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AN INTERACTIVE TELEMATICS SYSTEM TO IMPROVE SAFETY AND INFORMATION ON ROAD TRANSPORTATIONS

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***Abstract*— In this paper, there is a complete study of the Integrated Telematics System (ITS) in the Athens Urban Transport Organization for city buses and the company's trolley Road Transport SA, for passenger information, fleet management and supervision of project, through Public Private Partnership. In specific, the structure and operation of this system will be described and illustrated, the equipment used for the task and all necessary passenger information applications associated with this automated system. Furthermore, a comprehensive implementation of a network for Interactive Bus Stops will be included, which will be used for the first time by the traveling public. These innovative bus stops will provide in real-time, route-time information, optimal route suggestions for passengers and news of general interest, such as weather prediction and current affairs. In the last chapter of this paper body, conclusions of the advantages of using the above Telematics System are presented that ensure safety and fast transportation of passengers.**

Keywords—**Telematics, Data Transfer, Information System, Transport Safety**

I. INTRODUCTION

Telematics is defined as the technology that utilizes the combination of telecommunications and informatics for the bidirectional transmission of data, in order to update and remote control [1]. The term telematics derived from the combination of Telecommunications and Informatics words. These two sectors, applicable to wireless technologies and computer systems comprise the science of telematics. Recently, the use of the term telematics is connected closely with the GPS (Global Positioning System) in combination with the use of computers and wireless telecommunications for management of vehicle fleets. The adoption of this technology facilitated much of the development of the Internet, it became more affordable and economical for the user [2]. One of the sectors where telematics is applicable is the vehicle positioning associated with fleet management of urban transport. The term telematics is often identified with the management of a fleet, since this is the widespread use of this technology. With the use of telematics in a fleet of vehicles, the continuous monitoring of the position achieved vehicles, choosing the optimal route and another set of advantages [3].

II. DETAILED DESCRIPTION OF STRUCTURE AND OPERATION OF THE INTEGRATED TELEMATICS SYSTEM (ITS)

A. Integrated Telematics System (ITS)

The Integrated Telematics System (ITS) is an Integrated Passenger and Fleet Management Information System, which is built and operated for the Athens Urban Transport Organization and more specifically for urban buses and the company's trolley Road Transport SA by the Organization of the Athens Urban Transport, the association of companies Intrasoft International - Intrakat, which was awarded the project of Urban Transport Telematics through Public Private Partnership. The contractor, who recommended the special purpose Advanced Transport Telematics (ATT) company undertook the design, financing, installation, operation support, maintenance and technical management of the Integrated Passenger Information System and Fleet Management for Road Transport SA to total over 12 years and in addition to a network of 1,000 "smart" optical media bus stops shared across Athens Urban Transport organization service area. The ITS provides the following summary:

- Real-time monitoring of the position of all vehicles (buses and trolley).
- Coordinate fleet and monitoring of operation.
- Management, monitoring and supervision of transport work.
- Support planning and organizing transport work.

The integrated system is designed to help the optimal management, monitoring, supervision, planning support and organization of transport work of the Agency and to the improvement of services to citizens-passengers.

The design of the physical architecture of the IT infrastructure of the ITS has been given the basic design principles for all large-scale Information Systems, aimed at providing integrated services on a continuous and uninterrupted basis to end-users.

Especially because of the specificity of the project, which refers to telematics services offered to a broad base of «consumers» (service consumers), special care has been made in the following areas:

- Ensuring the maximum possible level of High Availability systems, applications and services on a 24 hour basis, based upon clustering / load balancing technologies and equipment with integrated high-availability data. This combination ensures the almost complete lack of unit failure point (SPOF).
- Select central servers High Performance equipment (High-end, Enterprise Class systems), through which the greatest possible reliability and ensure rapid response of the overall Information System even in peak situations. All equipment processor based 8-core and 6-core Intel Xeon 64-bit.
- Ensure systems security, data and services through the use of access control mechanisms, certification, formation seat belt use VPN technologies etc.
- Virtualization Technology Adoption on the layer of applications, based on technology Microsoft, Windows Server 2012 R2 Hyper-V. Through these technologies, the benefits are multiple, since creating economies of scale in physical facilities and operating costs, they add an extra layer of flexibility in IT infrastructure and make the management and maintenance of the system less cumbersome and more efficient.

The architectural design of the ITS has been to create a modern, modular Information System which offers the following advantages:

- Fully covers the functional requirements of the project.
- Based on an open architecture that allows for future extensions and modifications without changing the basic architecture.
- Ensures high performance and high availability of services to end-users of the infrastructure.
- Ensures the quality, integrity and continuous disposal of such information.
- Ensures graduate and personalized access to services and infrastructure data.
- Exploits to the maximum extent, the available technological cutting edge platforms in the field of information systems infrastructure, which save resources and optimize every modern information system.

