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!

I.G. Smith / Internet of Things 2012 New Horizons (2012)

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
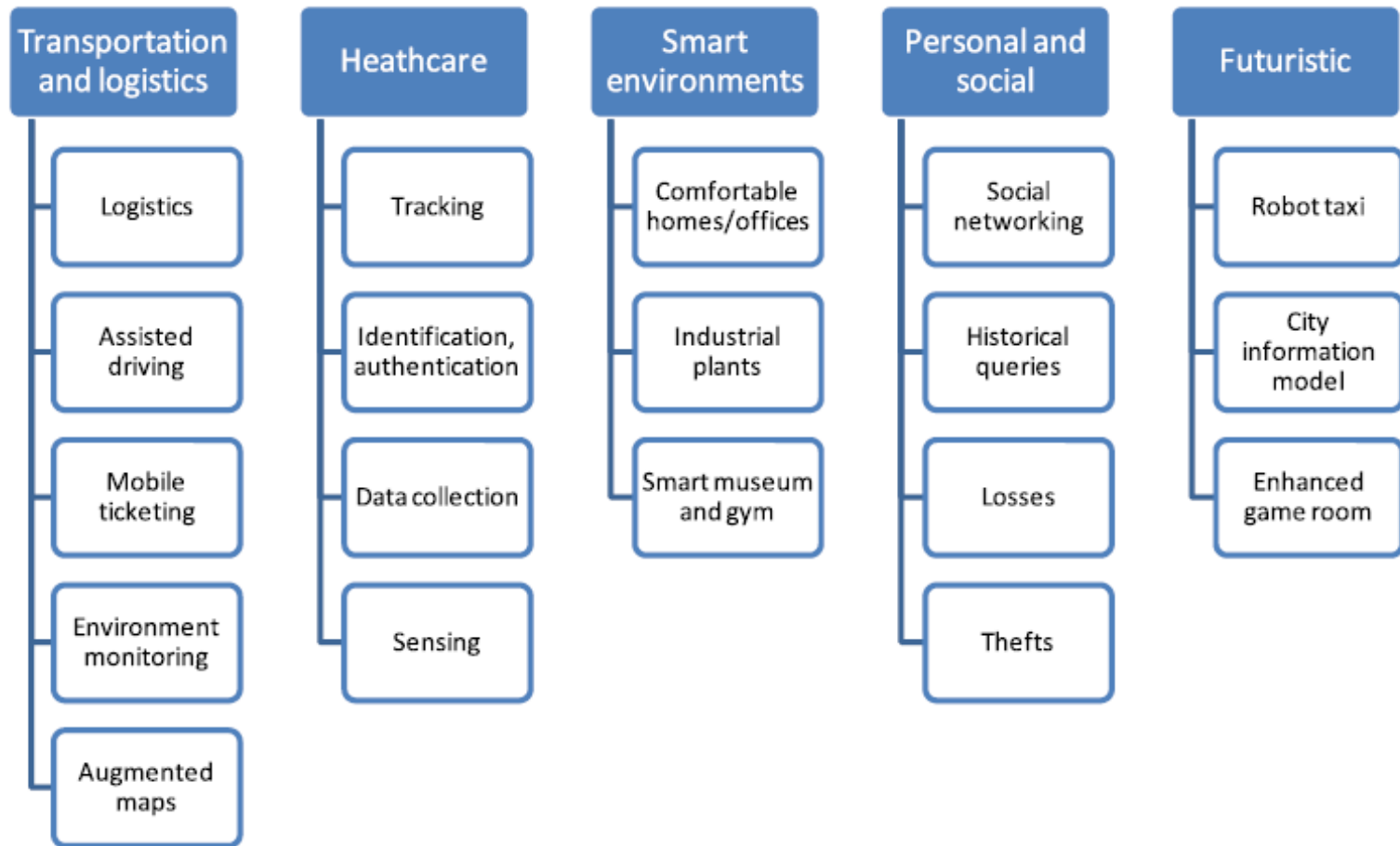
- Data Storage and Analytics

- 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
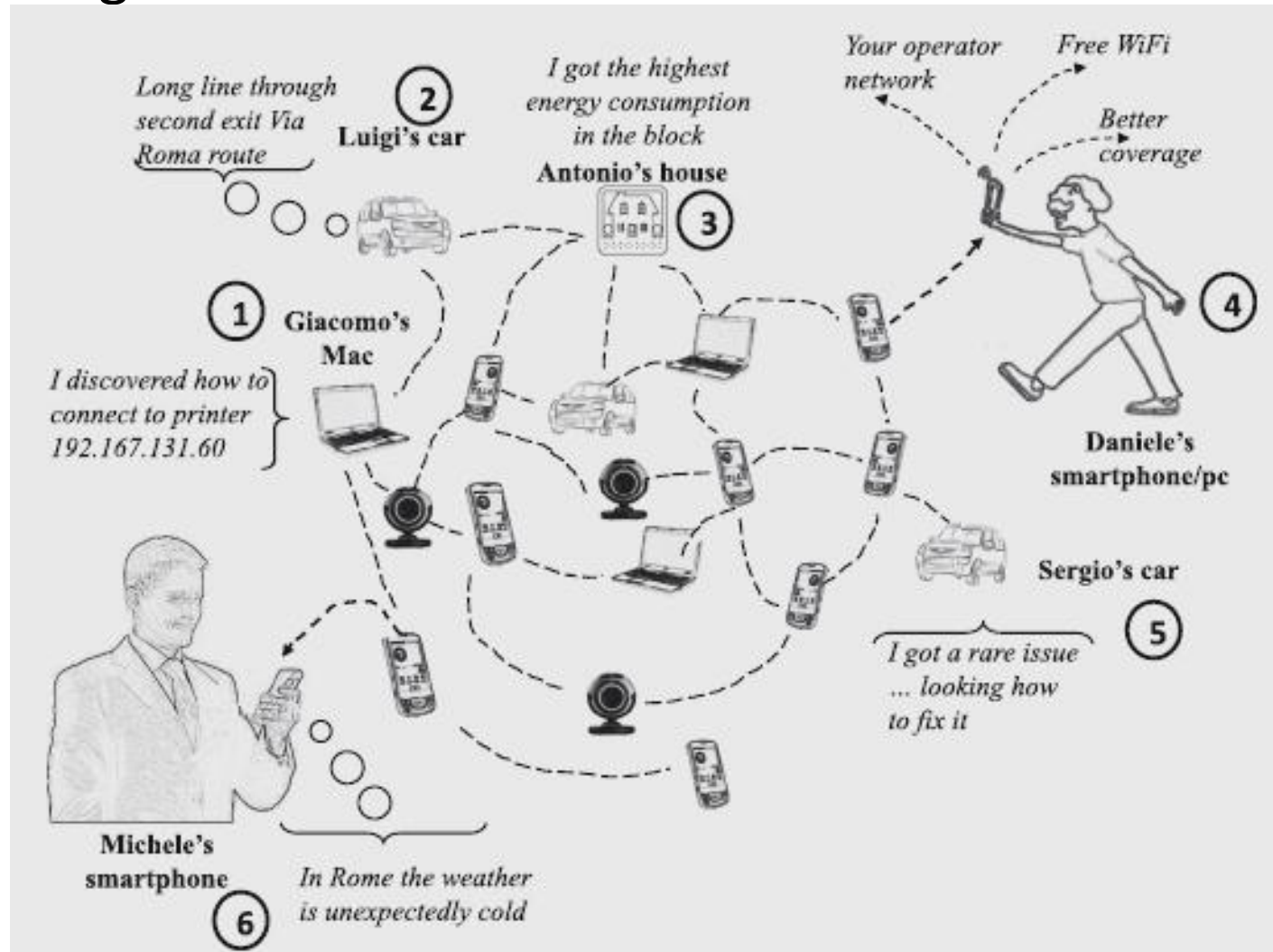
Application Areas of **Internet of Things**

J. Gubbi et. al./ Future Generation Computer Systems 29 (2013) 1645-1660
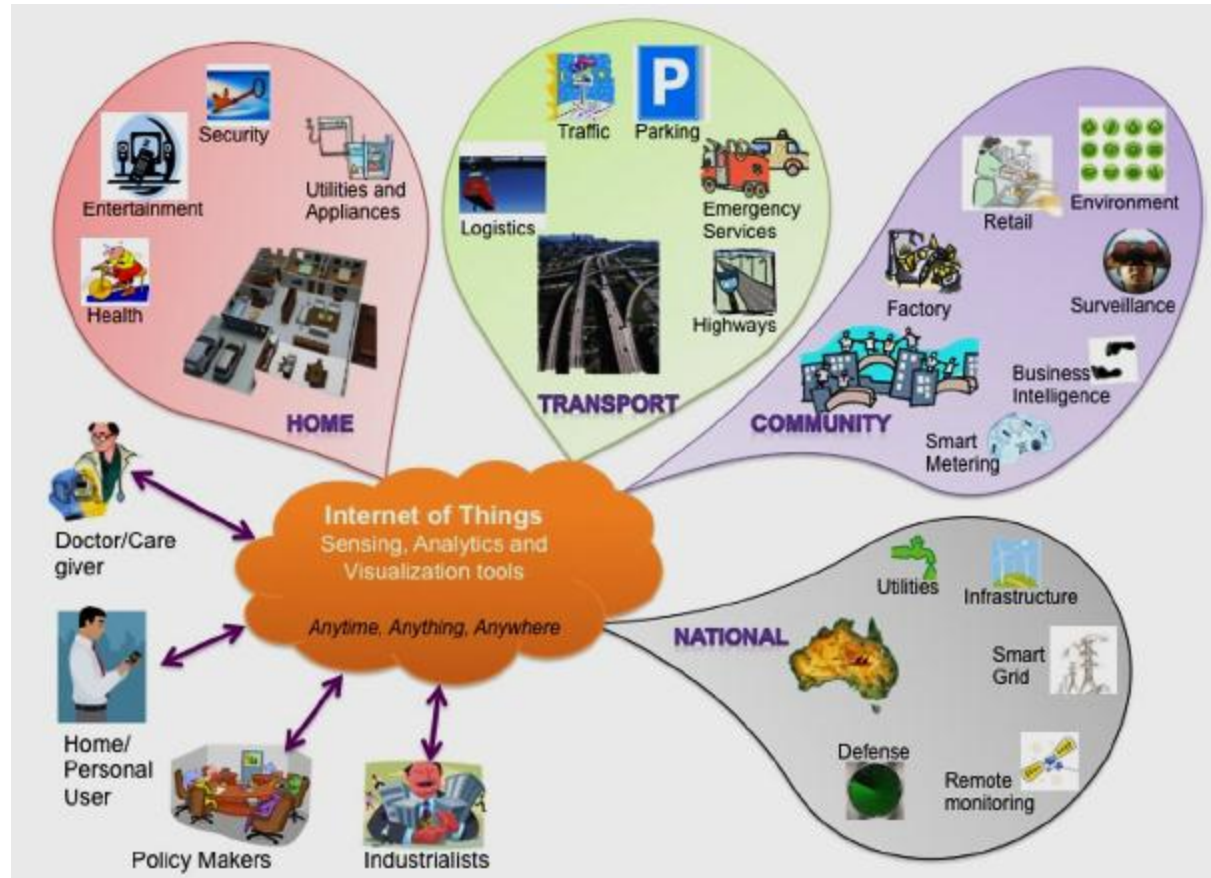
Application of **Internet of Things**

