Intelligent Transportation System

“The future shall be dependent on the power of the crowd. Its foundation shall be voluntary data investment of individuals. It shall address challenges directly from the source and intelligence in all area shall prosper.”

Dr. Francis Aldrine A. Uy

Dean, School of Civil, Environmental and Geological Engineering, Mapua Institute of Technology
2014 BOD, Transportation Science Society of the Philippines (TSSP)
Member, Eastern Asia Society for Transportation Studies (EASTS)
National Research and Development Director 2013 & 2014 PICE National Director
2014 PICE Quezon City Director
Board Member for Civil Engineering, Philippine Technological Council (PTC)
Accreditation and Certification Board for Engineering and Technology (ACBET)
National Research Council of the Philippines (NRCP), Transportation Systems and Infrastructure Specialist
Internet of Things

Connected! All the time! Everywhere!

Internet of Things (IoT) - Defined

• “a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols”

• ITU vision of the IoT: “from anytime, anyplace connectivity for anyone, we will now have connectivity for anything”

• European Commission: “Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and user contexts”

• US NIC foresees that “by 2025 Internet nodes may reside in everyday things – food packages, furniture, paper documents, and more”
IoT Elements

• Radio Frequency Identification (RFID)
• Wireless Sensor Networks (WSN)
• Addressing Schemes
• Data Storage and Analytics
• Visualization
Network Architecture of Internet of Things

• Sensing Layer
  – Includes sensors that capture, identify, share information without human intervention

• Access Layer
  – Transfers information from sensors to network, using mobile networks, wireless networks, wireless LANs, satellite networks, other infrastructures

• Network Layer
  – Integrates information of network into a larger network with Internet platform

• Middleware Layer
  – Manages information for real-time access

• Application Layer
  – Practical applications for different industries:
    Smart Grids, Smart Logistics, Intelligent Transportation, Precision Agriculture, Disaster Monitoring, Distance Medical Care
Application Areas of Internet of Things
Application of **Internet of Things**

L. Atzori et. al./ Computer Networks 54 (2010) 2787-2805
Social Network

Internet of Things

L. Atzori et. al./ Computer Networks 56 (2012) 3594-3608
Intelligent Transportation System

“The future shall be dependent on the power of the crowd. Its foundation shall be voluntary data investment of individuals. It shall address challenges directly from the source and intelligence in all area shall prosper.”

– Dr. Francis Aldrine A. Uy
The ITS Connection!

- People
  - Access
  - Connectivity

- Infra
  - Interoperability

- Vehicle
  - Communication
9 Areas of ITS Deployment: Japan

- Advances in Navigation
- Support for Pedestrians
- Increasing Efficiency in Commercial Vehicle Operation
- Optimisation of Traffic Mng’t
- Assistance for Safe Driving
- Electronic Toll Collection Systems
- Support for Emergency Vehicle Operations
- Support for Public Transport
- Increasing Efficiency in Road Mng’t

Source: ITS Japan
6 Areas of ITS Development/Deployment: Thailand

1. Traveler Information
2. Traffic Management
3. Commercial Vehicle
4. Public Transport
5. Safety
6. Electronic Payment
ITS Connection & Deployment

