

**AUSIAS: Contributing to the European urban transport telematics architecture**

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**Abstract**

The integration of different Information and Control Systems coexisting in a European city in a common architecture represents a benefit for the whole dynamics of the city. **AUSIAS** is a project, founded by the European Commission, that will integrate the existing systems of traffic, parking and public transport management in the city of Valencia (Spain), in a global and standard telematic architecture.

**1 Introduction**

Transport in Europe is a crucial issue affecting all aspects of the Union, specially in cities. A qualitative change takes place, as the number of cars increases, cost/effective new technologies open new possibilities, and cities want to devote urban ground to uses other than transport.

EC funded project AUSIAS will demonstrate under real conditions how ATT can help cities to reduce congestion, improve traffic management and provide sustainable socio-economic improvement. This Multiapplication-Single site project is favoured by current situation in Valencia, with different ATT systems recently financed by the Spanish Administration. The project has three goals:

i) **Integration**: AUSIAS will demonstrate the benefits of integrating different Control and Information Systems usually coexisting in a European city. All the potential sinergies (multipurpose use of common infrastructure, collaborative strategies, etc.) will be identified and exploited.
ii) **Standardisation**: AUSIAS will follow the emerging standardisation proposals resulting from previous EC funded work. Valencia will get the clear benefits derived from following what may become CEN or ISO standards, and, besides, AUSIAS experience will provide a valuable feedback to the harmonisation process taking place in Europe and world-wide.

iii) **New technologies**: AUSIAS will provide the opportunity of demonstrating new technologies. Part of them come from other EC/National RTD programmes (ESPRIT, PASO). Others, such as Multimedia, are impending technologies which are changing the life of European citizens.

These strategic objectives will be applied to:
- Traffic Management.
- Public Transport.
- Dynamic Information To Users.
- Parking Management And Information.
- Incident Management.

## 2 AUSIAS ARCHITECTURE

A global architecture will be defined, according to the guidelines proposed by SATIN task force. This architecture will include a Reference Model, an Information Architecture, a Functional Architecture, a Data Communication Architecture and a Physical Architecture. Within this global architecture, several application areas will be covered.

The project will start at the beginning of the five-phase model presented in the ATT Work Programme. The methodology to be used will consist of the development of the following project phases: Requirements, Functional Specifications and System Analysis, Development of the Demonstrator, Validation&Demonstration and Evaluation&Assessment. This methodology will be applied throughout all the application domains in the project:
Urban Transport and the Environment

3 TRAFFIC MANAGEMENT

Traffic management is a concept that has replaced the traditional idea of traffic control. The former includes the latter, together with a number of additional features. Nevertheless, the achievement of the management capability—as opposed to just control—involves basically the integration of information from different systems and the availability of the means to define a global strategy. In this context, AUSIAS will develop and demonstrate two aspects of traffic management:

a) Real time dynamic network signal control: Valencia’s current urban traffic control system will be enhanced by the development and incorporation of a dynamic plan generation feature. Instead of selecting—according to different criteria—the best traffic plan in a given moment out of a set of pre defined plans, the system will work in an adaptive manner, generating in real time the optimal plan to tackle the traffic conditions in that precise moment.

b) Interconnection of traffic control centres: within AUSIAS project, the city’s urban traffic control centre—operated by the Municipality—and the city’s interurban traffic control centre—operated by the DGT—will be interconnected, so that:

   b.1) Information can be shared between both centres—including multimedia data—
   b.2) Multipurpose use of shared infrastructure can be carried out.
   b.3) Co-ordinated control strategies can be defined.

The above benefits can be quantified in a reduction of the PT company maintenance costs in the range from 5 to 10 percent.

4 BUS PRIORITY AT CROSSINGS

Giving priority to buses at crossings is a technique that is getting increasing importance as a mean to promote public transport use by increasing its commercial speed. This involves a clear social and environmental benefit, as it reduces the journey times, and hence pollutants emission, improving at the same time the service to customers.

AUSIAS will cover prioritisation of buses at crossings. The city of Valencia has a dedicated bus lane in its main arterials, and the deployment of a priority system is expected to have a great impact on traffic conditions.

Although there exist different approaches and technologies to bus prioritisation, the underlying philosophy is the same in all the cases. It consists of detecting the proximity of a public transport vehicle and communicating it to the Traffic Control System (at a local or central level) in order to make the needed adjustments to the split, so that the priority is achieved. The main differences between the different approaches is the way the bus (or tram, etc.) is detected. It can be detected by magnetic loops, CCTV cameras, tags, beacons, etc.
During last edition of ATT Programme, some projects (for example PROMPT, V2049) carried out field trials in different European cities, working mainly with buses and trams. There exist also other recent experiences in Munich, in Europe, or Houston, in USA.