L. Atzori et. al./ Computer Networks 54 (2010) 2787-2805
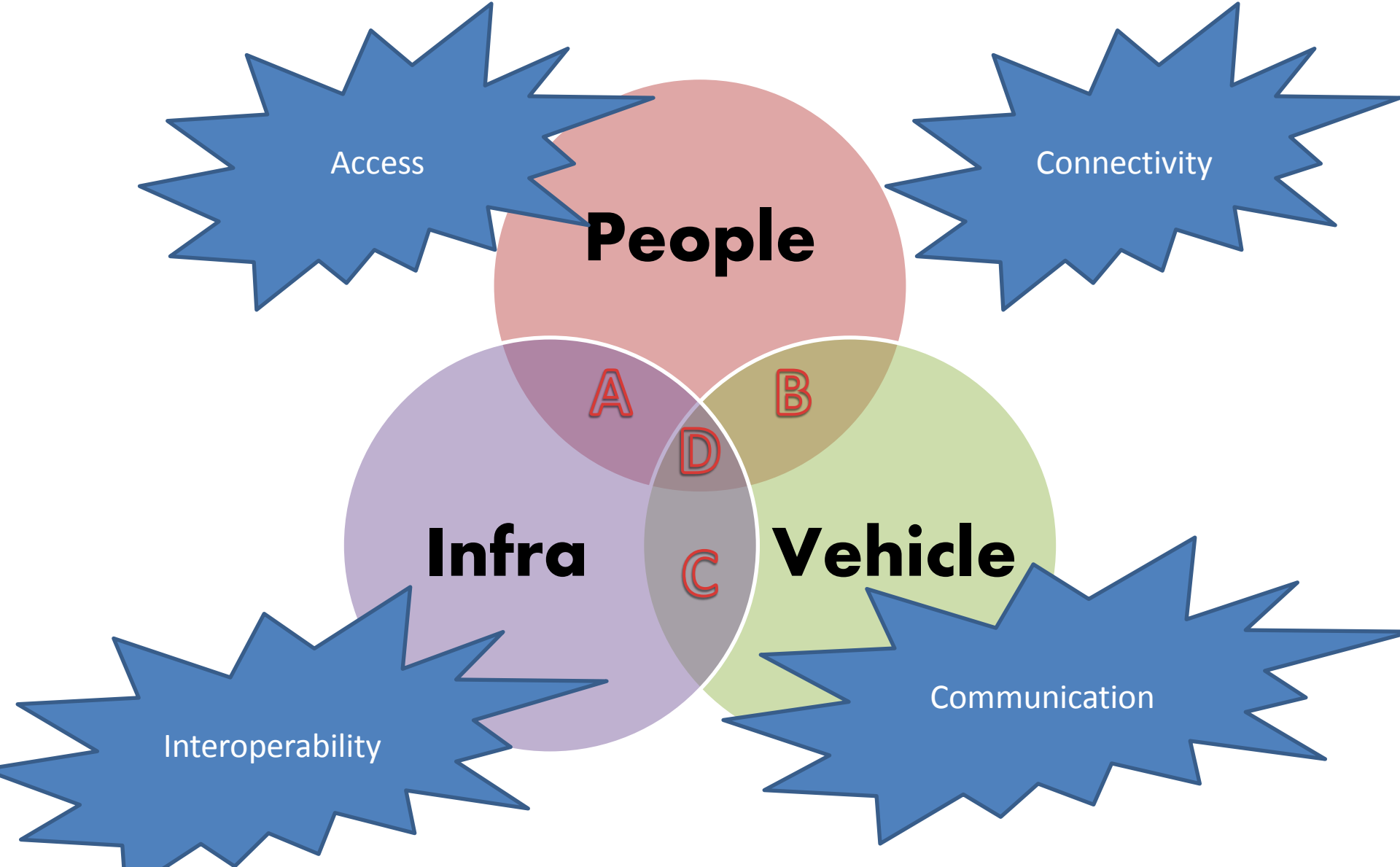
Social Network
Internet of Things
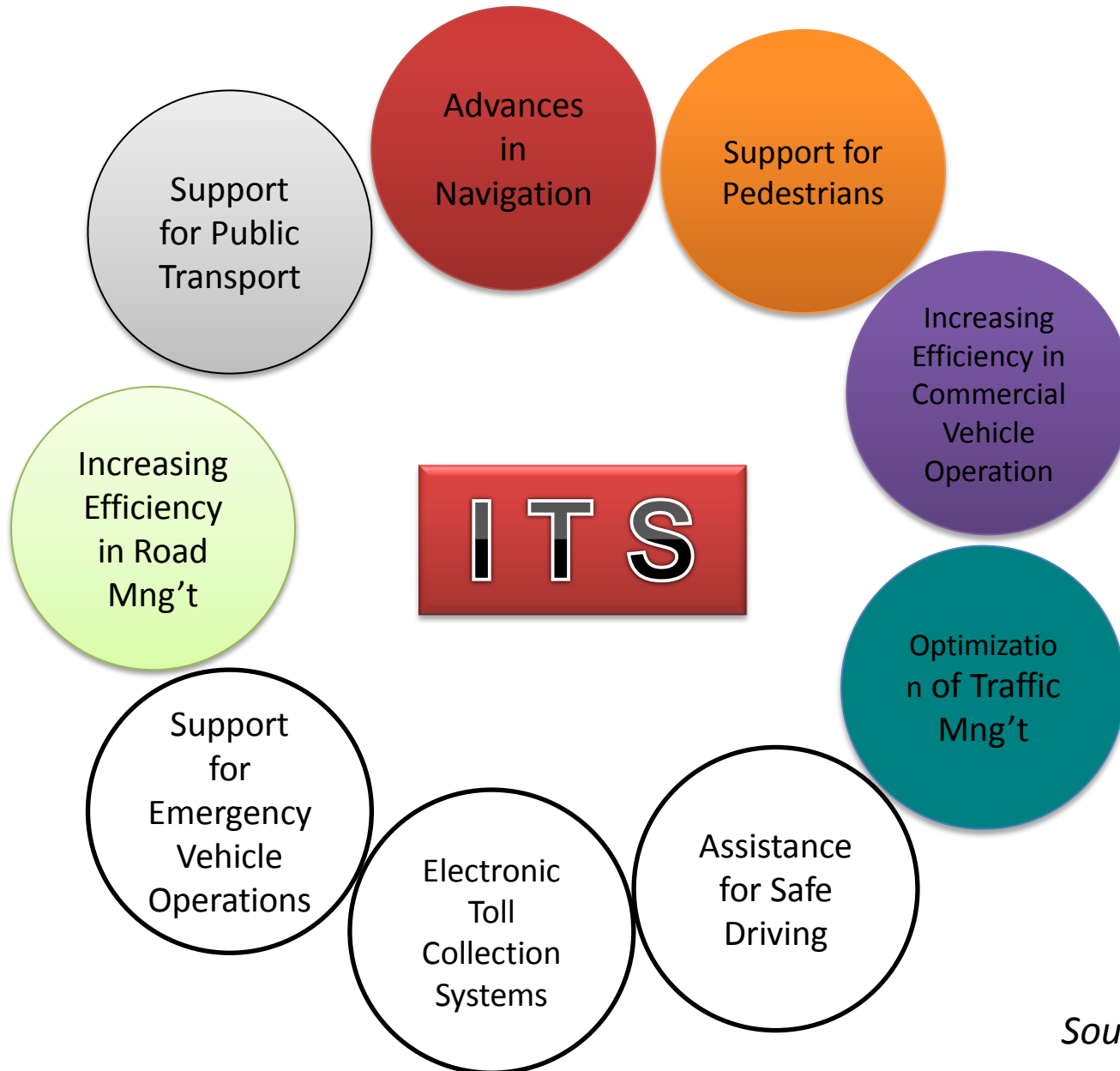
Intelligent Transportation System

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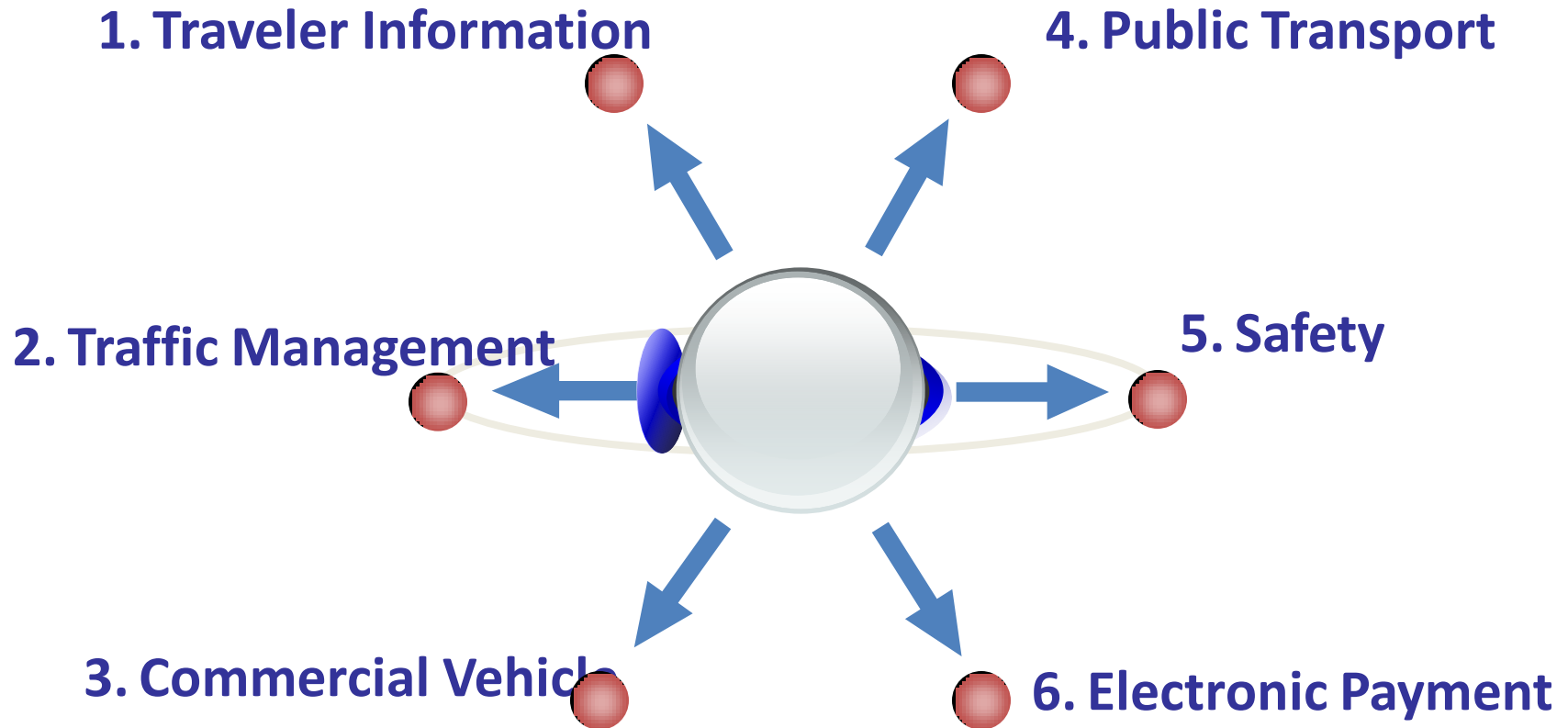
– Dr. Francis Aldrine A. Uy

9 Areas of ITS Deployment: Japan

Support for Public Transport

Advances in Navigation

Support for Pedestrians

Increasing Efficiency in Commercial Vehicle Operation

Increasing Efficiency in Road Mng't

ITS

Optimization of Traffic Mng't

Support for Emergency Vehicle Operations

Electronic Toll Collection Systems

Assistance for Safe Driving

Source: ITS Japan

6 Areas of ITS Development/ Deployment: Thailand

1. Traveler Information

4. Public Transport

2. Traffic Management

5. Safety

3. Commercial Vehicle

6. Electronic Payment

ITS Connection & Deployment
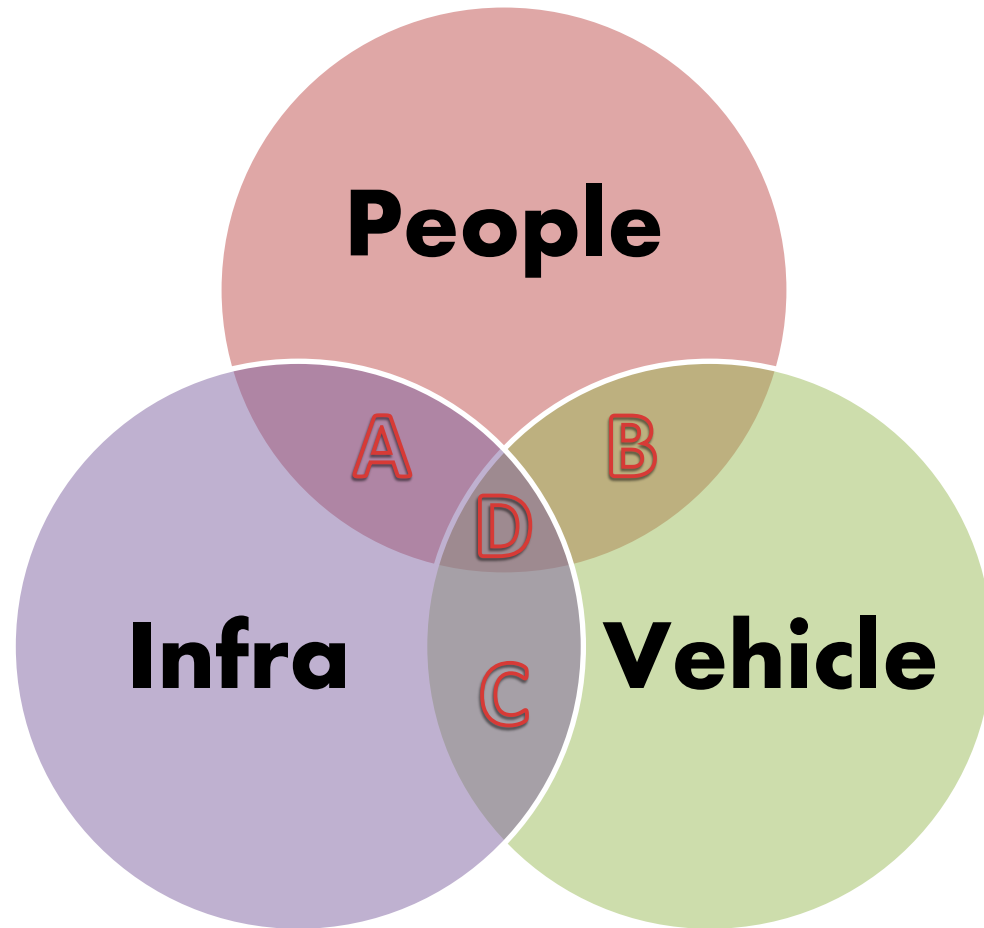
ITS Applications

A People-Infra	B People-Veh	C Infra-Veh	D People-Veh-Infra
Advanced Traffic Information System (ATIS)	PUV Management	Crash prevention sensors	Transportation Information System
Traffic Management	Advance Navigation	Air/Noise Pollution Monitoring	Traffic Enforcement System
Traffic Safety Assistance	Fleet Management	Physics and Service Integration	Road Management
Mobile Application		Traffic Signal Control	Toll/Fare Collection
Parking System		GPS Navigation	Accident Reporting and Evaluation System

ITS Development/Deployment Areas	ITS User Service
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.

