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WIRELESS SENSOR NETWORKS AND SERVICE-ORIENTED ARCHITECTURE, AS SUITABLE APPROACHES TO BE APPLIED INTO ITS

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IX CONGRESO INTERNACIONAL ITS XXXVII REUNIÓN DEL ASFALTO



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WIRELESS SENSOR NETWORKS AND SERVICE-ORIENTED ARCHITECTURE, AS
SUITABLE APPROACHES TO BE APPLIED INTO ITS

OUTLINE

MOTIVATION

WSN ON ITS APPLICATIONS

SOA AND ITS

A CASE STUDY

CONCLUSIONS

WSN ON ITS APPLICATIONS

SOA AND ITS

ΜΟΤΙVΑΤΙΟΝ

A CASE STUDY

CONCLUSIONS



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MOTIVATION

WSN ON ITS APPLICATIONS

•

SOA AND ITS

A CASE STUDY

Conclusions



WIRELESS SENSOR NETWORKS AND SERVICE-ORIENTED ARCHITECTURE, AS SUITABLE APPROACHES TO BE APPLIED INTO ITS

MOTIVATION

 Transportation plays a key role to economy and social growth of countries

- Passengers and Freight Transportation
 - Transportation ways (Road, Air, Maritime, Rail)

- To 2050, world population will be 9000 millions (World_Bank, 2010)
- Services Sector associated to transportation → will grow up (Jenkins, B. & Boucher, 2007)





MOTIVATION

A CASE STUDY

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- Intelligent Transportation Systems (ITS) day by day become in a key technological element for most of countries (Figueredo et al., 2001) (European_Commision, 2010)
- However, Take-up of Intelligent Transportation System (ITS) solutions in the road transport has been slower than expected (European_Commision, 2011)
- Technological and emerging approaches \rightarrow suitable ITS solutions







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WSN ON ITS APPLICATIONS

SOA AND ITS

A CASE STUDY

CONCLUSIONS



Wireless Sensor Networks (WSN) and Services Oriented Architecture (SOA) approaches.



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A CASE STUDY

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- WSN: collection of nodes organized into a cooperative network.
 - Each node is made up of (Herrera-Quintero L., et al. 2009):
 - a processing unit (one or more microcontrollers, CPUs or DSP chips)
 - multiple types of memory (ROM, RAM and FLASH)
 - a wireless communications systems
 - a power source (e.g., batteries, solar cells)
 - An instrumentation board made up of various sensors and actuators
 - Management through operating Systems
- WSN tends to become a revolutionary technology
 - Traffic management and control
 - Driving safety and transportation efficiency
- Group on Sensor Networks (SGSN) belonging to ISO (ISO/IEC_JTC_1, 2009)
 - WSN as a primary technology to perform ITS applications.



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- On the other hand, Service-Oriented Architecture (SOA) approach, widely used in several domains
 - e-business, manufacturing, the automotive industry
- SOA is associated with a collection of self-contained services (system functions) that communicate with each other over specified interfaces (esafety,2010).
- From a business perspective, the SOA approach is a style of multi-tier computing that helps organizations share logic and data among multiple applications and usage modes (Papazoglou, M. P. et al., 2007)
- The SOA approach along with web services technology, allows the achievement of key concepts that are highly valuable for ITS
 - Integration, interoperability, Reusability, Scalability



- WSN ON ITS APPLICATIONS
- SOA AND ITS
- A CASE STUDY
- Conclusions





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- eSafety Forum Working Group on SOA
 - ISO/TC204: ISO 24097
- Easyway Project (Easyway, 2012)





WSN on ITS Applications

SOA AND ITS

A CASE STUDY

Conclusions



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MOTIVATION

WSN ON ITS APPLICATIONS

SOA AND ITS

A CASE STUDY

CONCLUSIONE



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WSN ON ITS APPLICATIONS

- Infrastructure-based sensors (e.g., inductive loops, RFID tag readers for toll collection, cameras) have been in use for transportation for many years in order to decrease and help efficiently to the management of ITS
- Principals applications of WSN are reflected in ITS context:
 - Parking management system,
 - Harbor freight intelligent management system
 - Advanced travelers information systems,
 - Advanced traffic management systems,
 - Advanced public transportation systems,
 - Commercial vehicle operation systems,
 - Fleet management systems and car-2-car communication for early warning systems





WSN ON ITS APPLICATIONS

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A CASE STUDY

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WSN ON ITS APLICATIONS

- Parking management system
 - In almost major cities around the world, parking problems are ubiquitous. It is well known that the limited availability of parking contributes decrease mobility, increase roadway congestion as well as air pollution, and generates finally, driver frustration.
- Smart parking management technologies such as WSN provide a costeffective tool to address near term parking constraints.
- To parking operator
 - It can have a suitable management system for the localization of parking spaces. Besides they can know the whole information about the state of parking spaces either by "occupied", or "unoccupied".
 - An estimation plan can be obtained to determine the future behavior over parking lot.
 - By knowing the behavior of parking lot, pricing strategies can be designed to o raise the competitiveness of parking lot.





