

u-media 2011
São Paulo, 04-Jul/2011

Towards an Ubiquitous and Context Sensitive Public Transportation System

Vaninha Vieira
vaninha@dcc.ufba.br

Luiz Rodrigo Caldas
lrrcaldas@gmail.com

Ana Carolina Salgado
acs@cin.ufpe.br

Motivation

Urban mobility and public transportation in big cities, specially in developing countries, is complex and presents many problems

CIDADES

todas as notícias de CIDADES

02/05/2010 às 11:00 | ATUALIZADA às 14:39 | COMENTÁRIO (0)

Trânsito engarrafa em vários pontos da cidade por causa da Parada Disney

A TARDE On Line | Egi Santana, do A TARDE

>> Quais foram os transtornos que você enfrentou durante a Parada Disney?

O trânsito ficou congestionado nas principais vias da cidade, por conta do evento Parada Disney, que aconteceu na orla, neste domingo, 2, entre o Jardim de Alah e o Aeroclube. De acordo com a Superintendência de Trânsito e Transporte (Transalvador), a avenida Paralela, nos dois sentidos, ficou engarrafada por conta do fluxo de veículos.

Transportation systems deal with dynamic and sometimes inconstant events:
- traffic jams
- incidents
- accidents

Motivation

Users of public transportation have to wait a long period of time with no information about what is happening in the context of their buses:
Will it arrive on time?

CIDADES

todas as notícias de CIDADES

27/02/2010 às 00:28 | ATUALIZADA EM: 27/02/2010 às 00:33 | COMENTÁRIOS (16)

Usuários de ônibus sofrem em pontos de Salvador

Luiz Fernando Lima, do A TARDE

Estimated arrival time of a bus, previewed on its schedule, almost never is accomplished in real life.

Iracema Chequer / Agência A TARDE

O vendedor de automóveis Fábio Pinto, de 28 anos, vai e volta do trabalho todos os dias de ônibus. Ele se diz indignado com a condição de alguns pontos. "Durante o dia, sofremos com o tempo, tanto faz se é sol ou chuva. À noite, o problema é a segurança", desabafa. A cadeirante Lourdes Maria Barbosa, de 68 anos, enfrenta problemas maiores. "Muitos pontos não têm rampa para quem é deficiente", afirma.

Atualmente, a população de Salvador conta com 2.736 pontos de ônibus para atender os cerca de 39 milhões de usuários mensais de transporte público. Como se vê, as reclamações que eles fazem sobre o estado de manutenção dos pontos e seus equipamentos são frequentes.

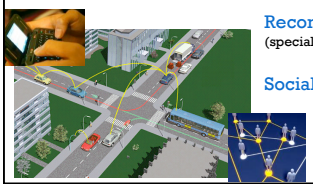
Challenges X Possible Solutions

Provide smart solutions to support users of public transportation

Increase quality of public transportation
(aid visitors and less private vehicles)

Stress and anxiety of drivers and passengers

Real-time contextual information: Routes, traffic conditions, transportation arrival time and location



Recommentation: itineraries, routes
(specially for visitors)

Social network support: information sharing about real time events

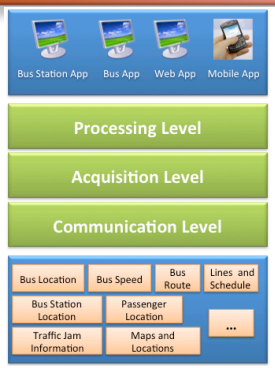
Existing Approaches

- ITS to improve passenger information
  - e.g. Google Maps, OnibusRecife.com, SPTrans…
    - Information is static and do not consider the context dynamicity
    - Algorithms, models and tools are proprietary
- Context sensitive ITS still an open issue
  - Few approaches found
    - Sustainable transport (Froehlich et al, 2009)
    - Integrated navigation (Kruger et al, 2004)
    - Road safety (Gregoriades, 2007)
    - People with disabilities (Carmien et al., 2005)

Our proposal – Objectives

- **UbiBus System**
  - Integrated ubiquitous context-sensitive ITS system
  - Characteristics
    - Open solutions (models, algorithms, tools, middleware)
    - Focus on passengers of public transportation
      - particularly buses on urban areas of big cities
    - Real-time dynamic information to support decision making
    - Accessible from multiple devices