The single system that has been implemented include:

1. Flexible, modular 3-tier shape: This format allows in future expansions, replacements, embodiments and upgrades to all of Architecture layers. Briefly, these levels are the Web / Presentation Tier: Presentation / Access layer to the ITS, the Enterprise Application Tier: Layer of implementation of business applications and the Enterprise Data Tier: Storage Layer / operational data management.

   In addition to these three basic layers for optimal administration and separation of Architecture, has created a distinct sub-central layer infrastructure services (Infrastructure Tier).

2. Open Architecture shape: Based on open application development environments, to officially documented interface systems, and open data exchange standards for information systems which open to customization.
3. High Performance shape: fully covers the specified performance and response time requirements for end-users of the system.
4. Reliable and Stable shape: Consists of central, building hardware and software elements that are shown to be reliable and certified by their manufacturers, with great presence and installations worldwide. The processing power and data storage to equipment level provided by Fujitsu company's central servers and disk subsystems, and operating systems that can accommodate all the applications belonging to the Microsoft family top version (Windows Server 2012 R2).

Furthermore, storage, retrieval and management of infrastructure data it's done by the Enterprise-Level, High-Performance Relational Database Management System (RDBMS), Microsoft SQL Server 2012. The virtual machines (Virtual Machines) created mostly the Application and Infrastructure tiers, based on Virtualization Microsoft Hyper-V platform. Compliance of the whole backup infrastructure implemented through specialized HP Data Protector Software.

5. Highly Available - Durable shape: ensured by multiple mechanisms and alternative components which provides the equipment (fault tolerance at HW level), as well as specific software technologies that have been developed in the infrastructure, such as Clustering and Network Load Balancing (high-availability at SW level). These are fully supported and work optimally with other technological platforms. Especially for Failover Clusters which are widely used in the architectural design.
6. Expandable Shape: Horizontal and vertical scalability features (scale-out and scale-up respectively) are provided because of the information distribution system architecture, if this proves necessary at a future date, to meet increasing user needs or data.
7. Easy and Accessible shape: All of the ITS implementation philosophy is based on the principle of availability of information and services through a specially designed environment (either Web-based or a special GUI to selected workstations), offering the end user a friendly interface, based on the role assigned to it.
8. Safe scheme: The provided safety is covered by the base following main areas:

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- Information Protection: The architectural design of the ITS allows the protection of stored information throughout the life circle of the covering agents such as the loss of data (random or not), the alteration of the structure and its integrity.
- Access protection information: The ITS is designed to minimize the chances of unauthorized access, search, read, input, alteration or deletion of information hosting.
- Protection, use and maintain the value of information: The ITS is designed to protect the value of information and knowledge within. Thus, the total investment is maintained and maximized, and given the necessary tools for data recovery, even for decision support at a high level (Decision Support Services, Analysis Services, Reporting Services).

Finally, the topology architecture of the infrastructure fully covers the basic concepts of a modern Information System through:

- Discrete and complete separation of the levels with the use of active network devices (firewalls, switches).
- Use Gigabit Ethernet network capacity lines and Switched Ethernet technology for high performance LAN communication.
- Using Backup / Restore with Disk-to-Disk (D2D), Disk-to-Tape (D2T) and Disk-to-Disk-to-Tape (D2D2T) technologies for the redundancy backup.
- Use of technology and Monitoring / Management products through vendor-specific tools for each subsystem equipment [4].

B. Central Management System (CMS)

The Central Management System (CMS) is the central datacenter of the IT infrastructure of the ITS. It has installed a CMS in Road Transport SA company and hosted there all the equipment and subsystems provide telematics services. The housing space has been tailored to meet the commonly accepted physical security standards for the establishment of computer rooms. In implementing the project, is designed to develop the information system only in the central datacenter, without a separate room or equipment for Disaster site.

C. Central Management System (CMS)

It has developed a fleet management area of Telematics Vehicle installed at Road Transport SA Company. In this configured jobs for vehicle operators with personal computers and other ancillary equipment (printers, video walls). These positions associated with both the vehicles and the central systems of CMS they monitor and manage vehicles watermark data to generate three watermark images extracted.

D. Supervision Centre (SC)

The Supervision Centre (SC) is the point where it can operate as a surveillance area of the ITS and its services. A SC installed on the Athens Urban Transport Organization and within these specific jobs for highly qualified staff that draw and process information, data and other elements of the ITS configured properly. These locations are interconnected with the central systems of CMS. The physical location of the SC is in a separate area from which housed the CMS and VMC.

E. Telematics Depot (TD)

There are ten (10) totals Telematics Depots (TD) installed in the Road Transport SA company and has created a special space that houses a local server, the necessary active network equipment and two jobs. The above equipment is interconnected with the central systems of CMS and with local Telematics Vehicles (TV) and through the staff of the depot performs routing and control operations of the motion of the vehicle depot.