In AUSIAS developments, buses will use a beacon-based system, which will allow the interaction between public transport VSCS (Vehicle Scheduling And Control System) and the traffic control infrastructure. It will also be detected if the vehicle abandons the crossing, so that normal traffic operation can be restored or possible incidents detected.

5 DYNAMIC SCHEDULING

In order to promote a modal shift from private to public transport, this needs to be attractive and efficient, as well as financially feasible. A prerequisite public transport operators need to achieve this is having the capability of carrying out flexibly dynamic rescheduling.

Flexibility is needed to cope with evolving requirements of public transport operators. Dynamic or reactive rescheduling capability is needed to respond to incidents and unexpected events that disrupt a planned schedule. By this mechanism, the situation can be assessed and actions recommended in real time. The aim is to minimise disruption by returning to an orderly level of service as quickly as possible. The use of such a system can help create a more efficient public transport system that provides greater customer satisfaction and makes a more efficient use of its resources (namely buses and drivers).

SUPERBUS system, developed within ESPRIT EP8742, pursues the following goals:

a) Developing a planning and scheduling tool (PST) for public transport fleets that incorporates the flexibility the end user (the public transport operator) needs in order to implement his evolving requirements and constraints (including ways to express non-numerical ones).
b) Achieving an integration between an advanced VSCS and the developed PST, so that a feedback from the real world through the control system (the VSCS) can be introduced. This capability enables a rescheduling process to take place, allowing automatic reactions from the system and on line modifications to the initial assignment of resources (reactive planning).

The following step within this public transport control framework would consist in further developing and integrating the results of SUPERBUS with the rest of services and control systems related with transport in a city. In this way, AUSIAS, will allow the demonstration of a new system providing the following capabilities:

a) More reliable public transport incident management: Superbus system will be informed automatically about the state of the traffic, being then able to calculate the incidence of the traffic status in the evolution of the public transport network.
b) Connection of SUPERBUS with Information systems to the users in order to provide information about the state of the urban transport network. This kind of information system would be complementary with already existing systems like INFOVOZ.

The following diagram shows the architecture of the proposed public transport scheduling system integrated with the traffic control and information systems.

**SUPERBUS system within AUSIAS**

**6 INTEGRATED FLEET MAINTENANCE**

The maintenance sub-system is a crucial part of a public transport operator information system (in fact, it is important to any operator of a fleet of vehicles). It has a direct impact on the operator’s financial feasibility, as it affects the operational conditions of the vehicles, as well as their availability. An integral maintenance system has to cover three types of maintenance:

a) Preventive maintenance.

b) Corrective maintenance.

c) Predictive maintenance (AI-based diagnosis allows to anticipate breakdowns before they actually occur).

The project DIAMANTE, within the framework of the special initiative ESPRIT-PASO, has prototyped a public transport predictive maintenance system. AUSIAS project intends to develop and demonstrate, on the basis of DIAMANTE technology, an integral public transport maintenance system which will be also interconnected with the rest of the ATT systems.
The planned maintenance system, as it can be seen below, is divided into three modules: the acquisition module (AM), the diagnosis module (DM) and the co-ordination centre (CC).

If it detects values out of a specific range, an alarm is triggered and the Co-ordination Centre is informed about the operational state of the vehicle. This communication is established through standard protocols and using multipurpose communication infrastructure. If no alarms are produced, the Co-ordination Centre requests the information collected in each vehicle after a maximum time has elapsed (taking advantage of low activity periods in the communication system). This is done to update the historical data-base and free memory in the on-board unit.

An alarm is triggered to activate the Diagnosis Module when a deviation in the parameters used to monitor the vehicle is detected. It consists of a rule-based Expert System (ES) which determines the severity of the anomaly by comparing the information describing the present state of the vehicle with the information stored in its knowledge base (historical information such as latest actions undertaken, detected symptoms and the rules needed to infer the diagnostics). If an action on the vehicle is deemed necessary, the ES informs of the severity level and suggests correcting actions to be taken.

The Co-ordination Centre is connected to the fleet management because a good anomaly management does not only require a precise mechanical diagnostic, but also information on where the bus is, remaining service time, consequences of stopping the bus, etc. The combination of these two types of information will allow the fleet controller to take the adequate measures. The Co-ordination Centre is also the link of this system to the overall AUSIAS architecture.

7 DYNAMIC INFORMATION TO USERS

Up to now, drivers -and users of transport services in general- received insufficient traffic information before and during their trips. The channels used were radio or TV giving a general overview of traffic at given points in time, with limited practical use to individual users. On the other hand, information dissemination to users is the best way -not to say one the few available- that traffic managers have to implement a certain transport strategy in a urban and/or peri-urban area. Bearing this in mind, AUSIAS is going to develop and validate the impact that an integrated and real-time updated information system has on the users in a urban and peri-urban environment. To do so the project intends to:

a) Consider as valuable inputs the conclusions of the relevant DRIVE II projects.
b) Take advantage of the existing information dissemination infrastructure in Valencia: INFOVOZ system, and plans to deploy more than 50 VMS of different types.
c) On the basis of b) and c), the project will develop a system to manage the information dispatch to users.

