Services in Smart City and IRMA

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NICST 2014
CHINA-FRANCE INTERNATIONAL WORKSHOP ON NEW INFORMATION COMMUNICATION SCIENCES AND TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT
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Part 0: the issue: a sustainable and smart city
The vision: toward a smart and green city

<table>
<thead>
<tr>
<th>Mobility Profile</th>
<th>Small city (E.G. Pavia)</th>
<th>Midsize city (E.G. Clermont Ferrand)</th>
<th>Metropolitan area (E.G. Barcelona)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rings</td>
<td>&lt; = 2</td>
<td>2 - 3</td>
<td>&gt;3</td>
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<tr>
<td>Bus &amp; Train &amp; Motorways</td>
<td>X</td>
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<tr>
<td>Tramways &amp; surface rails</td>
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<tr>
<td>Underground transport Subways</td>
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Our goal: Mobility for ALL in a sustainable city

Our focus: mobility of citizens (user systems)
The University of Pavia

- 30 km from Milan (40 minutes drive or train)
- Born as Studium in 825 AD
- Founded as University in 1361 AD

- 20K Students
- 25 dormitories / colleges
- Italian ranking (2012)
  - Research: 5th
  - Teaching: 1st
Abstract

- Service Systems are a new generation of systems. They add to a new layer to the layers of Internet of Things (IoT) and Internet
- This new layer is Internet of Business (IoB), that includes value propositions to stakeholders as patients, elderly, disabled people, policemen etc.
- Value propositions are typically delivered by Apps that aggregate lower level services provided by IoT and IoS layers.
- This layered architecture imply a twofold development paradigm, that designs top down the value propositions while it implements them bottom up by using open source software.

- Service Systems are exemplified by the IRMA case study.
  - IRMA (Integrated Real time Mobility Assistant) is carried on with the cooperation of Pavia University Governance and the Municipality of Pavia and embraces some 10 value propositions (services).
  - The development of IRMA has also raised a new vision of Internet Information, leading to a new layer called Internet of Data, i.e. the semantic or dependency links between data.
  - Based on IRMA European project for the 2020 call 7.1 has been submitted.
  - IRMIS comprises IRMA services and special services to Very Impaired People and to Municipality; it include the active cooperation of LIMOS (France), UPC (Spain), HIT (PRC), University Milano Bicocca (Italy), University of Athens (Greece) FUCG (Brazil).
Mobility for ALL in a sustainable city

Part 1: the IRMA project

Pavia 2014
H2020 proposal
A future scenario
2014 Pavia: Integrated Mobility

How to get to the station?

Where is the bus?
Integrated Mobility: Trip Planner + Alert Manager

Plan and store your trip on the web

Monitor your trip on smart-phone

You have arrived!

Receive real-time information about the bus and check your position
Pavia 2014: City Feed

CITIZEN

Forward Feed

Forward Report

MUNICIPALITY

Open Ticket

Close Ticket

PV 2014

Proposal H2020

Future Scenario
Trip Planner / web: display the map
Trip Planner / web: display / select options (walk, bus)
Trip Planner / web: address hint
Trip Planner / Android: login
Trip Planner / Android: Itinerary planning
Trip Planner / Android: set date and display itinerary

PV 2014

Proposal H2020

Future Scenario
Trip Planner / Android: show itinerary detail and current position

From: Via Adolfo Ferrata, 27100 Pavia PV
To: Lungoticino Visconti, 4, 27100 Pavia...
Dep.: 10:44  Arr.: 11:09
1. takes 24m 52s walking 12m 50s

Walk from Via Adolfo Ferrata to FERRATA Tangenziale Ovest (lineservizi pv0236) [334,48m]

Get on Line Spa BUS 3 at 10:49
At FERRATA Tangenziale Ovest (lineservizi pv0236)
8 Stops in between

0. ISTITUTI UNIVERSITARI Avis (lineservizi pv0237)
1. TARAMELLI Bassi (lineservizi pv0238)
2. GOLGI Taramelli (lineservizi pv0239)
3. GOLGI Policlinico (lineservizi pv0240)
4. TRIESTE D. Chiesa (lineservizi pv0241)
5. TRIESTE Filzi (lineservizi pv0242)
6. STAZIONE 5 (lineservizi pv0243)
7. CAVALIERI Minerva (lineservizi pv0244)

Get off Line Spa BUS 3
At CAVALIERI Tribunale (lineservizi pv0245)
Proposal H2020: 5 pilot cities