Dr. Sigua

(Draft)ITS Master Plan for Metro Manila +2 regions (Region 3 and 4A)

AVERAGE POPULATION GROWTH RATE (YEARS 2000-2010)

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

Dr. Sigua
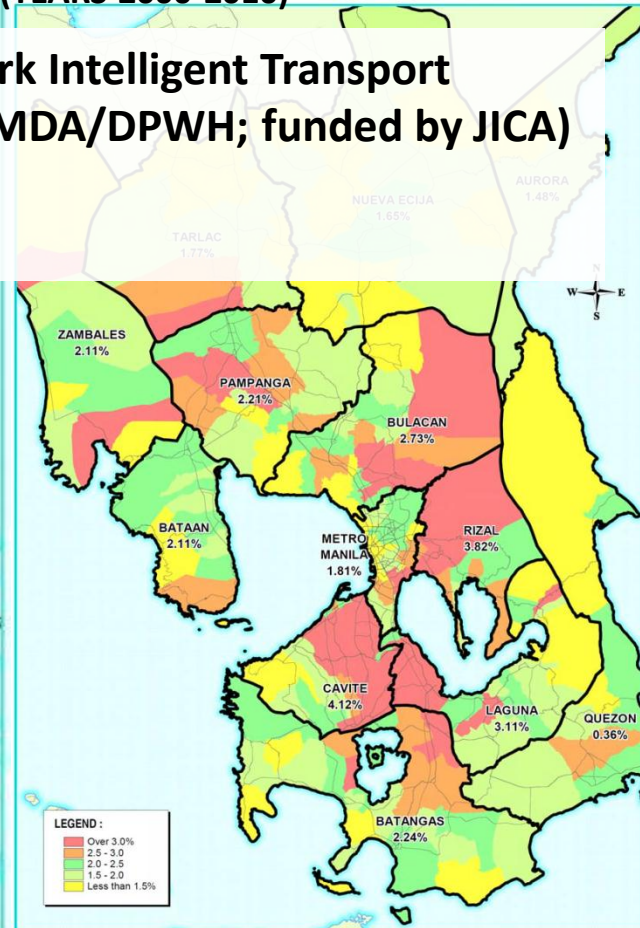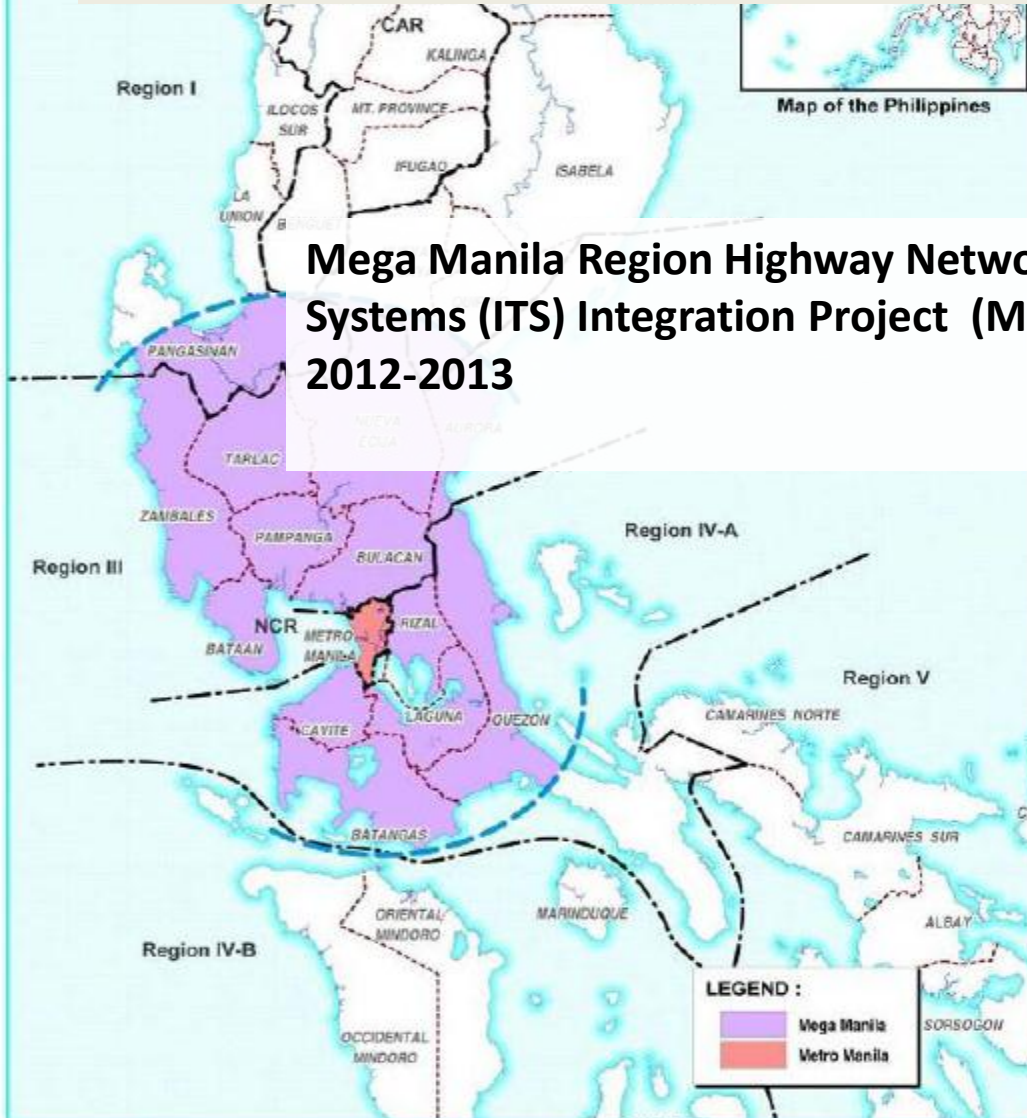
Development of ITS Master Plan

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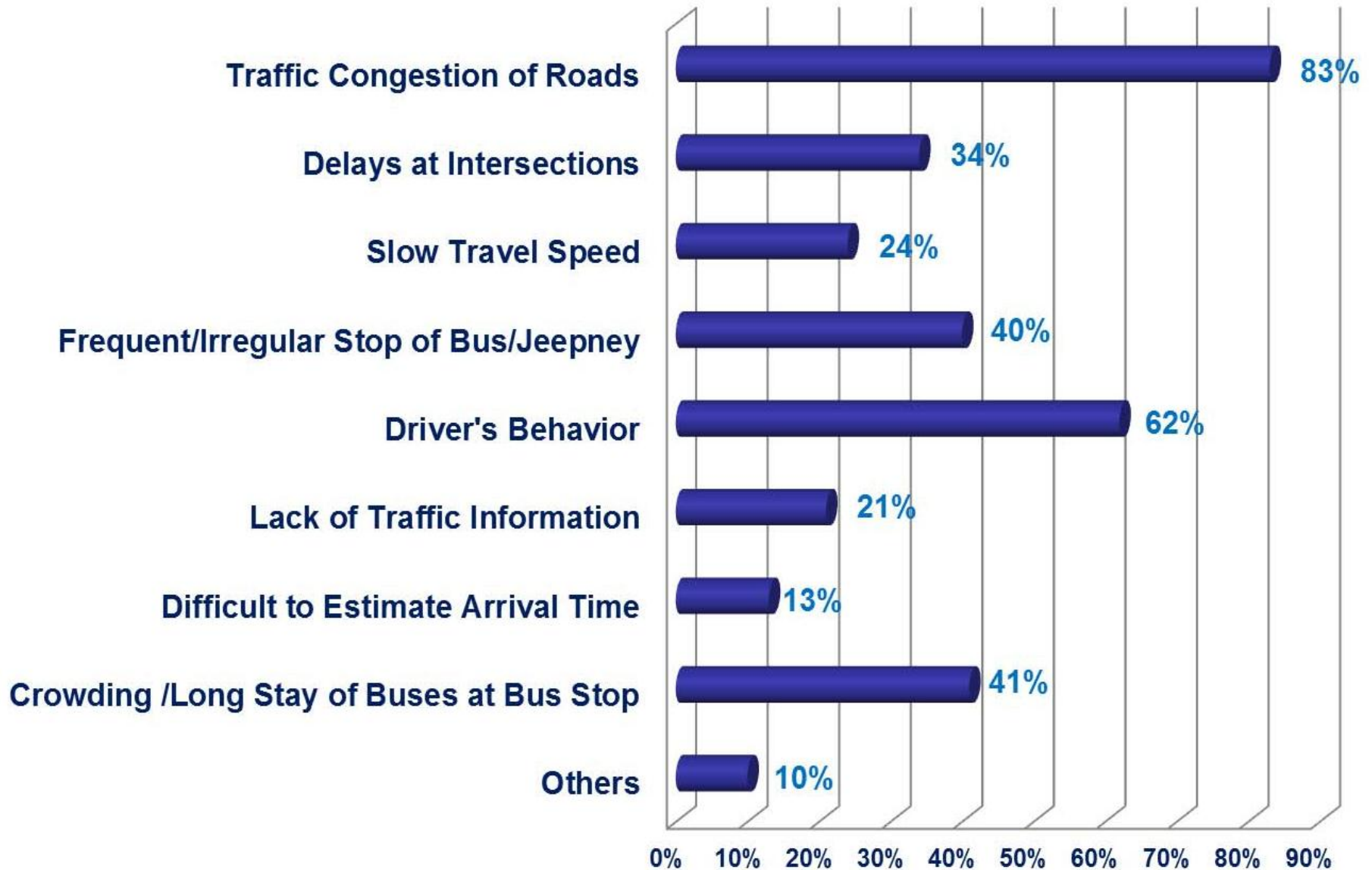- ITS Needs Survey
- ITS Current Applications