UbiBus Architecture



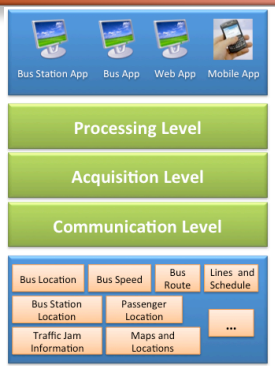
Application Level

Middleware for Ubiquitous Systems

Data Level

7

UbiBus Architecture



Application Level

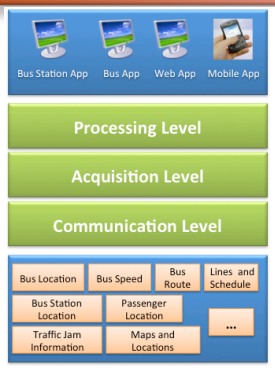
Middleware for Ubiquitous Systems

Data Level

Static structured (provided - enterprises)
Dynamic structured (acquired - sensors)
Dynamic textual (informed – users' msg)

8

UbiBus Architecture



Application Level

- Real-time, personalized information
- Recommendations
- Information sharing through social networks

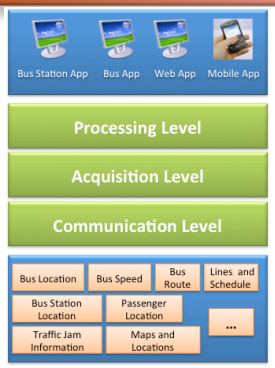
Available in many, different devices

Middleware for Ubiquitous Systems

Data Level

9

UbiBus Architecture



Application Level

Middleware for Ubiquitous Systems

Abstract functionalities related to:

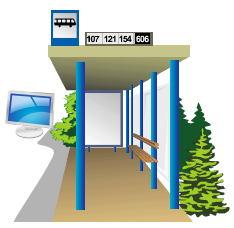
- Different devices communication
- Context acquisition from many sources
  Context processing and reasoning

Data Level

10

A Case Study

- **Your City on Time (YCT)**
  - Prototype of a Bus Station application
  - Acquires and infers real-time context information to estimate a bus arrival time at a given bus station



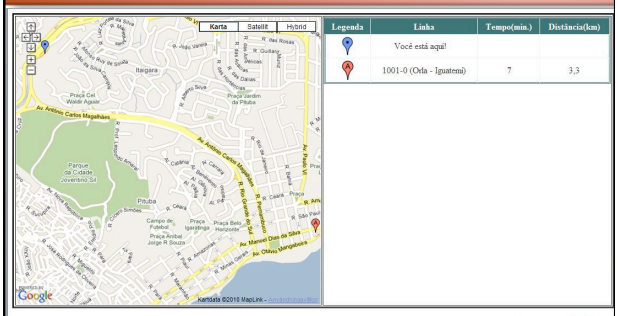
11

Contextual Elements for YCT

Entity	Contextual Element	Context Source	Acquisition	Description
Station	Location	GPS	Acquired (Static)	Georeferenced location
Bus	Location	GPS	Acquired (Dynamic)	Georeferenced location
Bus	Avg Speed	YCT	Calculated (Dynamic)	Average speed of a bus calculated from stretches it passed by
Bus	Line	Bus operator	Provided (Static/ Dynamic)	Current line a bus is allocated to
Bus	Latest Station	Sensor	Acquired (Dynamic)	Previous station a bus has just passed by
Bus	Distance to next station	YCT	Calculated (Dynamic)	Distance from a bus current location to the next station in its route
Bus	Time to next station	YCT	Calculated (Dynamic)	Estimated time from a bus to arrive on the next station in its route.
Stretch	Avg Speed	YCT	Calculated (Dynamic)	Average speed of a stretch - from buses speed that recently passed by
Stretch	Traffic Level	YCT	Calculated (Dynamic)	The traffic level intensity on a stretch (low, moderate, high).