Universities & Municipalities are developed a proposal for Horizon 2020 – Call 7.1 Connectivity & information sharing for intelligent mobility

The project proposes 4 service groups
1. Smart Citizen
2. Smart Chair
3. Smart Municipality
4. Web of Data

The proposal is on 5 pilot cities, with the participation of:
- 7 universities and municipality bodies with ATOS as Project Manager
- Universities: Pavia, Politecnica Cataluna, Blaise Pascal, Athens, Milano Bicocca, Federal UFCG (Campinna), HIT (Harbin, China)
Proposal H2020 (recap)

**Smart Citizen**
- Trip Planner
- City Feed
- Alert Manager
- Indoor Guide *
- Long Distance Planner

**Smart Municipality**
- Mobility Analyzer
- Short Term Planner
- Urban Planner
- Pollution Control

**Smart Chair**
- Elderly Guide
- Disabled Guide

* Not included in H2020

Web of Data
Proposal H2020: Smart Chair

- Pilot: Clermont Ferrand
- Extension to 5 pilot cities

PV 2014

Proposal H2020

Future Scenario

- Disabled and blind
- Developed by LIMOS/Université Blaise Pascal
Proposal H2020: Smart Elderly

• Extension for Smart TV
• Developed by Unipv

PV 2014
Proposal H2020
Future Scenario

How can I get to the the Doctor?
How can I go to the nearest pharmacy?
Proposal H2020: Mobility Analyzer

- Performance Indicators
- Real-time analysis and simulation of mobility flows
- Services to Municipality
- Developed by Barcellona & Pavia

Pavia Mobility Analyzer

Future Scenario

PV 2014

Proposal H2020
Proposal H2020: *Indoor Guide*

Maps and Indoor Navigation

Complex buildings:
- Universities
- Hospitals
- Stations

- Developed by Pavia (*not included in H2020 proposal*)

PV 2014

Proposal H2020

Future Scenario

Anchors network (WIFI, etc.)
Proposal H2020: Web of Data: maps

- Long Distance Flow
- Traffic Flow
- Pedestrian Flow
- Accessible Map
- Elderly Map
- Indoor Map
- Disruption Map
- Transport Map
- Street Map

- Long Distance Planner
- Mobility Analyzer
- Smart Chair
- Smart Elderly
- Indoor Guide
- Alert Manager
- Trip Planner

Developed by Milano Bicocca and Athens
Release Plan: from individual to municipality services

1st SEM 2014
Trip Planner Alert Manager

2nd SEM 2014
City Feed Mobility Analyzer

2015
Smart Elderly
Smart Chair Indoor Guide

2016
Urban Planner
Short Term Planner
Long Distance Planner
Pollution Control

Proposal H2020
The sustainable future: Pavia’s strategy

As is (2014)

- Service city:
  - 71,345 residents,
  - over 20,000 students,
  - around 20,000 patients in 4 hospitals.
- Strategic Agreement of University and Municipality signed on March 6, 2014.
- University program for indoor mobility.

To be (2016)

- Cars outside 1st ring (city walls).
- Urban transport on hybrid / green public and shared vehicles.
- Disabled and special users circulate safely,
  - city substantially pedestrian
  - position of wheelchairs forwarded to transports.
- Guests serviced by multi-lingual services.
- Mobility data published for additional services as tourism and itinerary planning.
An international team: Pavia & China (HIT + TJU + UESTC)

IRMA Team almost complete (without Daniele Sacco)

Presentation to IBM

Presentation to Somma Lombardo (Malpensa)
References

• Applications (beta version)
  – Web app: http://tripplanner.unipv.it
    ma.opentripplanner.android (oppure cerca «Pavia Trip Planner» in Google Play, è più semplice!)

• Prototypes
  – http://mobilitymap.unipv.it
  – http://mobiboston-robolab.rhcloud.com

• Reference sites
  – Service Engineering lab: http://camellia.unipv.it
Part 2 : Service Systems (SS) Impact
The SS perspective

- SSs are built on IoT and IoS
- Their specific components are Business Services (IoS) and Web of Data (IoD)
- IoB are value propositions to individuals and enterprises: e.g. Patient Data, Indoor Mobility, Support to Disable People, Services to Citizens etc.
- IoD store semantic links of the information being used in IoB: relations between government services, transport systems, health services and health insurances etc.
SS versus Enterprise Systems