⬇

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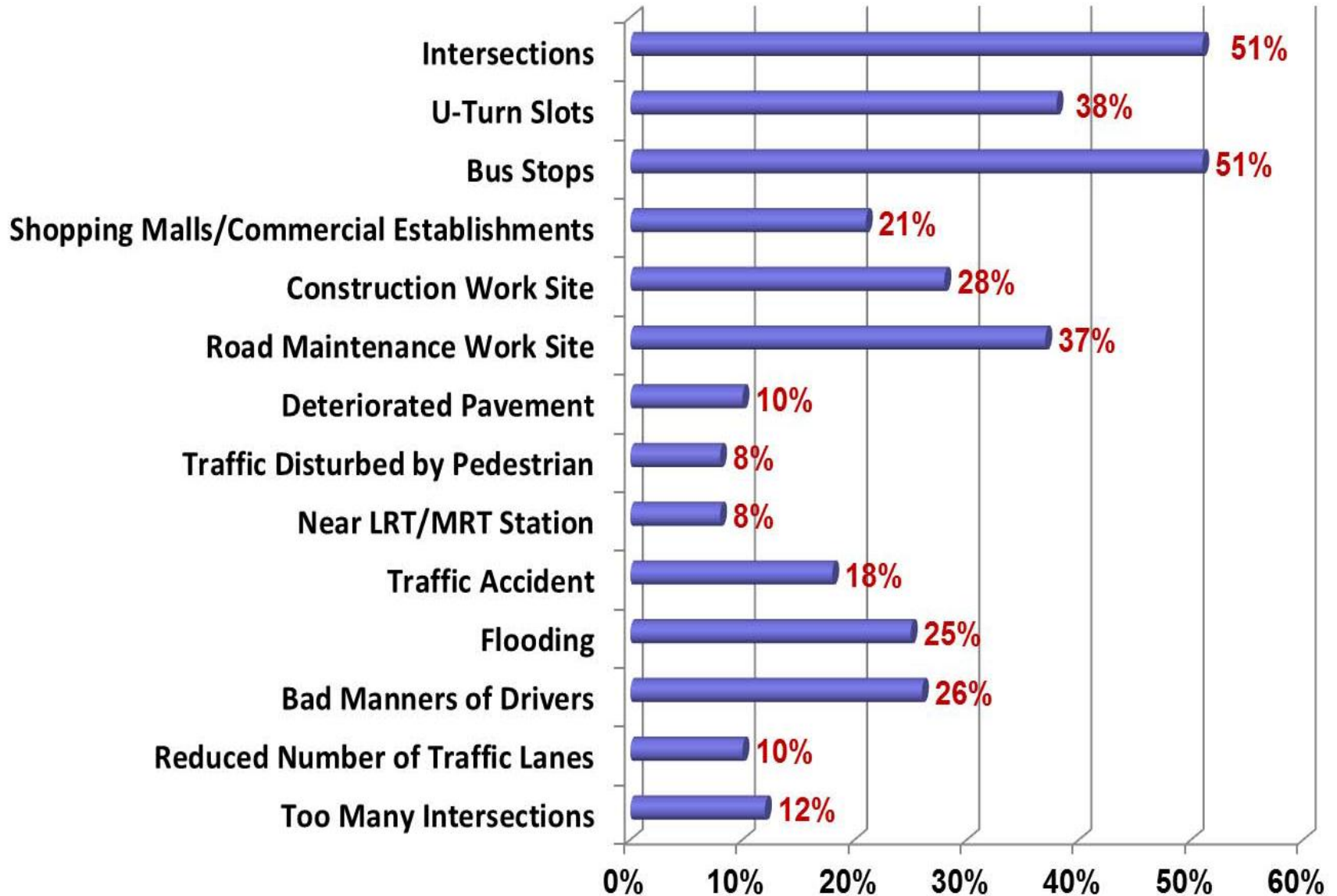- Development/Deployment Areas
- Implementation Schedule and Cost

⬇

Measures for Sustainable ITS Development

Dr. Sigua

Traffic Problems Experienced in Metro Manila

Problem	Percentage
Traffic Congestion of Roads	83%
Delays at Intersections	34%
Slow Travel Speed	24%
Frequent/Irregular 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

Cause	Percentage
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
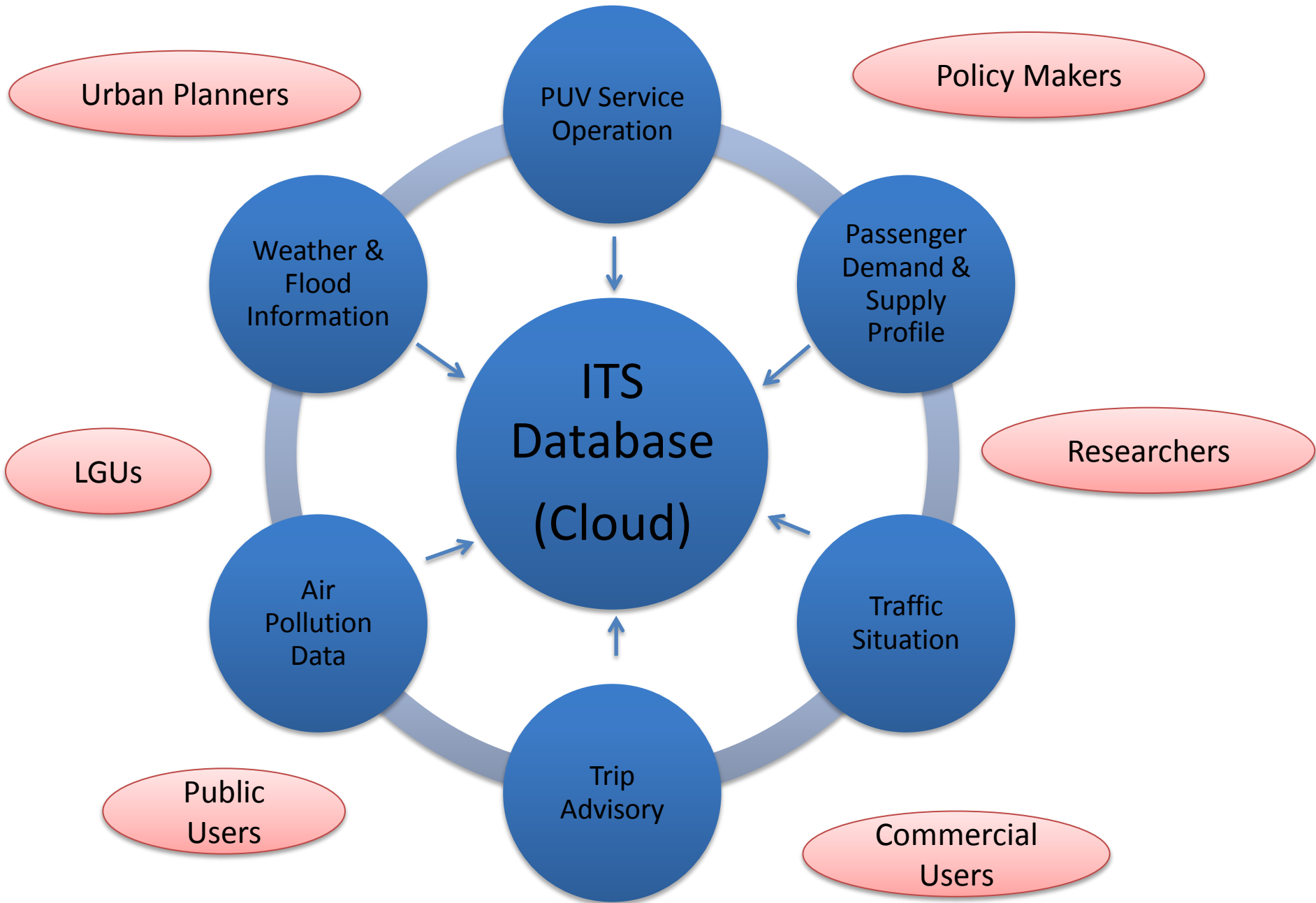
'Towards a Competitive, Inclusive
And Resilient Metropolis' - MMDA

'A Sustainable and Caring Global Gateway
through Public-Private Partnership and
Growth for All'

ITS Goals and Services

Major Transport Problems

Metro Manila

- 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

Mega 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

Metro 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
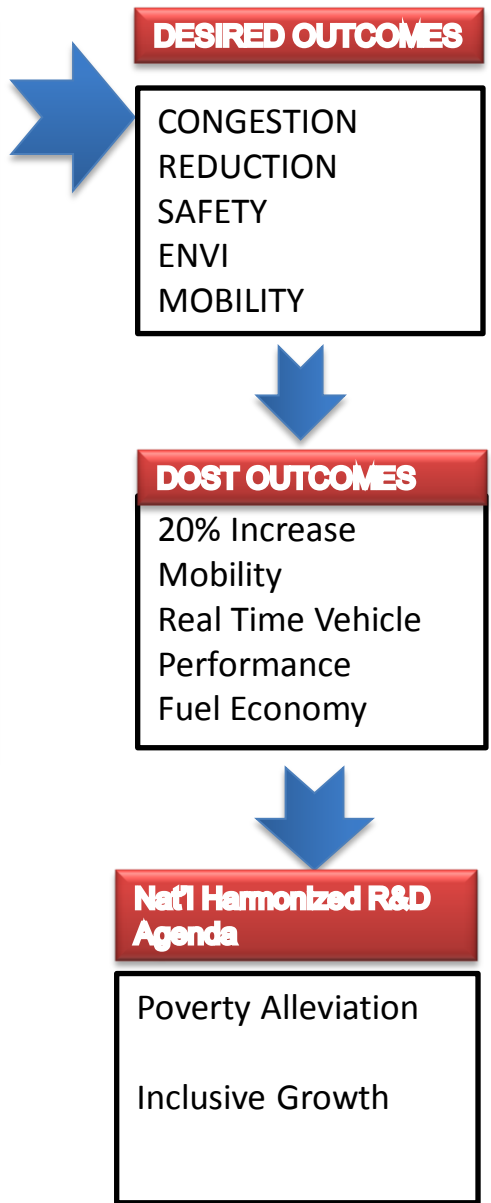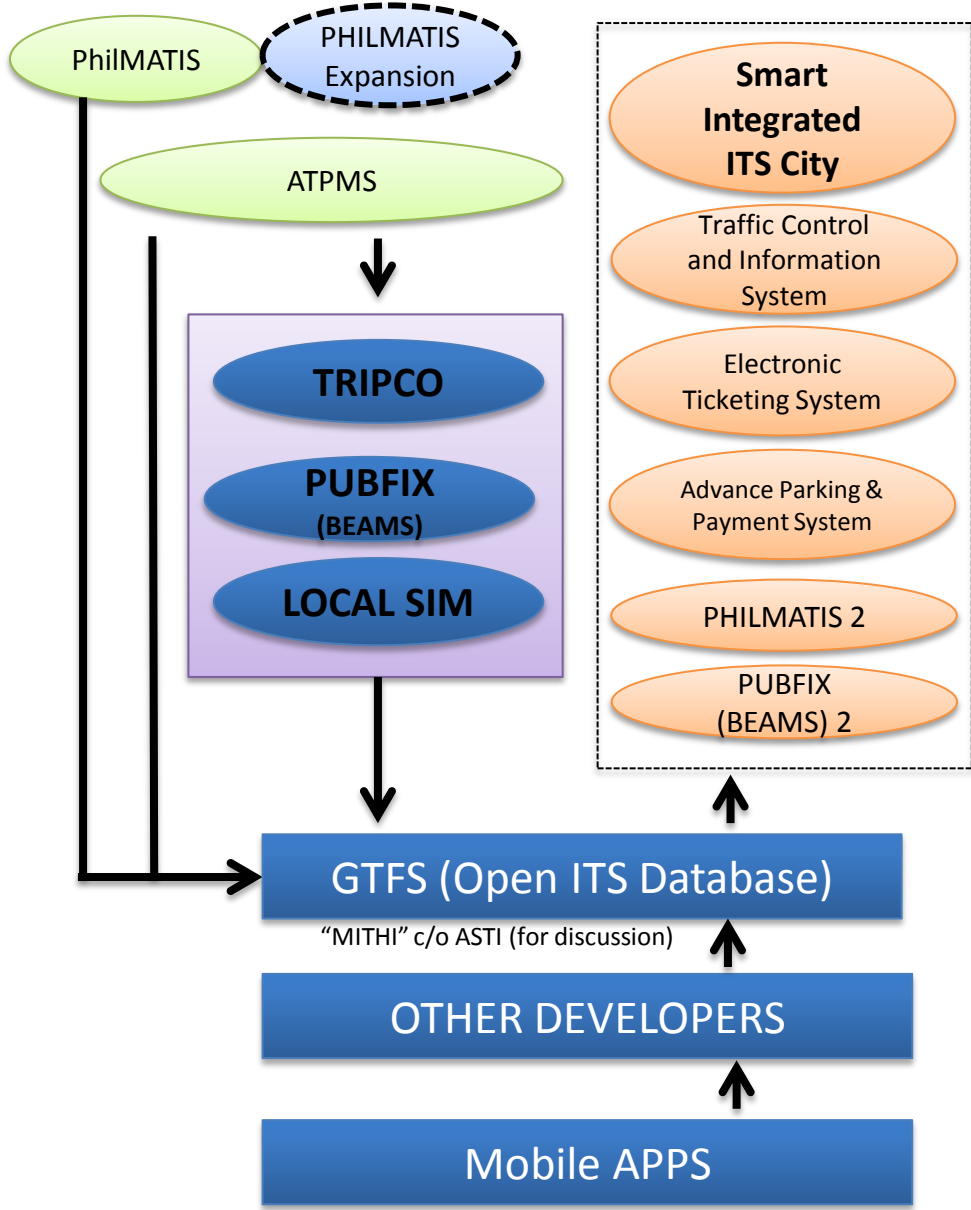
Current ITS Initiatives