People

Infra

Vehicle
## ITS Applications

<table>
<thead>
<tr>
<th>A People-Infra</th>
<th>B People-Veh</th>
<th>C Infra-Veh</th>
<th>D People-Veh-Infra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Traffic Information System (ATIS)</td>
<td>PUV Management</td>
<td>Crash prevention sensors</td>
<td>Transportation Information System</td>
</tr>
<tr>
<td>Traffic Management</td>
<td>Advance Navigation</td>
<td>Air/Noise Pollution Monitoring</td>
<td>Traffic Enforcement System</td>
</tr>
<tr>
<td>Traffic Safety Assistance</td>
<td>Fleet Management</td>
<td>Physics and Service Integration</td>
<td>Road Management</td>
</tr>
<tr>
<td>Mobile Application</td>
<td>Traffic Signal Control</td>
<td>GPS Navigation</td>
<td>Toll/Fare Collection</td>
</tr>
<tr>
<td>Parking System</td>
<td></td>
<td></td>
<td>Accident Reporting and Evaluation System</td>
</tr>
<tr>
<td>ITS Development/Deployment Areas</td>
<td>ITS User Service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
<td>------------------</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 1. Traffic Management/Traffic Signal Control | (1) Advance Traffic Control System at Intersections to improve traffic efficiency at intersections  
(2) Emergency Vehicle Priority System for safer lives of people |
| 2. Traffic Information Provision | (3) Upgrading of Traffic Information Collection and Provision System on real-time basis for faster and comfortable travel and to maximize the use of existing road facilities  
(4) Events Information Provision System to reduce traffic congestion at and around event sites  
(5) Route Guidance System to direct drivers to less congested routes to maximize the use of existing road facilities  
(6) Information Provision System for Temporary Traffic Bottlenecks to achieve less frustrating trips and to reduce traffic congestion at temporary traffic bottlenecks  
(7) Traffic Management System at Large-scale Shopping Malls to reduce localized traffic congestion  
(8) Parking Space Information Provision System to improve traffic flow in CBDs and for better road user service  
(9) Commercial Vehicles Location System for more orderly trips of commercial vehicles |
| 3. Traffic Safety Assistance | (10) Danger Warning System to reduce road crashes to improve traffic safety  
(11) Pedestrian Safety Support System to reduce road crashes  
(12) Weather Condition and Prediction Information Provision System for safer travel and to improve resiliency to natural disaster. |
| 4. PUV Management | (13) Bus operation Monitoring and Control System to reduce traffic congestion at bus stops and to eliminate illegal bus operations  
(14) Rail Operation Information Provision System for better passenger services |
| 5. Traffic Enforcement Assistance | (15) Traffic Rules Surveillance and Control System to achieve smooth traffic flow and to reduce road crashes  
(16) On-street Parking Control to improve traffic capacity for smoother traffic flow  
(17) Over Speeding Control System reduce road crashes  
(18) Overloaded Truck Control System to provide better surfaced roads. |
| 6. Road Management | (19) Upgrading of Road Condition Information Collection to improve Road Management and to Secure Service Level |
| 7. Toll/Fare Collection | (20) Road Pricing System to reduce cars on the roads for smoother traffic flow  
(21) Common Ticketing System for easier transfer. |
ITS Master Plan for Metro Manila +2 regions (Region 3 and 4A)

Mega Manila Region Highway Network Intelligent Transport Systems (ITS) Integration Project (MMDA/DPWH; funded by JICA) 2012-2013

AVERAGE POPULATION GROWTH RATE (YEARS 2000-2010)

LEGEND:
- Mega Manila
- Metro Manila
Development of ITS Master Plan

Identification of Transport Problems/Issues
• ITS Needs Survey
• ITS Current Applications

ITS Master Plan Development
• Development Vision
• Overall Goal and Objectives
• Development/Deployment Areas
• Implementation Schedule and Cost

Measures for Sustainable ITS Development

Dr. Sigua
Traffic Problems Experienced in Metro Manila

- Traffic Congestion of Roads: 83%
- Delays at Intersections: 34%
- Slow Travel Speed: 24%
- Frequent/Irrregular Stop of Bus/Jeepney: 40%
- Driver’s Behavior: 62%
- Lack of Traffic Information: 21%
- Difficult to Estimate Arrival Time: 13%
- Crowding/Long Stay of Buses at Bus Stop: 41%
- Others: 10%
Causes of Congestion in Metro Manila

- Intersections: 51%
- U-Turn Slots: 38%
- Bus Stops: 51%
- Shopping Malls/Commercial Establishments: 21%
- Construction Work Site: 28%
- Road Maintenance Work Site: 37%
- Deteriorated Pavement: 10%
- Traffic Disturbed by Pedestrian: 8%
- Near LRT/MRT Station: 8%
- Traffic Accident: 18%
- Flooding: 25%
- Bad Manners of Drivers: 26%
- Reduced Number of Traffic Lanes: 10%
- Too Many Intersections: 12%
Development Visions

‘Towards a Competitive, Inclusive And Resilient Metropolis’ - MMDA

‘A Sustainable and Caring Global Gateway through Public-Private Partnership and Growth for All’
ITS Goals and Services

**Major Transport Problems**
- Serious Traffic Congestion
- Limited Traffic Information
- Road Crash
- Aggravation of Environment
- Bad Driving Manner
- Violation of Traffic Rules & Lack of Enforcement
- Paralyzed Traffic by Floods