WSN ON ITS APPLICATIONS

A CASE STUDY

WIRELESS SENSOR NETWORKS AND SERVICE-ORIENTED ARCHITECTURE, AS SUITABLE APPROACHES TO BE APPLIED INTO ITS

WSN ON ITS APLICATIONS

- To parking User
 - A wasted time factor is strongly overcome which increase transportation efficiency
 - They can organize, in a better way, the planning of activities when are moving around city, town or even among countries.
 - Fuel consumption will be reduced
 - From freight transportation point of view the mobility factor is enormously improved
 - They can reserve the parking spaces before reaching the destination.
 - Quality of life is increased







WSN ON ITS APLICATIONS

- Freight intelligent management system
 - Monitoring freight is highly important for customers and plays a key role for ITS solutions.
 - A little example Deployed a WSN on a container
 - Get an intelligent container for decentralized decision-making and autonomous coordination of logistic objects in transportation processes
 - on-line freight quality assessment and robust management of process disturbances.
 - WSN allow:
 - Increase quality information during the transportation process under given conditions
 - Their use in freight transportation can improve logistics processes given that provide more efficient, environmentally friendly, safer and cheaper services.



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MOTIVATION

WSN ON ITS APPLICATIONS

SOA AND ITS

A CASE STUDY

CONCLUSIONE





WSN ON ITS APLICATIONS

- Advanced travelers information systems
 - Designed for assisting travelers for pre-trip and on-trip route travel information
 - Improve the convenience, safety and efficiency of travel.
 - These systems acquire, analyze, and present information associated with pretrip or on-trip information for travellers that are moving from a starting location (origin) to their desired destination.
 - WSN fit perfectly into these applications because generate to traveller a large quantity of information that can be conducted by several communication channels.
 - Major part of gathering information can be supplied for ITS User
 - These Networks can offer their data with traffic management centers.
 - WSN can be used to assists the driver in knowing the current status of the traffic in real time, and to make intelligent decisions.
 - The information will include locations of incidents, weather and road conditions, optimal routes, recommended speeds, and lane restrictions.



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MOTIVATION

WSN ON ITS APPLICATIONS

SOA AND ITS

A CASE STUDY

CONCLUSIONE





WSN ON ITS APLICATIONS

- Advanced traffic management systems
 - To manage traffic along cities, roadway, and highways; traffic surveillance systems play a key role for ITS
 - Currently, there are a lot of intrusive technologies
 - (inductive loop, pneumatic road tube, piezoelectric cable, and weigh-in-motion system)
 - refer to those that require installation directly onto the pavements, in saw-cut, holes or tunneling under the surfaces.
 - Drawbacks include the disruption of traffic for installation and repair, failures induced by poor road conditions, and system reinstallation caused by road repairs or resurfaces.
 - To face off these facts reliable and cost-effective alternative system can be used for instance WSN.
 - WSN can provide traffic data at the same accuracy level as inductive loop systems, while minimizing the disruption during installation and maintenance.



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WSN ON ITS APPLICATIONS

A CASE STUDY





WSN ON ITS APLICATIONS

- Advanced traffic management systems
 - WSN can used variety of sensors (acoustic, magnetic, etc.) even, through them can be detect type of vehicle (ambulance, motorcycle, truck, medium truck, cranes, caravan, buses, etc.).
 - planning forecast can be done for determining vehicular flow
 - WSN can be used for controlling traffic flow into single or multiple intersections
 - WSN can be used as a tool to instrument and control traffic signals roadways.
 - By applying WSN, adaptive and efficient traffic estimation can be obtained which represent a dynamic change in the traffic signals' flow sequence and traffic variation.
 - This fact provides a better way for managing ITS infrastructures.
- To get in practice that ITS applications based on WSN can be carried out; it is necessary to highlight that a lot of sensor nodes will be used along the road or highways.



MOTIVATION

WSN ON ITS APPLICATIONS

SOA AND ITS

A CASE STUDY

CONCLUSIONE





SOA AND ITS

- ¿What is SOA? and ¿how this approach have been applied into ITS?.
- SOA is an advance methodology that allows the construction of loosecoupled distributed systems
- In fact, SOA approach offers flexibility in the design and implementation of applications that are able to provide accepted standards in the deployment of services.
- In the field of ITS, traditional software methodologies, CORBA, RMI and DCOM, have been used to integrate ITS solutions (center to center communications), but they are highly dependent on the programming language provoking the creation of ad-hoc systems.



MOTIVATION

WSN ON ITS APPLICATIONS

SOA AND ITS

A CASE STUDY

CONCLUSIONS





SOA AND ITS

A CASE STUDY

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SOA AND ITS

- Likewise, the traditional way to manage many ITS devices is by means of the SNMP protocol (center to device communications), which has begun to change due to the demand for ITS services
- According to future requirements, a new generation of standards that goes beyond SNMP and CORBA and embrace new technologies and standards, such as SOA and DATEX II, have begun to change the way that ITS services are deployed [32].
- Projects such as:
 - PRE-DRIVE C2X project.
 - NeTEx,
 - SIRI proposal





A CASE STUDY

 The scenario was based on deploy a WSN over a parking lot (Politecnica's School) located at the University of Alicante (see Figure), and in turn, by applying SOA-based approaches to design and implement a suitable parking management systems.







A CASE STUDY











A CASE STUDY

MOTIVATION

WSN on ITS Applications

SOA AND ITS

A CASE STUDY

CONCLUSIONS





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WSN ON ITS APPLICATIONS

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A CASE STUDY

CONCLUSIONS



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CONCLUSIONS

- WSN and SOA approaches were presented as suitable solutions for ITS
- WSN can be seen that this emerging monitoring technology that can be so useful to development several ITS applications
- SOA approach was analyzed as successful solution for ITS given that allows carry out loose coupling among each of the technologies and services present in technological heterogeneous scenario
- Finally, in our case study we combined these approaches (WSN and SOA) to generate a solution that works on University of Alicante
- Both approaches are focused on generation of ITS value-added Services



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