PUV Management

PUBFIX (jeepney fleet)

BEAMS (bus fleet)

- Passenger Count with origin-destination
- Route Demand Forecasting
- Fuel Economy

Traffic Information Provision

TRIPCO (Commuters)

- Track Passenger Transfer (History)
- Passenger individual count (MRT, Taxi, UV Express)
- Forecast individual and aggregated routes
- Navigation Guide for the PWD (Blind)

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

Traffic Information Provision

PhilMATIS

ATPMS

- Traffic Volume
- Traffic Forecasting
- Flood Level Info
- Air Quality Data

Current ITS Initiatives vis a vis targets & demonstration

PROJECT

TARGET OUTPUT

PROBLEM ADDRESSED

PUBFIX (jeepney fleet)

BEAMS (bus fleet)

TRIPCO (Commuters)

LOCAL SIM (Traffic Mgt)

Fuel Economy

Route Demand Forecasting

Navigation Guide for the Commuters & PWD (Blind)

Traffic Simulation Models

EDSA DECONGESTION (INCREASE MOBILITY BY 20%)

PhilMATIS

ATPMS

Traffic Volume & Forecasting

Flood Level Info

Air Quality Data
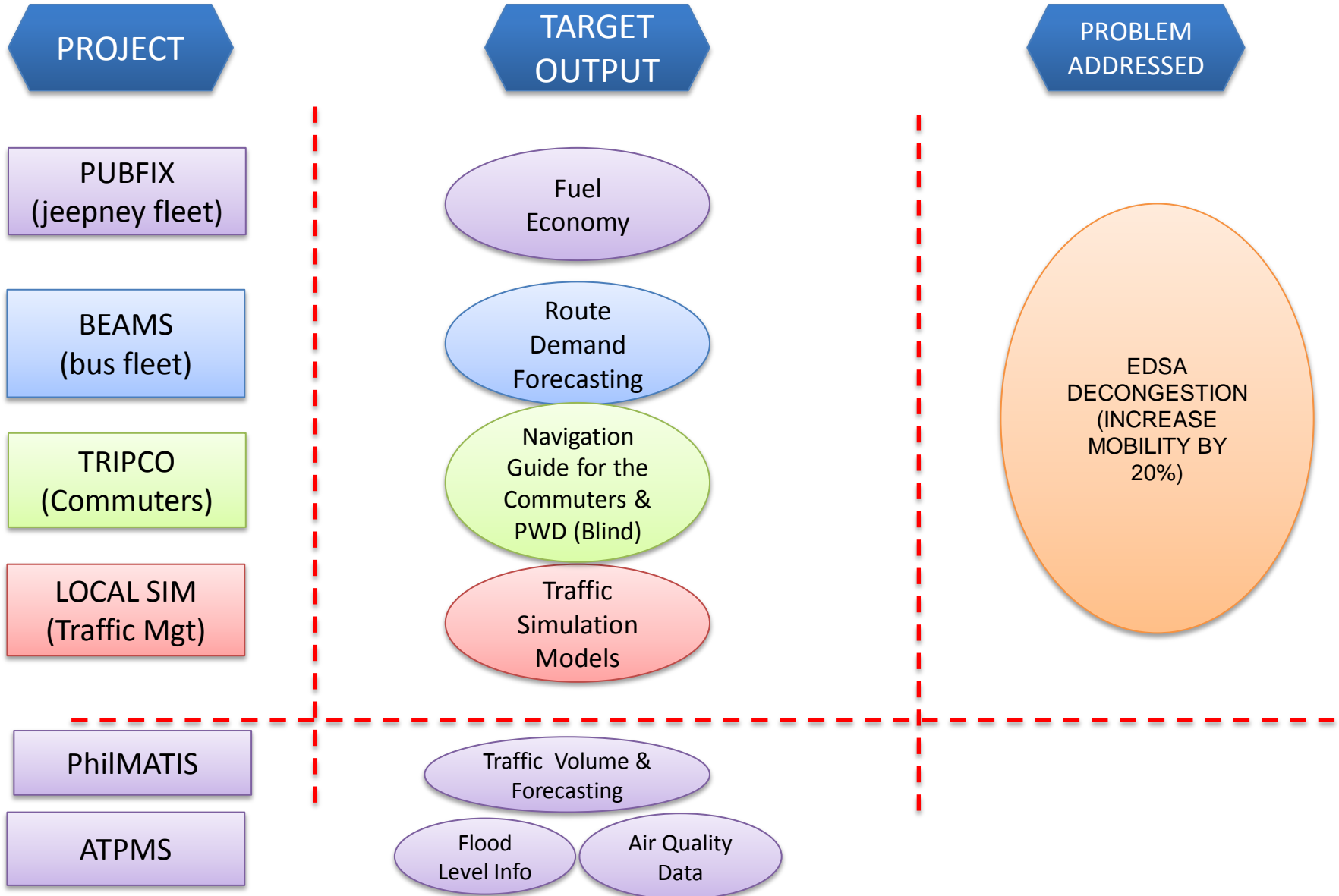
On-going Initiatives

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

www.philstar.com

Street Floods

PhilMATIS

AFP News Sep. 23, 2013

Image Processing/ vehicle tracking

Urban Flood Monitoring System

- Rain Gauge
- Ultrasonic Sensor
- Battery
- Solar Panel
- Data Logger
- Flood Water Inlet

URBAN FLOOD MONITORING STATION

GSM Network
Data

Central Server

Info

Variable Message signs

Web Client

Mobile Phone

Pilot Corridor (España Boulevard, from Welcome Rotonda to Lerma Street.)
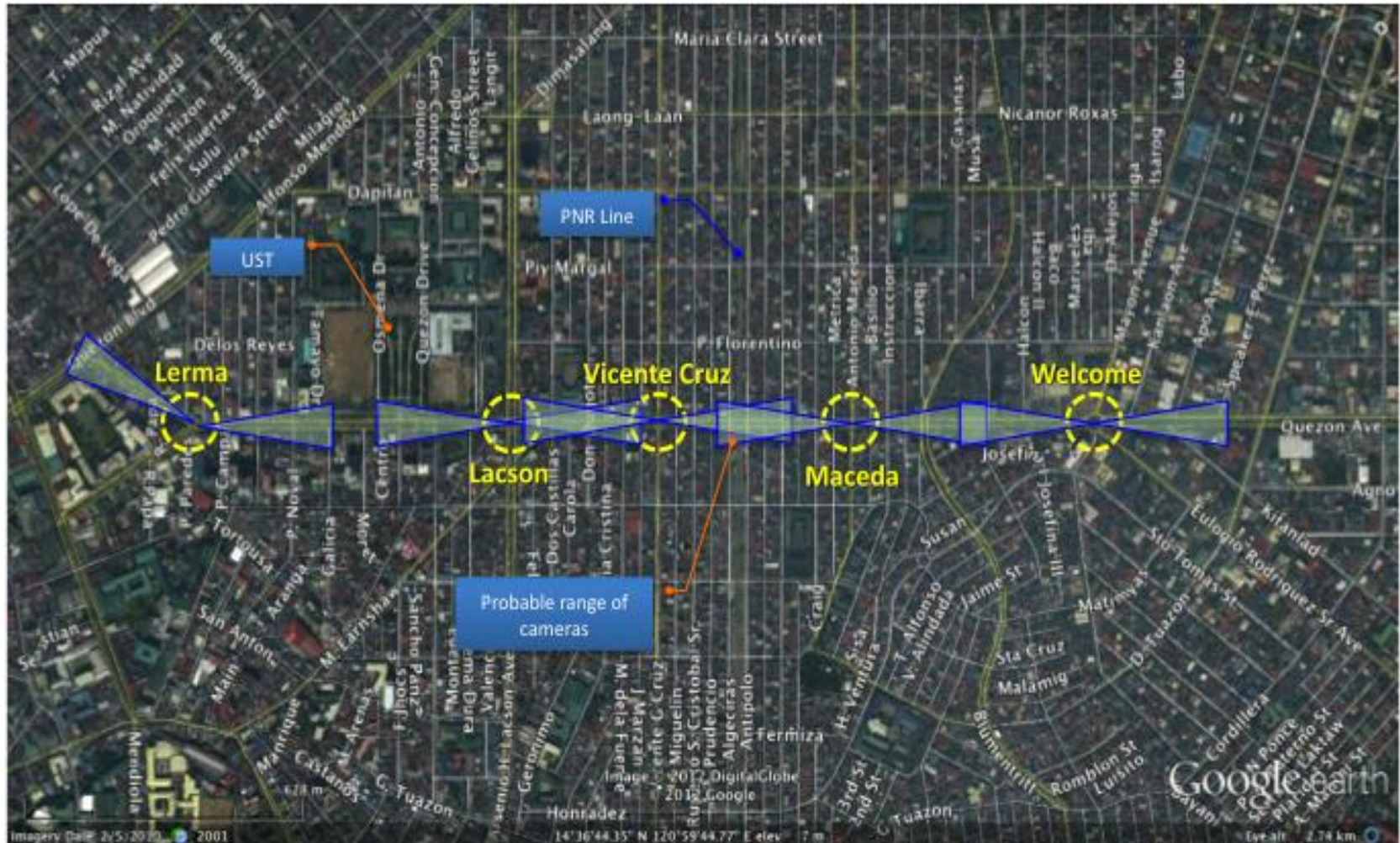
Advanced Traffic and Pollution Monitoring
and Analysis System
Based on GPS Data, Air Quality Data and Engine Status Data from Tracked Taxis in Metro Manila
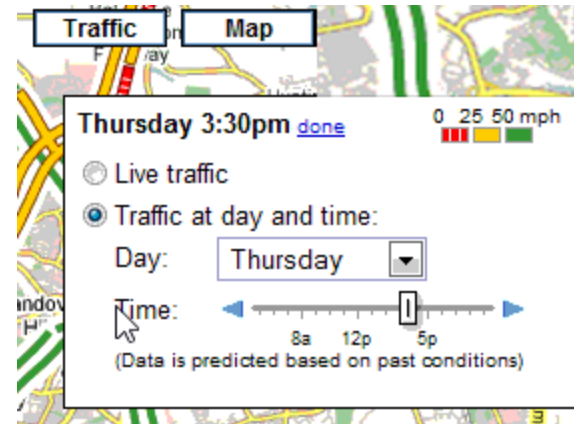# (ATPMS)