**Metro Manila**
- Traffic Congestion
- Limited Traffic Information
- Bad Driving Manner & Lack of Enforcement
- Paralyzed Traffic by Floods
- Low Rate of ETC Users on Expressway
- Independent Operation by Each Toll Operator

**Overall Goal of ITS Services**
- To Reduce Traffic Congestion
- To provide Safe, Comfortable, and Less Frustrated Travel
- To contribute to Sound Environment

**Targets of ITS Services to Achieve Development Visions**
- Improvement of Mobility
- Sound Environment
- Safe and Comfortable Life with Less Road Crash
- Resiliency to Natural Disaster

**Metro Manila**
- Faster and More Reliable Travel
- Safer and More Comfortable Travel
- Economical Travel
- Environmentally Sound Travel

**Mega Manila**
- Improvement of Mobility
- Sound Environment
- Safe and Comfortable Life with Less Road Crash
- Resiliency to Natural Disaster

**Mega Manila**
- Faster and More Reliable Travel
- Safer and More Comfortable Travel
- Economical Travel
- Environmentally Sound Travel
Current ITS Initiatives
Consolidated

DOST
ITS Database (Cloud)

- Passenger Demand & Supply Profile
- Traffic Situation
- Trip Advisory
- Air Pollution Data
- Weather & Flood Information
- PUV Service Operation
- Urban Planners
- Policy Makers
- Researchers
- LGUs
- Public Users
- Commercial Users
Current ITS Initiatives

PUV Management
- PUBFIX (jeepney fleet)
- BEAMS (bus fleet)

Traffic Information Provision
- TRIPCO (Commuters)
- Passenger Count with origin-destination
- Route Demand Forecasting
- Fuel Economy
- Passenger individual count (MRT, Taxi, UV Express)
- Forecast individual and aggregated routes
- Navigation Guide for the PWD (Blind)
- Track Passenger Transfer (History)
- Forecast individual and aggregated routes

Traffic Management/Traffic Signal Control
- LOCAL SIM (Traffic Mgt)
- Passenger Count with origin-destination
- Route Demand Forecasting
- Track Passenger Transfer (History)
- Fuel Economy
- Traffic Simulation Models
- Passenger Count with origin-destination
- Traffic Forecasting

Traffic Information Provision
- PhilMATIS
- Traffic Volume
- Traffic Forecasting
- Flood Level Info
- Air Quality Data
Current ITS Initiatives vis a vis targets & demonstration

**PROJECT**
- PUBFIX (jeepney fleet)
- BEAMS (bus fleet)
- TRIPCO (Commuters)
- LOCAL SIM (Traffic Mgt)
- PhilMATIS
- ATPMS

**TARGET OUTPUT**
- Fuel Economy
- Route Demand Forecasting
- Navigation Guide for the Commuters & PWD (Blind)
- Traffic Simulation Models
- Traffic Volume & Forecasting
- Flood Level Info
- Air Quality Data

**PROBLEM ADDRESSED**
EDSA DECONGESTION (INCREASE MOBILITY BY 20%)
On-going Initiatives

DOST
Philippine Metropolitan Advanced Traveler Information System (PhilMATIS)

An advanced traveler information system (ATIS) on traffic and incidence of flooding along major roads in Metro Manila
Traffic information
Image Processing/ vehicle tracking
PhilMATIS Components

Urban Flood Monitoring System

![Diagram of the Urban Flood Monitoring System](image)

- **Rain Gauge**
- **Ultrasonic Sensor**
- **Battery**
- **Solar Panel**
- **Data Logger**
- **Central Server**
- **GSM Network**
- **Info**
- **Variable Message signs**
- **Web Client**
- **Mobile Phone**
Pilot Corridor (España Boulevard, from Welcome Rotonda to Lerma Street.)
Advanced Traffic and Pollution Monitoring and Analysis System Based on GPS Data, Air Quality Data and Engine Status Data from Tracked Taxis in Metro Manila (ATPMS)

A traffic and air pollution monitoring system
System Overview
Expected Output

• Advanced Traffic and Pollution Monitoring

• Advanced Traffic and Pollution Info

• Advanced Traffic Prediction

• Shared Data
Proposed ITS for 2014

Requesting for DOTC & MMDA
Endorsement
LocalSim (Localized Traffic Simulator)