**Internet of Things (IoT)**
- A set of business services to individuals and/or enterprise that access on demand internet services at IoT or IoS levels (and ES as well)
- Information sources are typically multiple, diverse and Internet

**Internet of Services (IoS)**

**Internet of Business (IoB)**

**Internet of Data (IoD)**
- Crowd Data
- Open Data
- Social Data

**Enterprise Business Services (Enterprise Systems)**
- A set of business services (e.g. Order Entry) that share databases that stores enterprise data
- Generally ESs are developed by customizing an application software platform as CRM, ERP etc. that runs on premises or in cloud
SS Information Layers

- SS information is layered.
- Each layer includes:
  - Intra-layer relations (e.g. Street-Map)
  - Inter-layers links (e.g. Event-Maps-Twitters)
- To link layers:
  - Ontology that models relations and links
  - Big Data technology that deploys huge volumes in a distributed cloud
SS Information Engineering

- **A drastic impact**
  - (a) theoretical: ontology
  - (b) technological: Big Data - Hadoop, JSON etc.
- **“Meta-ontology” (by stakeholder)**
  - Information types.
    - Structural Data (e.g. Timetables in a City)
    - Event data (e.g. RT position of buses)
    - Analysis Data (e.g. clustered preferences of passengers).
  - Information domains e.g.:
    - stakeholders (e.g. passengers)
    - geography (e.g. map)
    - ....
- New data analysis approaches e.g. heterogeneous graphs, fuzzy proximity
SS Layered Services

- Business services are built on lower level services
- Business Services use Open Software with a Lego logic

The Trip Planner application accesses Open Street Map (master data) and GTFS files and RT data (events) by a set of Open Software
Elicitation of Stakeholders’ Needs

• Each IOB application reflects needs of a specific stakeholder class
• Stakeholder classes are numerous, layered and diverse
• Seldom stakeholders know their needs.
• Hence, the analyst shall identify and check needs by interviews, benchmarks, case studies.
• This implies a combined approach to projects

Main stakeholder classes in IRMA case study
A new development cycle

THE SERVICE SYSTEMS PERSPECTIVE

SERVICES SYSTEMS & INFORMATION ENGINEERING

SERVICES SYSTEMS & SOFTWARE ENGINEERING

CONCLUSIONS

Top-down Design

User needs
E.g. Mobility needs about public transport

Value proposition (App or Web)
E.g. Mobility planning on multi-model transports

Aggregate services
E.g. Real-time position of buses on the city map, real-time rescheduling

Bottom-up Implementation

Access services
E.g. API to access real-time data of buses

Published services
E.g. Real-time position of buses

IoT/Local services
E.g. On board GPS devices/GNSS

• The SS architecture implicates a top design and a bottom up implementation
## A new Development Process

<table>
<thead>
<tr>
<th>Stage</th>
<th>Top-down analysis</th>
<th>Bottom-up implementation</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>Communication</td>
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<td>Stakeholders elicit needs and confirm the analysis, e.g.</td>
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<td></td>
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<td>- transport provider needs to monitor specific KPIs on the quality of service</td>
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<tr>
<td>Planning</td>
<td></td>
<td></td>
<td>Analysis enables a better planning that reflects real needs of stakeholders and their feasibility</td>
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<tr>
<td>Modeling</td>
<td></td>
<td></td>
<td>Modeling matches top-down and bottom-up approaches e.g.:</td>
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<tr>
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<td>- The analysis model identifies the needs of monitoring buses in real-time</td>
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<td></td>
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<td>- The implementation model identifies existing data sources</td>
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<tr>
<td>Construction</td>
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<td>Construction follows the layers that have been defined for implementation</td>
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<tr>
<td>Deployment</td>
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<td>Deployment validates services and layers defined and implemented in previous phases</td>
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New contents in software engineering courses

- Education for SS engineers requires a specific theory and practice on top-down design
  - System Architecture
  - User needs elicitation
- The bottom up implementation based on OpenS Software requires specific focus on WS integration
- The stakeholder orientation implies a specific focus on SW QA and SW management
Conclusions

- Service Systems (SS) are a new generation of systems based on a layered architecture with:
  - Layers of information
  - Layers of services
  - Top down design & bottom up development
  - Stakeholder oriented needs elicitation
  - Stakeholder oriented testing

- These characteristics imply a framework with top down analysis and bottom up implementation.

- Such framework is successfully used in IRMA (Integrated Real Mobility Time Assistant), a project carried on by University of Pavia with the cooperation of HIT.