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

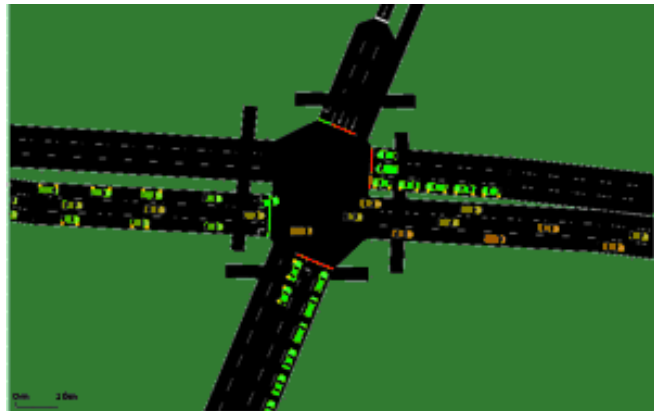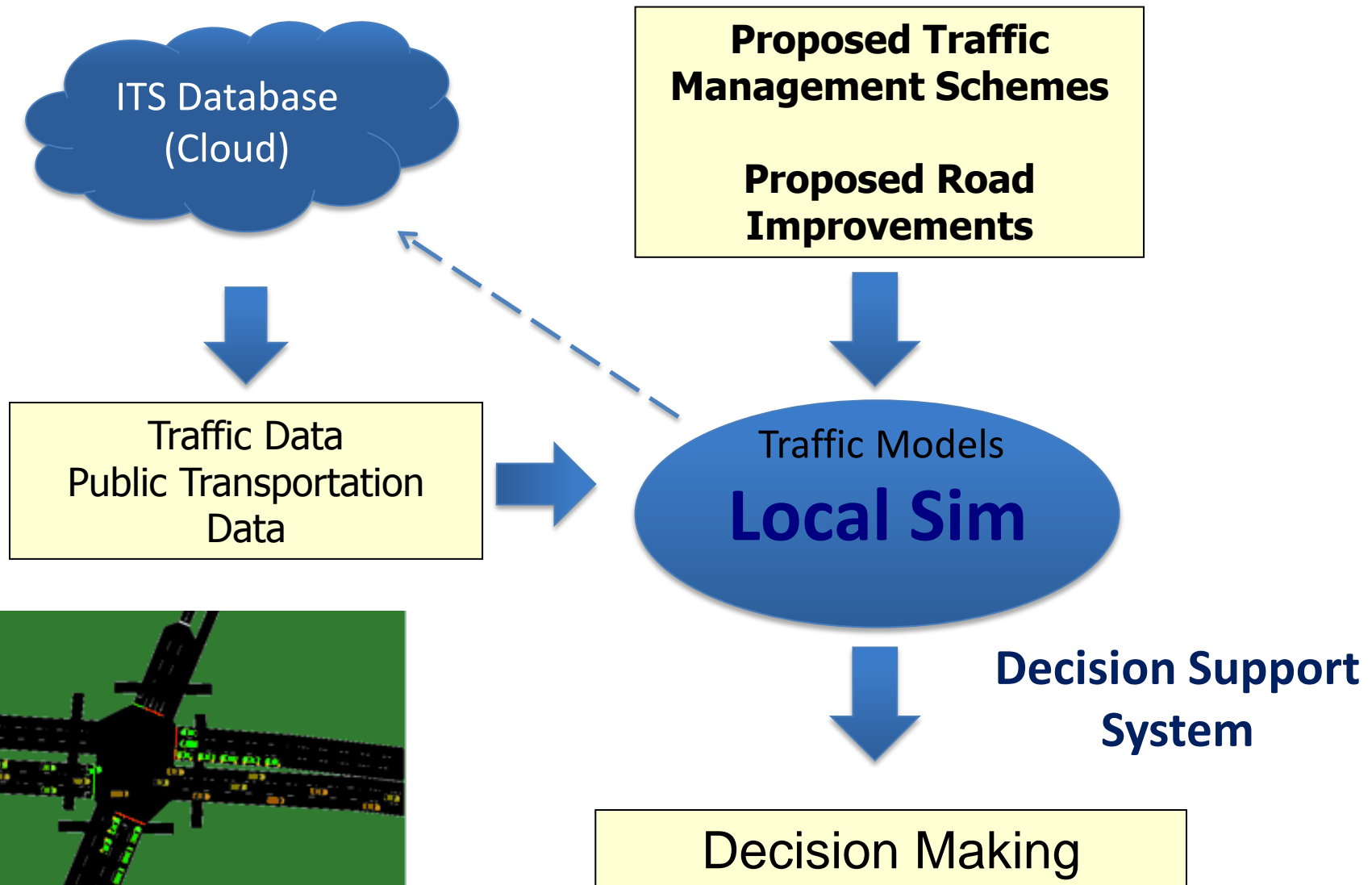# Development of a customized local traffic simulator (LocalSim)

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
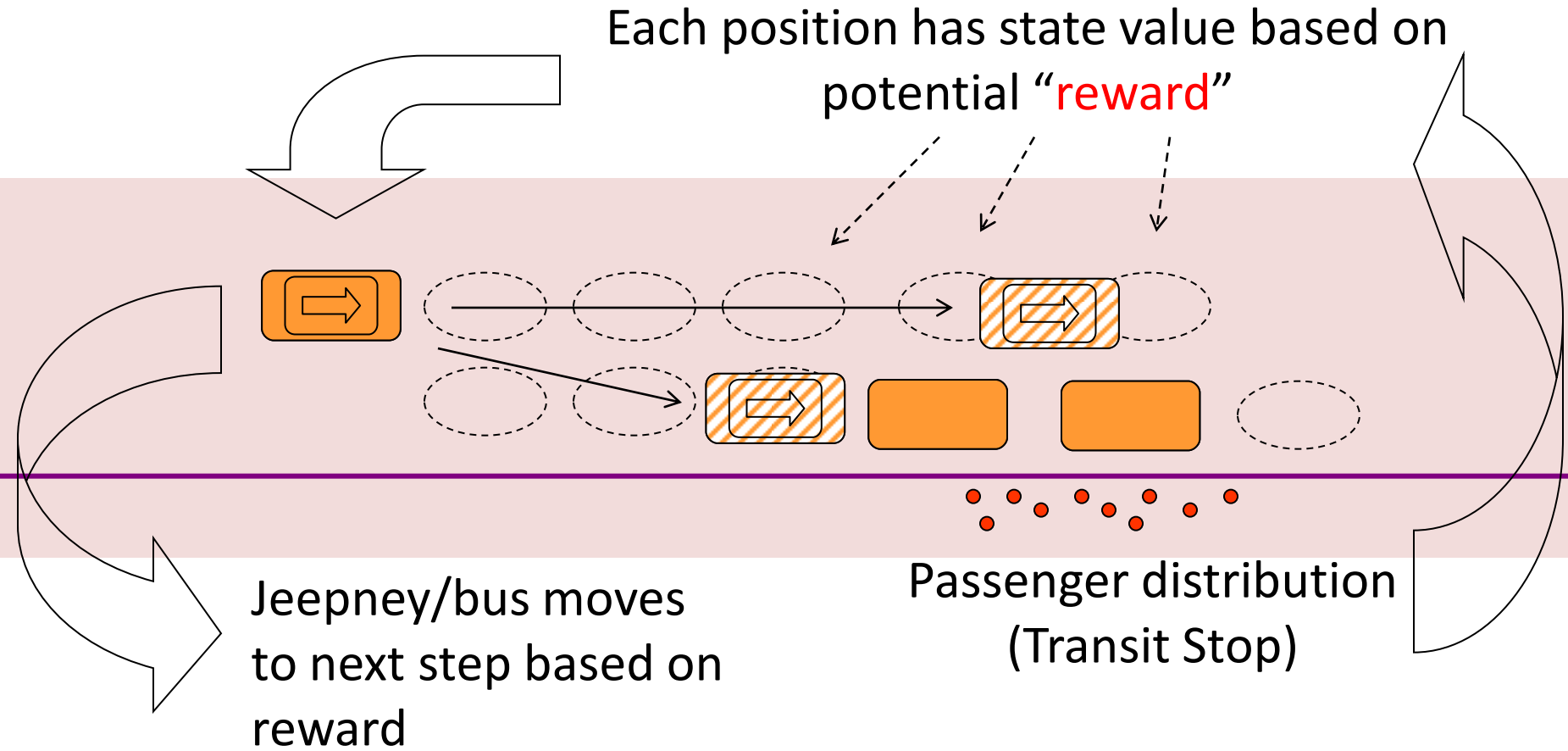
Expected Outputs

- 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

ITS Database
(Cloud)

Proposed Traffic Management Schemes

Proposed Road Improvements

Traffic Data
Public Transportation
Data

Traffic Models
Local Sim

Decision Support System

Decision Making

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

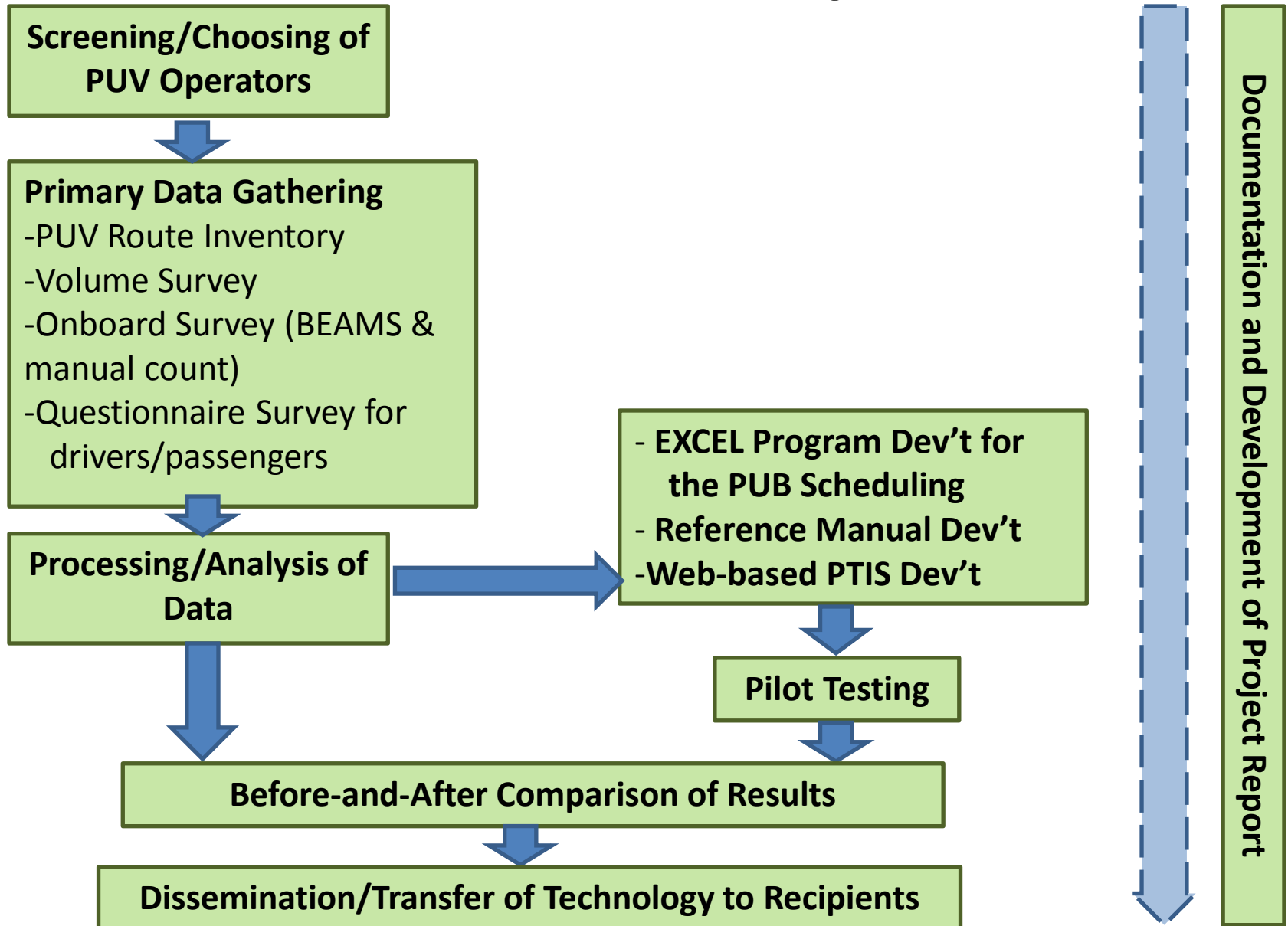# Optimal Scheduling of Public Transport System along a Route (PUBFix)

- ## 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 (**0n**)
Peak Sched (7-9AM, 4-6PM): Every 5 min
Off Peak Sched: Every 10 min
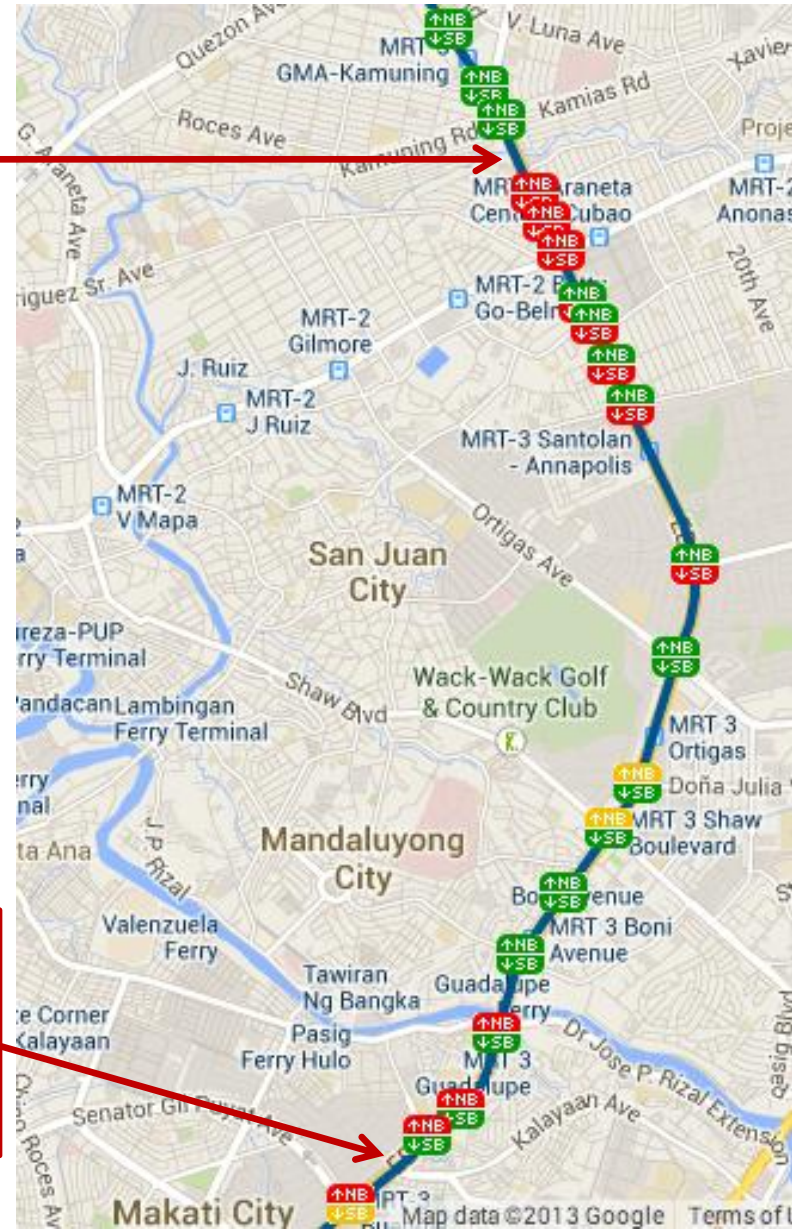Ave. Boarding Passenger: ___
Ave. Alighting Passenger: ___