A decision support tool for traffic simulation and experiments
Development of a customized local traffic simulator (LocalSim)

R&D Objectives

• Develop agent-based microscopic models of driving behavior
• Develop microscopic traffic simulation software for local traffic management applications
• Verification/Validation
• Benchmark the application against existing traffic simulators; pilot test using several traffic scenarios

Expected Outputs

• Behavior models of traffic agents
• Microscopic Traffic Simulation Software for use by local government agencies (LocalSim)
• Traffic Simulation of EDSA as a pilot project
Development of a Customized Local Traffic Simulator

Proposed Traffic Management Schemes
Proposed Road Improvements
Traffic Models
Local Sim
Decision Support System
Decision Making

Traffic Data
Public Transportation Data

ITS Database (Cloud)

image source: http://sumo-sim.org/
Concept of PUJ/Bus Stopping Behavior

Each position has state value based on potential “reward”

Jeepney/bus moves to next step based on reward

Passenger distribution (Transit Stop)
Optimal Scheduling of Public Transport System along a Route (PUBFix)

An Inventory System on the public transport vehicles and routes
Optimal Scheduling of Public Transport System along a Route (PUBFix)

**Objectives**
- Inventory the public transport system and their service operating characteristics especially those using EDSA
- Develop a basic methodology of optimally scheduling the daily operation of public transport
- Develop a web-based Public Transport Information System (PTIS) for the existing PUV operation along EDSA

**Expected Outputs**
- List of public transport system by route and their service operating characteristics like average speed, dwell time at stops, load profile, etc.
- A basic computer program on PUB scheduling using MS EXCEL and with a reference manual
- A web-based PTIS accessible to the public
Flow of the Study

Screening/Choosing of PUV Operators

Primary Data Gathering
- PUV Route Inventory
- Volume Survey
- Onboard Survey (BEAMS & manual count)
- Questionnaire Survey for drivers/passengers

Processing/Analysis of Data

- EXCEL Program Dev’t for the PUB Scheduling
- Reference Manual Dev’t
- Web-based PTIS Dev’t

Pilot Testing

Before-and-After Comparison of Results

Dissemination/Transfer of Technology to Recipients

Documentation and Development of Project Report
Optimal Scheduling of Public Transport System along a Route (PUBFix)

Route Name (No.): Southbound Kamuning – Cubao (On)
Peak Sched (7-9AM, 4-6PM): Every 5 min
Off Peak Sched: Every 10 min
Ave. Boarding Passenger: ___
Ave. Alighting Passenger: ___

Route Name (No.): Ayala Ave. – Buendia (01)
Peak Sched (7-9AM, 4-6PM): Every 5 min
Off Peak Sched: Every 10 min
Ave. Boarding Passenger: ___
Ave. Alighting Passenger: ___
Mobile Millennium Manila

Professor Francis Aldrine Uy, Mapua
Professor Alexandre Bayen, UC Berkeley
Professor May Lim, UP-NIP
‘Traffic costs P2.4B daily’

Neda chief cites Jica study for dev’t road map

By Michelle V. Remo
Philippine Daily Inquirer
12:41 am | Saturday, July 6th, 2013

If time is money, then the Philippines is losing P2.4 billion a day in potential income due to traffic congestion that eats up time that could have been used for productive pursuits, Socioeconomic Planning Secretary Arsenio Balisacan said.

Balisacan, National Economic Development Authority (Neda) chief, was quoting a study by the Japan International Cooperation Agency (Jica) that the government has tapped to help come up with a transportation development road map for the country.

“It’s a no-brainer that we need to boost infrastructure. We have a huge backlog in almost all types of infrastructure,” Balisacan said, adding that the government intends to invest in more roads, bridges, railways, airports, and sea ports during the remainder of President Benigno Aquino III’s term.

Compared with neighboring countries, the...
In the future...

“The future shall be dependent on the power of the crowd. Its foundation shall be voluntary data investment of individuals. It shall address challenges directly from the source and intelligence in all area shall prosper.”

– Dr. Francis Aldrine A. Uy
Four (4) Underlying Principles of M3

People Power in its high-tech form called Crowd Power
- Filipinos started people power then now crowd power to provide an advance solution!

