Smart traffic for Guadalajara City: crowdsourcing, analytics and forecasting for commuting time optimization

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Urban Systems Collaborative Webinar
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Agenda

• Context in Guadalajara City
• The project development:
  ▶ Architecture, TOTEMS, Organization
• Current achievements
• Discussion & concluding remarks
Context

Guadalajara City (GDL)
GDL Facts

- Founded in 1539
- 4.2 million people in the metropolitan area
- 4x growth in last 20 years
- 6 Municipalities interconnected
- 17 Km distance crossing north to south
- 1/4 of Mexico City
### GDL compared with other world cities

<table>
<thead>
<tr>
<th>#</th>
<th>City</th>
<th>Population (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tokyo</td>
<td>8.477</td>
</tr>
<tr>
<td>2</td>
<td>New York</td>
<td>8.175</td>
</tr>
<tr>
<td>3</td>
<td>London</td>
<td>7.754</td>
</tr>
<tr>
<td>4</td>
<td>Rio de Janeiro</td>
<td>5.940</td>
</tr>
<tr>
<td>5</td>
<td>Guadalajara</td>
<td>4.200</td>
</tr>
<tr>
<td>6</td>
<td>Madrid</td>
<td>3.373</td>
</tr>
<tr>
<td>7</td>
<td>Buenos Aires</td>
<td>2.891</td>
</tr>
<tr>
<td>8</td>
<td>Chicago</td>
<td>2.696</td>
</tr>
<tr>
<td>9</td>
<td>Paris</td>
<td>2.234</td>
</tr>
</tbody>
</table>
Traffic facts in GDL

- 1.7 million private vehicles
- Lack of efficient public transport services
- Public systems about traffic information are not available
- During rainy season, flooding causes traffic jams in many areas of the city
- City roads infrastructure is not enough in peak time
Smart Traffic project for GDL
Project Goal

Reduce commuting times by 15% in the metropolitan area of Guadalajara City

Over 1.7 million of cars, save 15% of commuting offers a potential daily saving* of $366,000.00 USD in productivity time for the city + reducing in pollution rates of CO2 emissions

* Estimation based by 3 salaries at GDL per day
Potential savings for GDL city

- Day: $366,000
- Month: $7,320,000
- Year: $87,840,000
Other goals

• Develop software applications demanding HPC support

• Traffic is the first of a set of systems to leverage the economy of the region and to attract new investments

• Prepare a group of skilled professionals to deal with complex projects

• Create, in long term, a world class research center focused on solving complex problems related to cities and industries
GDL is an excellent platform to test traffic solutions because it scales by 1/4 to Mexico City.
Smart Traffic System

Smartphones

Input from Sensors

Data Analytics Processing & Computing

Smart Traffic System

Status Map & Routing
Overall Architecture

1. Data Acquisition
   - GPS
   - Mega City Systems: Traffic, Health, Security, etc.

2. Smart Analytics
   - Data Quality Control
   - Semantic Analysis
   - Data security & privacy
   - Cloud Computing & Crowdsourcing

3. Simulation Prediction
   - Behavior model
   - Forecasting Information
   - Decision support to optimize city resources
   - Data Visualization
   - Semantic Analysis

HPC
Big Data
Storage
Classification
Integration
Crowdsourcing & Participatory Sensing

Smartphone App → TOTEM → High Performance Computer

Filter, Validation & WebService

Analytics, Forecasting & Visualization

Architecture Components
Smartphones for crowdsourcing feasibility in GDL

<table>
<thead>
<tr>
<th></th>
<th>Mexico</th>
<th>Jalisco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>112M</td>
<td>7.3M</td>
</tr>
<tr>
<td>Mobile phone</td>
<td>83.5M</td>
<td>5.44M</td>
</tr>
<tr>
<td>Smartphone</td>
<td>25M</td>
<td>900K</td>
</tr>
</tbody>
</table>

[admob metrics 2010], [TNS Mobile Life 2011]
Open questions

In GDL City

• How to interconnect sensors?
• How much data to process for the city?
• What about security and data storage?
Definitions
Network interconnection

Centralized

Descentralized

Distributed
GDL Data input

1.8 PB per year

- 3.8 millions of Cellphones@177 TB/Year in SMS Messages
- 900K Smartphones@1.5TB/Year GPS_Images_Audio_Video_Repports
- 800K Social Network users@500MB/year Facebook-Twitter-Blogs
- 800K Traffic Web Site users@100TB/Year
Security Issues

- Sensitive information from users can expose their privacy
- Sniffers can intercept traveling information
- DoS attacks
TOTEM Architecture
Talk about The state of Metropolis
TOTEM distribution by geographical regions
Smartphones

Road traffic sensors

Social networks

Other data sources

Data converter & fuser to CAP report

CAP Reports

CAP Reports Trustfulness validator

Filter for duplicated reports

Store & create partial replicas of reports in other TOTEMs

Parallel partial CAP reports replication

TOTEM Computing
Current achievements
Team organization

Funding & Strategic Direction

Management
- IBM GDL Leaders
- UDG leader
- Management staff (2 bachelor students in accounting)

Research
- 4 Professors
- 8 PhD thesis

Marines
- 6 bachelor students in computer science
- 2 graphic designers

Innovation

Business Plan
- 1 Master Student in Business
- 1 master student in Marketing
- 2 bachelor students in financial & accounting

Business

Smart traffic for GDL

Prototype Development

26 people working in the project under SCRUM/Agile Methodology!
Research Topics

• Big Data
• Data quality & crowdsourcing
• Optimization for path planning
• Semantics for social networks
• Recommendation systems
• Next Generation Networks
• Augmented Virtual Reality
• Flow simulation for transport systems
• Cloud computing & security
First prototype of a mobile App integrating traffic information and route optimization
Web Site for traffic monitoring and forecasting
Where we are today?

1st Stage:
Show skills to solve complex problems with IT

2nd Stage:
Negotiate with government full project deployment

3rd Stage:
Graduate Students & Create Spinoffs to Support Solutions

2011
IBM UDG Agreement + 100K Grant

2011
Proposal validation

2012
IBM PhD Fellowship achieved

2012
Team organization

2012
Publications Accepted

2012
Full prototype

2012
Talks with government

2012
Apr 2012

2012
May 2012

2012
Sep 2012

2012
Oct-Nov 2012

2013
Have a World Class Solution

2013

Discussion & concluding remarks
Concluding remarks

- The project is in the first stage
- Experience from both academia and industry to excel collaboration
- A group of passionate people dealing with the integration of different subsystems
- Based on the acquired experience we aim to enable a super computing center
- From the resultant traffic system we’ll be able to develop IT solutions for other problems in cities
Thank you!