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: ___
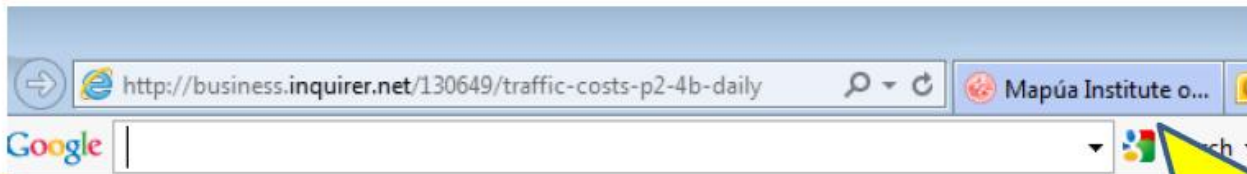Ave. Alighting Passenger: ___

Mobile Millennium Manila

Professor Francis Aldrine Uy, Mapua

Professor Alexandre Bayen, UC Berkeley

Professor May Lim, UP-NIP

Home > Business > Featured Gallery > 'Traffic costs P2.4B daily'

'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

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P2.4B daily?

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.

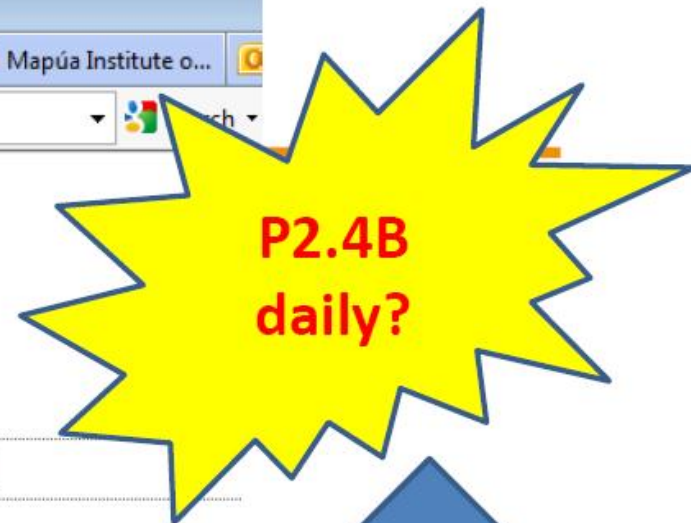Compared with neighboring countries, the

P2.4-BILLION TRAFFIC Congested streets and traffic jams cost the country as much as P2.4 billion a day in lost productivity and potential income, according to a study by the Japan International Cooperation Agency. Jica has been tapped by the government to come up with a transportation development road map for the Philippines. JOAN BONDOC

M3 project will cost approx. 8-9% of the daily traffic cost!

CALIFORNIA
PATH

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!

CALIFORNIA
PATH

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)

CALIFORNIA PATH

What can this PCARI project do?

Intelligent Trip Makers (ITM)
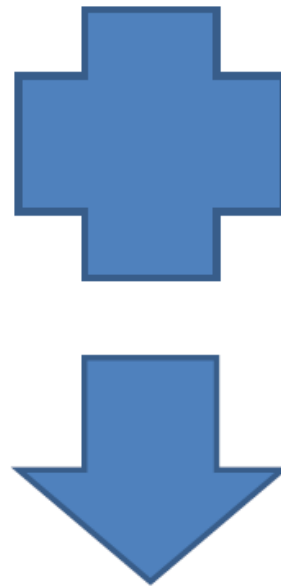
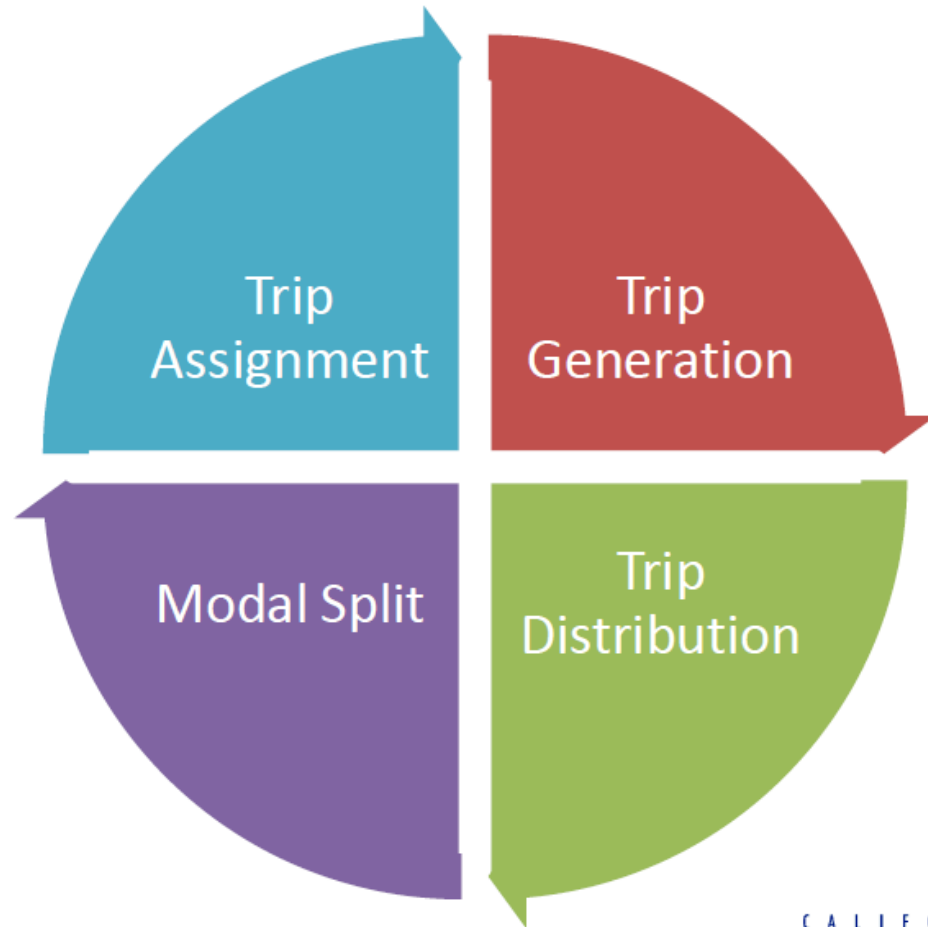Intelligent Transportation Infrastructure and Systems

Mobile Millennium Manila (3M)
– a well-managed traffic and travel demand resulting to inclusive mobility
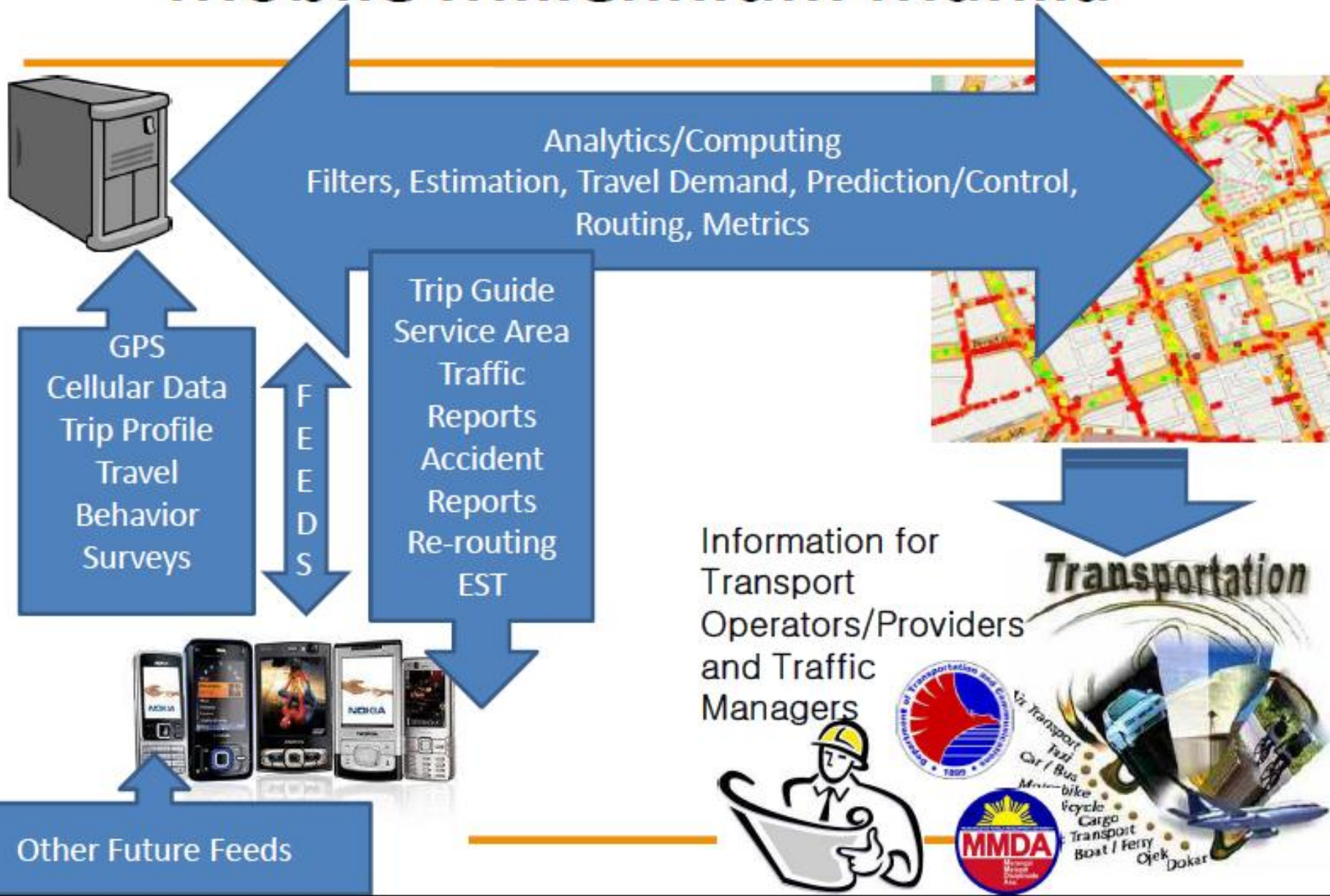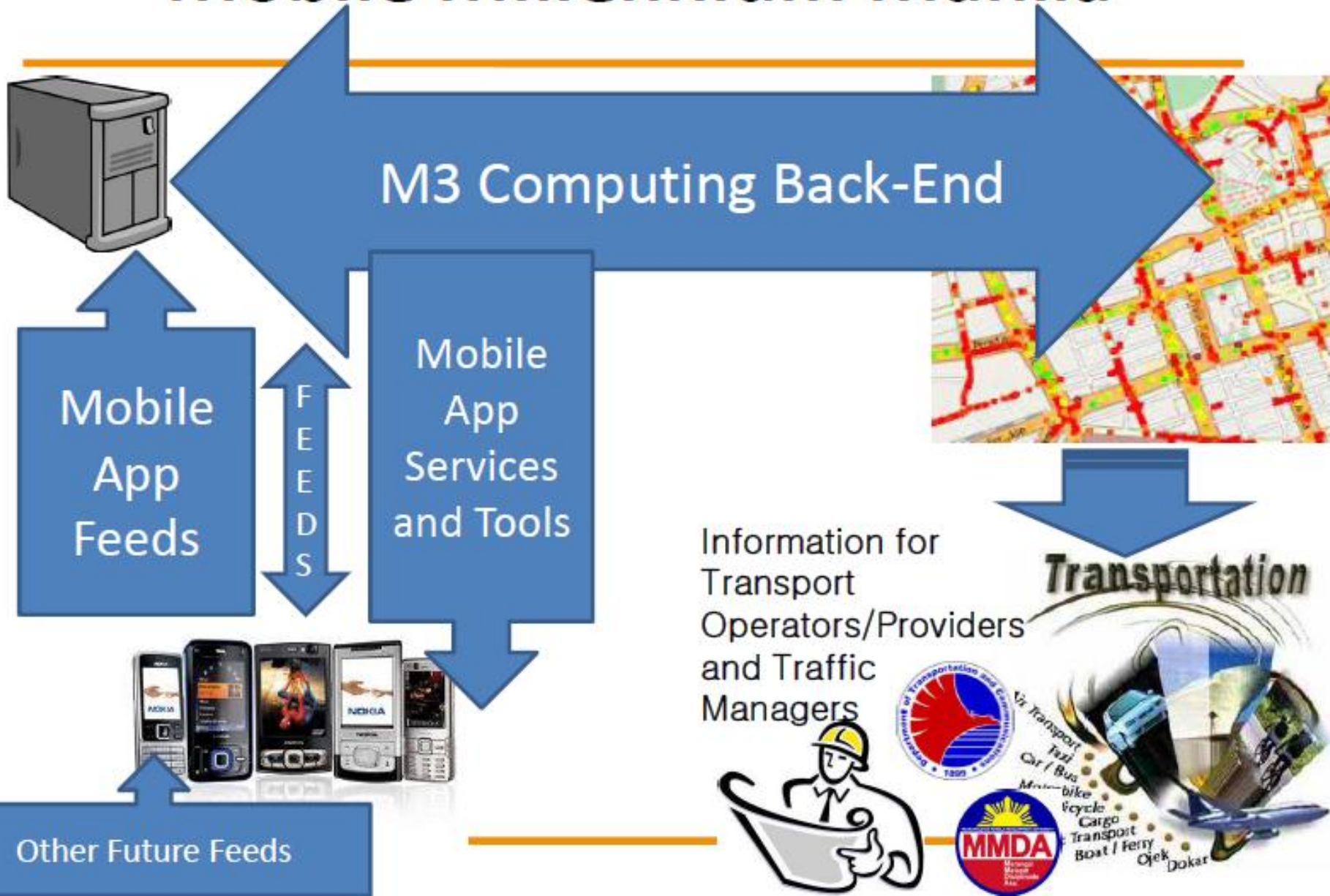
Automated and Updated Travel Demand Forecasting