Individual data investment for crowd/public information
- Contributing ones data to the M3 system to gain and profit bulk of transportation related information and tools. High-tech form of “Bayanihan”.

Addressing the problem from the source
- Current traffic management systems address the problem at the problem site (e.g. roads and highways). Aside from this M3 will address transportation problem from the source, each individuals trip demand.

A new society of intelligent trip makers
- Intelligent Transportation System (Infra) combined with Intelligent Trip Makers shall result to inclusive mobility!
What can this PCARI project do?

- To build on US experience – Mobile Millennium – to develop innovative and ground-breaking approaches to transportation system management in Metro Manila;

- To exploit the ubiquity of mobile communications and a social networking culture to enable travellers to become participants in increasing mobility and accessibility for all. (29 to 50% in the next 3 years)
What can this PCARI project do?

Intelligent Trip Makers (ITM)

Intelligent Transportation Infrastructure and Systems

Mobile Millennium Manila (3M) – a well-managed traffic and travel demand resulting in inclusive mobility
Transportation Engineers have been relying on estimates/projections based on surveys conducted 10 years ago…
Mobile Millennium Manila

M3 Computing Back-End

Mobile App Services and Tools

Information for Transport Operators/Providers and Traffic Managers

Transportation

Mobile App Feeds

Other Future Feeds
Mobile Millennium

- Extend the work of Mobile Century to arterials
- Use cabspotting data and other feeds
- Provide traffic information back to the user

An early instantiation of participatory sensing
- Consortium: NSF, US DOT, Caltrans, Nokia, NAVTEQ, + 10 others
- Initially, 5000 downloads of the FIRST Nokia traffic app worldwide
- Today: gathers about 60 million data points / day from dozens of sources (smartphones, taxis, fleets, static sensors, public feeds)
- Provides real-time nowcast (soon forecast) of highway and arterial traffic, provide routing and data fusion tools.
Prototype traffic information system
Mobile Millennium system architecture

Sensing
- Millions of mobile devices as new sources for data

Communication
- Existing cell phone infrastructure to collect raw data and receive traffic information

Data assimilation
- Real-time, online traffic estimation

Privacy Management
- Encrypted transactions
- Client authentication
- Data anonymization
National Development, Competitiveness and Resiliency
‘Traffic costs P2.4B daily’

Neda chief cites Jica study for dev’t road map
By Michelle V. Remo
Philippine Daily Inquirer
12:41 am | Saturday, July 6, 2013

If time is money, then the Philippines is losing P2.4 billion a day in potential income due to traffic congestion that eats up time that could have been used for productive pursuits, Socioeconomic Planning Secretary Arsenio Balisacan said.

Balisacan, National Economic Development Authority (Neda) chief, was quoting a study by the Japan International Cooperation Agency (Jica) that the government has tapped to help come up with a transportation development road map for the country.

“It’s a no-brainer that we need to boost infrastructure. We have a huge backlog in almost all types of infrastructure,” Balisacan said, adding that the government intends to invest in more roads, bridges, railways, airports, and sea ports during the remainder of President Benigno Aquino III’s term.

Compared with neighboring countries, the...
Benefits of ITS

- Congestion & Time: <20-40%
  480-960M
- Environment: <12%
- Efficiency
- Safety: < 20-40%
- Crash
Key strategies on ITS Development

1. Ensure Interoperability & International/National Standard
2. Create a National Institutional Framework
3. Improve Public and Industry Awareness
4. Foster a Competitive Philippine based ITS Industry
5. Promote International Cooperation
6. Establish and Monitor Demonstration Projects
7. Privacy Principles and Standards

ITS Strategy Australia
Creation of Strong Body for ITS Promotion

Office of the President

Top Level Coordination Committee
- Department of Public Works and Highways (DPWH)
- Department of Transportation and Communication (DOTC)
- Metropolitan Manila Development Authority (MMDA)
- Philippine National Police (PNP)
- Department of Science and Technology (DOST)

ITS Philippines

[Roles and Function]
- ITS Policy Formulation for ITS Development
- Inter-agency coordination/cooperation on jurisdiction/mandate issues.
- Coordination to avoid overlapped investment

Dr. Sigua
Thank You and God bless!