F. Telematics Vehicle (TV)

In addition to these sites which have reported data for the information system are also regarded Smart Bus stops and Telematics Vehicles (TV). These bearing installed terminal devices which are in constant contact (wirelessly) with the central systems of CMS exchanging dynamic data between them in connection with the operational needs of the ITS.

G. Smart Bus Stop (SBS)

As with TV, the Smart Bus Stops bearing installed terminal devices which are in constant contact (wirelessly) with the central systems of CMS, exchanging dynamic data between them in connection with the operational needs of the ITS.

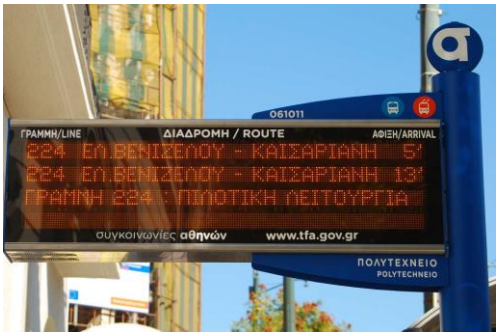

Fig. 1: Smart Bus Stop

The list of components consists of:

1. BSS6-L3 & L4

The systems BSS6-L3 and BSS6-L4 is a set of electronic integrated circuits design, which work together seamlessly to yield linear visual information via photodiodes (type LED Light Emitting Diode). Furthermore the above electronics take interconnection system with remote control centers and ensure their environmental adaptation. Also circuits BSS6-L3 and

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BSS6-L4 are those which characterize the final system as three-line or four- line. Bring upon them all the photodiodes LED as well as driving circuits and debugging. They have the ability to link together creating a continuous mosaic of LED able to imprint the desired visual information. Properly designed to achieve the maximum contrast of light and dark areas without posing Flickering where to be seen by humans. Moreover their design allows for operation in direct sunlight.

2. Athena MC

Each BSS6 system includes a central controller design (Athena MC), which controls the entire system using the operating system specially and exclusively designed for this purpose. Apart from the individual incorporating accepts additional electronic circuitry designed to adapt on it as natural extensions, which are directly controlled through appropriate channels.

In BSS6 systems are used as extensions circuits BSS6D and Athena GSM. The Athena MC circuit incorporates own transformation units of type Power Switching DC-DC converters to generate the necessary operating voltages.

3. BSS6D

Circuit BSS6D undertakes the safe transfer of data from the controller to the circuits of the LED screen and return error data from them. Additionally incorporating a sound generating system operates independently but is controlled directly by the central controller. The circuit incorporates BSSD own transformation units of type Power Switching DC-DC converters to generate the necessary operating voltages.

4. Athena GSM

The Athena GSM circuit ensures the safe transfer of the communication protocol through the mobile network. There isn't autonomous and its function is incorporated into the central controller operating system. The Athena GSM circuit incorporates own transformation units of type Power Switching DC-DC converters to generate the necessary operating voltages.

5. Hemera

The Hemera circuit is a monitoring and protection circuit through which passes the main system power supply to the powers supplies. This circuit is integrated planning and running specially designed firmware. It filters the mains from the provider network, insures against short circuits, integrates environmental control system, continuously reports the status to the central controller and has the priority rating to interrupt and restore power to the system if requested by the host controller, or if it loses communication with him. The power supplies are type AC-DC and DC-DC Switching, capable of accepting external power and to transform the necessary voltage of 5.5 Vdc, with which all the individual circuits.

6. frame / Shell protection of electronic circuits

The shell protection of electronic circuits is a specially designed self-alleged construction which is detached as a unit from the frame, enabling the direct replacement of all control circuits in minimum time. At the same time provides the necessary environmental protection to them. In summary, the frame provides the necessary support and protection for the entire system and the inner shell provides internal isolation circuits [6].

III. Future extensions and applications - Interactive Bus Stop

The existing telematics system upgrade capabilities and development of new services and applications, such as the implementation of a network of Interactive Bus Stops, which will be screens placed next to the bus stops. These bus stops will offer the possibility of interactive communication to the passenger with the ITS. This information will be offered in graphic touch environment and will include additional information than can be found in printed form at the bus stop. The information offered in each Interactive Bus Stop will contain line information, bus stops information and optimal route. At each Interactive Bus Stop will be interactive outdoor touch screen that will have anti-vandalism protection. The Interactive Bus stop will have connection through 3G modem with CMS. The monitor will be connected to the computer and will take data from the db server which will be implemented infokiosk web server to a virtual server. On the touch screen will be html5 and css3 technology website that the public will have access to all content and perform queries in information resource of the central system. The implementation of these functions can be based either on a tablet-type computer or a computational set with discrete cpu and touch screen as shown below.