The technologies the project will use to disseminate information will be VMS (Alternative Itineraries Signs, Graphic Congestion Displays...) and multimedia (interactive phone services, interactive information kiosks,...).

8 PARKING MANAGEMENT AND INFORMATION

AUSIAS project will include a demonstration on parking information. The drivers arriving to Valencia by road, will find panels informing them about the existing parkings in the city and the parking places currently available.

There will be a specific demonstration of a Park & Ride system. The parking placed on the access to Valencia from Madrid, will receive the vehicles arriving to the city and offer information about public transport network, etc. to the drivers parking their vehicles there.

9 TRAFFIC MODELLING

Managing urban traffic is a difficult task. The response time of Urban Traffic Control (UTC) systems for solving a given congestion is high, due mainly to the great inertia of the evolution of the traffic, and also to the restrictions imposed by acceptable moments for taking control actions (it is not possible to change immediately the behaviour of traffic lights: the changes must be adapted progressively). This fact implies that one of the main goals of a UTC system is to prevent congestion situations before it occurs, and for this task tools for modelling traffic evolution are needed.

In previous works during ESPRIT project EQUATOR EP2409, a qualitative traffic simulator known as QSEA was developed, and it has shown to be adequate for modelling urban traffic behaviour.
Spatio-temporal evolution of traffic density

The basic idea of the qualitative model is to represent the spatio-temporal evolution of traffic density in a given street, defining a quantity discrete space (or qualitative values) in which the density takes values. The figure gives a clearer idea of the representation capacity of the traffic evolution using the density as a bidimensional parameter (space versus time) and using the quantity space. The vertex of each region are named events (in the figure are denoted by e1, e2, e3,...), and they represent changes in the dynamic of the system (i.e. appearance or disappearance of a qualitative region). In this way, the vertex or events can represent phenomenon such as appearance or disappearance of a traffic queue, saturation of a street by a traffic queue, a change in the color of a traffic light, etc.).

With the consideration of events as primary entities in the representation of the system evolution, we use entities with cognitive meaning, achieving a great level of compactness in the temporal database which represents the system evolution (we only need the initial state of the street and the events generated). For these reasons, it can be obtained both high execution speed and easy high level interpretation of the temporal database content.

The QSEA has been built with this theoretical base. The system behaviour is modelled by means of a set of objects (streets, intersections, traffic lights, entries to the city, exits from the city, etc.) each one of them having several
parameters (one-dimensional or bidimensional parameters, like density) whose possible evolution is defined by constraints between them. The qualitative data used by QSEA are generated from the quantitative data obtained from the traffic sensors, by means of a pre-processing module.

The aim of this task in AUSIAS is to develop a good computational model of the QSEA for representing the traffic behaviour of the whole city of Valencia. This model will be demonstrated later in the following way:

a) Working on real time with the data provided by the sensors for predicting the future evolution of urban traffic for a given traffic plan. In this way, it will be possible to use the model to test the results of applying a certain traffic control plan, providing a method for determining the best traffic plan to adopt. This control strategy will minimize emergence of problematic situations in the future.

b) Other advantage of the model that will be exploited is the possibility of using the qualitative simulator for generating traffic state information richer than the one provided by the sensor loops. This additional information will be provided to the traffic control system for improving the data that it uses for calculating the control plans.

10 INCIDENT MANAGEMENT

Traffic incidents have enormous costs (time, money, ...) for the citizens because of the great number of people that use to be involved in them every day.

There have been important results in DRIVE II on automatic incident detection (for example the project INVAID II), following different technological approaches like magnetic loop detector, computer vision systems, etc. The infrastructure of Valencia provides with the necessary elements to carry out this detection, as there exist a network of more than 1,000 loop detectors and more than 400 CCTV cameras for the surveillance of the main intersections and streets of the city.

Nevertheless, the results on incident management systems are not so advanced. This is the case of Valencia, where there is a lack of integrated incident management capability.

AUSIAS will tackle these problems by developing and demonstrating a system integrating and automating as much as possible the management of traffic incidents. This will be accomplished in the following way:

a) Integrate all the methods available for detecting traffic incidents under a single interface through which receiving the alarms detected.

b) Incident management will be source-independent, and will imply taking corrective actions (on traffic lights, public transport, etc.) and to communicate with relevant services like police, hospitals, towing vehicles, etc. Covering:

   b.1) Automatic warning to emergency services.
b.2) Communicating the incident and its characteristics to the traffic control system for it to take correcting actions.

b.3) Communicating the incident and its characteristics to the public transport real-time control system.