPEG, commissioned by the EBU's Broadcast Management Committee, is to develop a new protocol for Traffic and Travel Information, for use in the multimedia broadcasting environment. TPEG will develop applications, services and transport features which will enable travel-related messages to be ceded, decoded, filtered and understand both by humans (visually and audibly) and by agent systems.

The TPEG Specifications comprise a number of parts, defining the mechanisms that permit Service Providers to operate services which can use one or more delivery technologies (RDS, Internet, UMTS, DAB, etc.) from one message generation process. Furthermore, they will allow a range of receiver types to be used simultaneously, ranging from sophisticated agent receivers serving navigation systems, through to simple receivers only able to decode 'top level' information.

The first priority for the Project Group was to develop an end-user oriented Application for Road Traffic Messages, together with the core protocol, network and service layers. The Road Traffic Messages Application uses a construction of the DATAX Data Dictionary to ensure that the knowledge regarding RDS-TMC and such services is reflected in this application.

The TPEG Specification consists of 4 Parts:

Part 1 (TPEG-ING), 2000 – describes other parts and their relationships

Part 2 (TPEG-SSF), 1998 -- describes the Syntax, Semantics and Framing structure, which is used for all TPEG applications

Part 3 (TPEG-SNI), 1999 – describes the Service and Network Information Application, which is likely to be used by all service implementations to ensure appropriate referencing from one service to another

Part 4 (TPEG-RTM), 1998 – describes application for Road Traffic Messages

The basic TPEG frame structure has the following organisation:

Synch. word	Field length	Header CRC	Service frame

	Service Provider	Service identific	CA Id	Application_multiplex

	Appl. frame 1	Appl. frame k	Appl. frame n

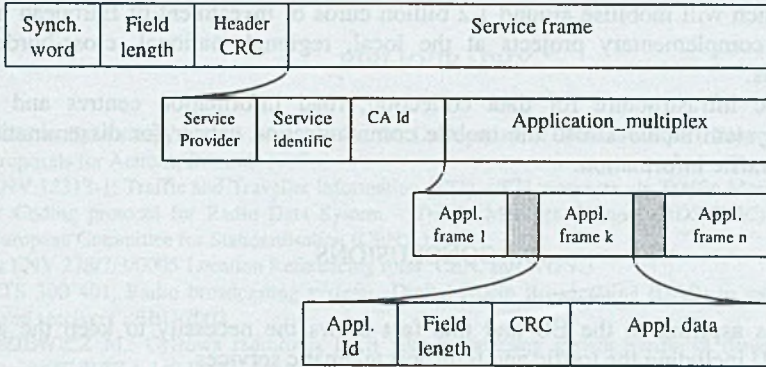|	Appl. Id	Field length	CRC	Appl. data

Fig.4. TPEG frame structure. Transport level

7. POSITIONING SYSTEMS → NAVIGATION SYSTEMS

Car navigation is one of elements of the Intelligent Transport Systems (ITS). Navigation systems require dynamic information on actual position of the car. Such information can now be obtained out of the United States' Global Positioning System and Russia's Global Orbiting Navigation Satellite System (GLONASS). The European Galileo system (the European Global Navigation Satellite System) [18] is supposed to start about 2008. It will be interoperable with both preceding systems and would allow to take position anywhere in the world from any combination of satellites with a single receiver. The Galileo system, which consists of 30 satellites orbiting the earth at a height of 15 000 miles in three circular Medium Earth Orbit planes at an inclination of 56 degrees relative to the equatorial plane. It is expected to pinpoint a geographical position to within a single meter. Two Galileo Control Centres in Europe will receive data from a global network of twenty Galileo Sensor Stations. Five S-Band and 10 C-Band uplink stations around the globe will manage the flow of data between the satellites and the control centres.

Digital radio system DAB allows additional information with witch GPS data can be processed into dGPS - more precise position data.

8. EC WHITE PAPER ON EU TRANSPORT POLICY

In the EC White Paper on EU transport policy [19] the Annex IV 'Technological Development and Intelligent Transport Systems' shortly characterises the new framework programme of research for 2002 – 2006. In the adopted by the Heads of State and Government at the Feira European Council in June 2000 the eEurope 2002 Action Plan puts accent on development and deployment of intelligent transport services and especially the traffic management systems. To this aim a European network of traffic management and the road information centres is declared to be developed across EU. According the EC intention

'this network, which should cover the whole of the UE, will provide users with traffic management and road information services on a fully European scale. The network is central to the European programme for funding deployment (around 200 million euros between 2001 and 2006), which will mobilise around 1.2 billion euros of investment of European interest and generate complementary projects at the local, regional, national, cross-border and European levels.'

Telematic infrastructure for data collection, road information centres and traffic management system includes also the mobile communication carrier for dissemination the transport and traffic information.

9. CONCLUSIONS

Poland is aspiring to the EU and this fact draws the necessity to keep the general standards of EU including the traffic and transport telematic services

In order to prepare our country for modern telematic services with the help of radio it is necessary to organise the fundamental infrastructure:
-   locations databank
-   event databank
-   transport information centres
-   transport management centres

In order to prepare adequate cadres and to recognise the best system for large-scale organisations it is necessary to start with radio telematic project on small scale. To this aim the international co-operation for recognition different data banks organisation is also natural. The cross border routes and highways especially demand consultations in order to preserve alike systems of information on both sides of border. Partners of such consultations and co-operation could be the road authorities from neighbouring countries and ERTICO experts.

The process of building internal databases should also be compatible with principles worked out for border crossing roads.

The program of building new highways in Poland should mobilise for starting the real process of organising the European standard Traffic and Travel Information for mobiles in Poland. Such process should include:
-   gathering data for databases.
-   organising data into a base normalised according to European standards
-   concept, projects and software for Traffic Centres
-   communication between Traffic Management Centres and Broadcasting Centres
-   multimedia TTI presentation on digital radio

After accepting the main principles by the preparatory project team the databases the wide-front data gathering for location database should include co-operation with local road authority, police (Ministry of Internal Affairs), automobile clubs.

Organisation of data should be elastic enough in order to allow for changes and updates. The ERTICO practice leads to the rule that building database needs information on new roads about 5 years earlier in order to introduce new codes [10].

The work on organisation the event databases, connection server- transmission centres - further transmission should include the telecommunication experts.

According to ERTICO experts [10] the cost of the whole TTI system is equal to cost of 1-km autoroute i.e. about 2 mln EURO.

The program organisation of TTI system in Poland should be not only government's concern but should include also regional and local authority attention.

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Reviewer: Prof. Andrzej Karwowski