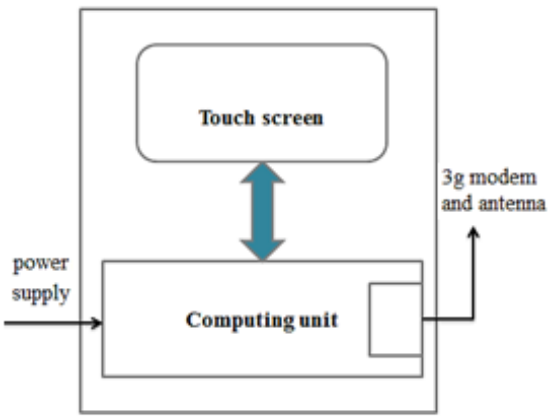

Fig. 2: computational set with discrete cpu

The software of the Interactive Bus Stop will be linked via GPRS (IPsec) on the Web Server of CMS which will receive all the information necessary for its operation.

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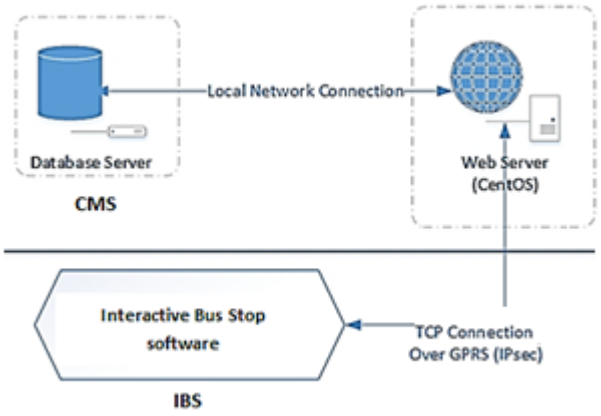

Image 3: Architectural software diagram

The Interactive Bus Stop will be the application that will be located at points - lines bus stops that would have installed this system. The bus stop will include a visual interface that will be used exclusively by touch.

- Home - Display next arrivals

The home page of the application will show the position of the bus stop on the map as well as the arrival times of the next line to bus stop. Left will appear the options of the application and the base will show the date, time, current weather of the city and news, which are taken from the Athens Urban Transport Organization website. The application will be characterized by its large buttons and eligible parties because it will be used exclusively via the touchscreen.

- Bus Stop View - Arrivals lines

Choosing the tray icon, the user will be taken to bus stop information page. There will be displayed the bus stop on the map again, the passing lines and arrivals all buses passing through this bus stop. The user can select one of the lines to go on-line information.

- Line Information

When the user selects the line which is interested in information, then the corresponding tab with the line information is displayed. The information line will include the display of line with the bus stops on the map, and the line scheduled departure program. Available will be through touch selection of any bus stop line so that the user can be transferred back to the staging information.

- Optimal Route

Through optimal routing tool, the user can select departure point and end-point and transition preferences as the maximum walking distance and the criteria based on which the system will return results. The start or finish selection methods will be:

  - Select points of interest.
  - Introduction and Division number.
  - Bus stop select from list.
  - Choice of the bus stop will be the user at this time.

The criteria which the system takes into account will be:

  - Maximum walking distance.
  - Results in terms of minimum distance.
  - Results in terms of the minimum time.

The results of the optimal route search will return step by step and the display on the map with the routes which the passenger will have to follow to reach its destination. The display will be a large map in the application center and verbal description of each step of the path left of the map. Selecting each step of the verbal route description, the system will display next to the map the route which will be followed.

IV. CONCLUSION

In the above paper was carried out the study of an Integrated Telematics System (ITS), which is an Integrated Passenger Information Systems and Fleet Management for Road Transport SA with Public Private Partnership. Specifically, for the installation of a network of 1,000 «smart» bus stops across Athens Urban Transport Organization service area, for a total period of 12 years. This telematics system, operating since March 2016 in Athens, has contributed significantly to the improvement of services offered to the traveling public, but also to optimize the operation of the Agency.
The telematics system at smart bus stops informs passengers about the arrival times of buses. The implementation of Interactive Bus Stops network will be able to offer the possibility of passenger interactive communication with the Integrated Telematics System (ITS). This information will be offered in graphic touch environment and will include additional information than can be found in printed form the bus stop. The Interactive Bus Stops can be used for the first time by the traveling public and not only. These innovative bus stops will provide in real-time, route-time information, they suggest the optimal route for passengers as well as news of general interest, such as weather and current affairs.
The ITS help improve management of the movement of buses and fleet of buses, in the monitoring of services and the rational management of staff and resources. The ITS besides the many benefits available, promotes the use of buses, reducing the use of cars, thus reducing congestion, noise, accidents and reduce air pollution.

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