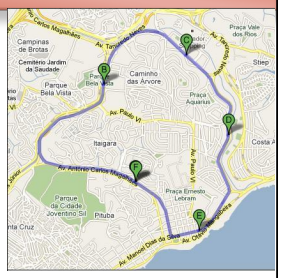
12

YCT Prototype Interface



YCT Evaluation Scenario and Methodology

- Simulated a scenario with real data
- Collected from the city of Salvador
  1. Define a bus route composed by existing bus station
  2. Acquire bus stations geo locations – GPS
  3. Register static data about the defined route in a database



YCT Evaluation Scenario and Methodology

- Simulated the dynamic bus movement in our defined route
  1. Install GPS in a car
  2. Drive the car on the route performing speeds and stops similar to buses
  3. Repeat step 2 in different times of the day simulating situations and scenarios

     Rush hour: high traffic

     Late at night: low traffic

Found Results on YCT Evaluation

Distance to the next Station (km)	Day		Night	
	Estimated Arrival Time (min.)	Difference Estimated x Real (mm:ss)	Estimated Arrival Time (min.)	Difference Estimated x Real (mm:ss)
3,3	6,8	01:48	4,9	00:28
2,9	6,2	00:24	-	-
2,3	4,6	00:00	-	-
1,9	-	-	2,5	00:04
1,3	2,2	00:24	-	-
0,5	1,2	00:36	-	-
0,4	-	-	0,6	00:10

Comparing our results with Google Maps

Update Time	Distance to Next Stop (km)	Difference Between Estimation and Reality (mm:ss)		Difference between Your City on Time and Google Maps
		Your City on Time	Google Maps	
12:41	3,3	01:48	03:36	01:48
12:43	2,9	00:24	02:36	02:12
12:45	2,3	00:00	01:36	01:36
12:47	1,3	00:24	01:36	01:12
12:49	0,5	00:36	00:10	-00:26
12:51	-	-	-	-

- Static information
- Do not consider context variations

Conclusions

- UbiBus project contributions
  - Solutions to support passengers' decisions
    - Different types of applications and information
    - Availability on different devices
  - Open models, algorithms and tools.
    - Usage of standard protocols
  - Middleware to support different applications development
- Preliminary experiments with Your City on Time prototype
  - Showed that context information aids providing more accuracy in estimating a bus arrival time

Further Work

- Work in progress
  - Effort involves researchers from several institutions
    - Academy and industry
  - We expect to use real data from the cities of Salvador and Recife
- Current work
  - Specification and development of
    - The five levels of UbiBus architecture
    - The Middleware for Ubiquitous Context-Sensitive ITS
  - Evolution of YCT application to support other devices
    - Web, Mobile phones and social networks (Facebook and Twitter)
  - Investigation of crowdsourcing, collaborative maps and information sharing using social networks

19

u-media 2011
São Paulo, Jul/2011

Towards an Ubiquitous and Context Sensitive Public Transportation System

Vaninha Vieira
vaninha@dcc.ufba.br
Luiz Rodrigo Caldas
lrrcaldas@gmail.com
Ana Carolina Salgado
acs@cin.ufpe.br

Questions?

Our proposal – The UbiBus System

- **Research Question:**
  - How Context and Ubiquity can improve ITS systems to better support **passengers** decisions?
- **Main Objective**
  - To specify and develop smart solutions to support public transportation users, particularly those in urban areas
- **Characteristics**:
  - Integrate methods and techniques from several areas: Ubiquitous Computing, Context Sensitive Systems, Middleware and Geographical Information Systems
  - Develop an integrated system with computational solutions, such as: Personalized information, recommendations, and information sharing through social networks

21

Issues Related to Using Context

- When designing a Context-Sensitive ITS
  - an emphasis should be given to the analysis of how users (should) interact with the system and how they expect the system to act on their behalf
  - Designers need to deal with issues associated to:
    - which information to consider as context
    - how to represent it
    - how to manage it and
    - how to integrate context usage into the system

22

Related Work

- Differs from existing ones on focus and scope
  - Sustainable transport (Froehlich et al, 2009)
  - Integrated navigation (Kruger et al, 2004)
  - Road safety (Gregoriades, 2007)
  - People with disabilities (Carmien et al., 2005)

23