Transportation Engineers have been relying on estimates/projections based on surveys conducted 10 years ago…

Trip Assignment

Trip Generation

Trip Distribution

Modal Split

Mobile Millennium Manila

Analytics/Computing
Filters, Estimation, Travel Demand, Prediction/Control, Routing, Metrics

GPS
Cellular Data
Trip Profile
Travel
Behavior
Surveys

F
E
E
D
S

Trip Guide
Service Area
Traffic
Reports
Accident
Reports
Re-routing
EST

Information for Transport Operators/Providers and Traffic Managers

Other Future Feeds
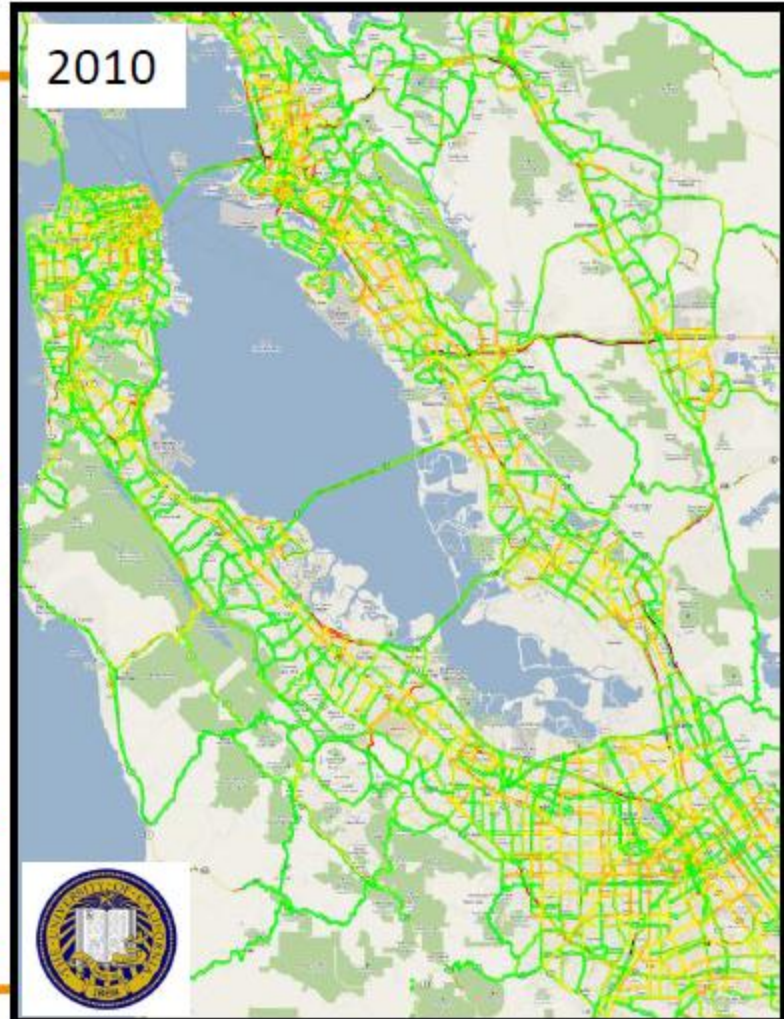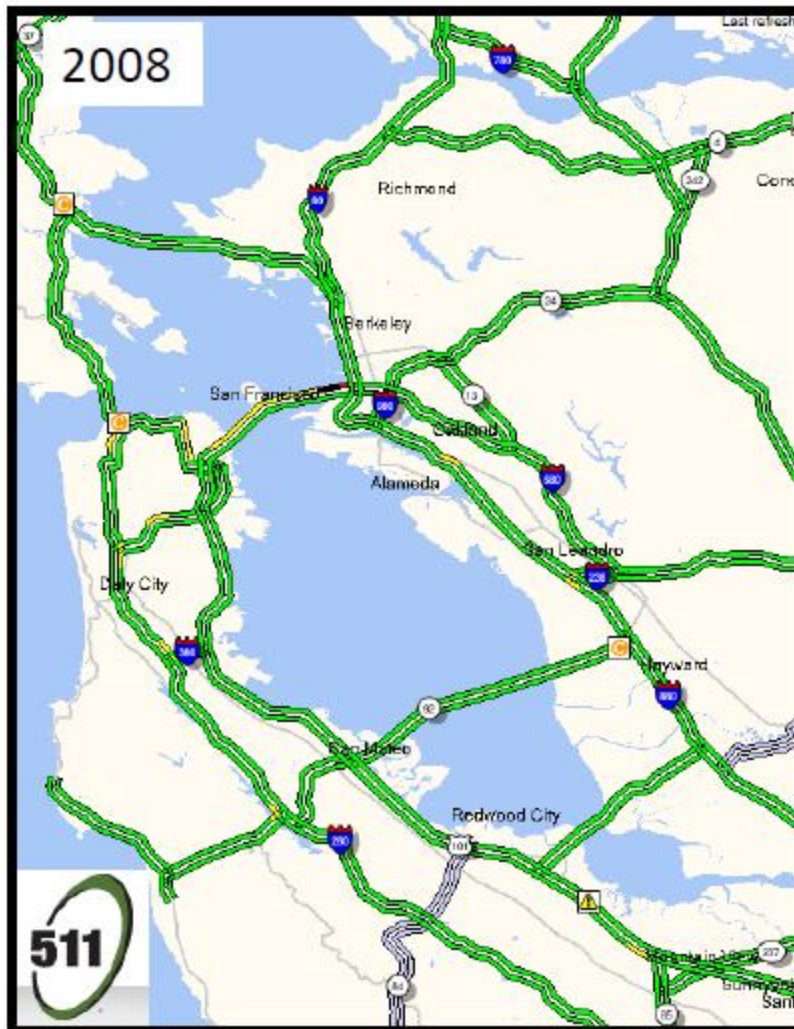
Mobile Millennium Manila

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.

CALIFORNIA

PATH

Prototype traffic information system

2008

2010

Mobile Millennium system architecture

Sensing
- Millions of mobile devices as new sources for data
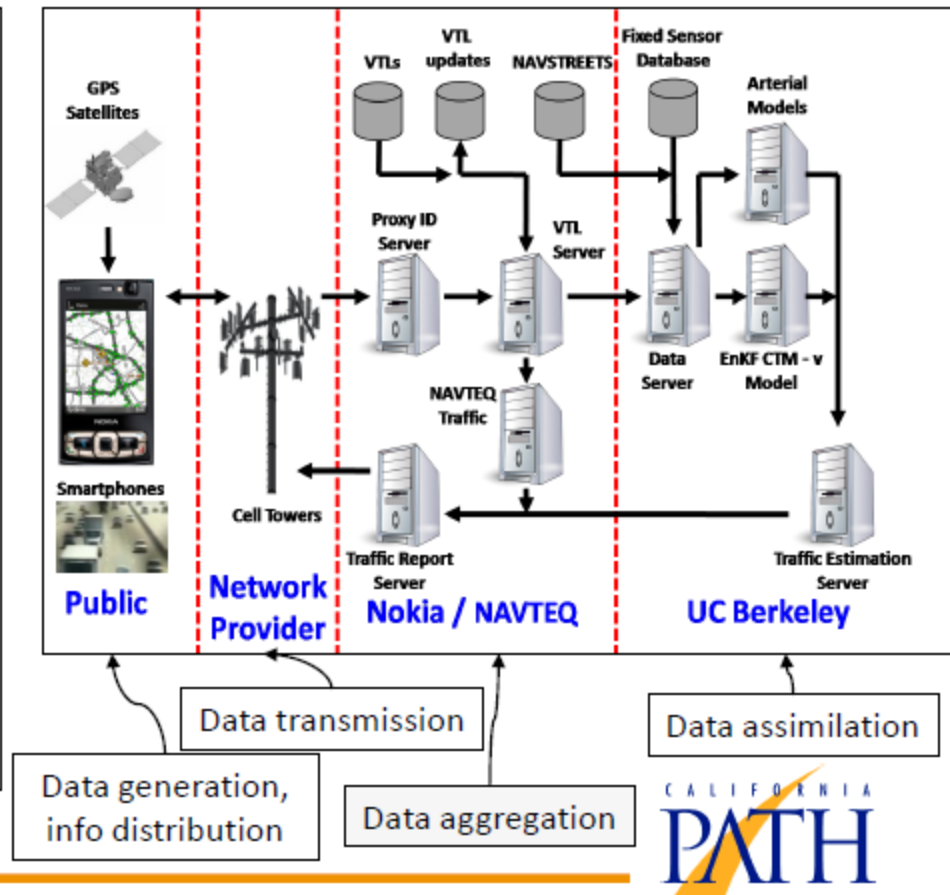
Communication
- Existing cell phone infrastructure to collect raw data and receive traffic information
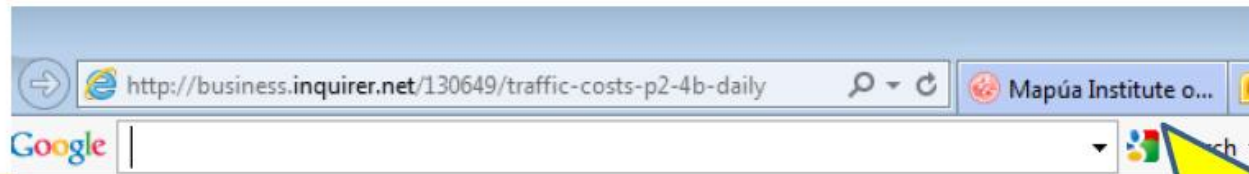
Data assimilation
- Real-time, online traffic estimation

Privacy Management
- Encrypted transactions
- Client authentication
- Data anonymization

National Development, Competitiveness and Resiliency

Home > Business > Featured Gallery > 'Traffic costs P2.4B daily'

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+1 8   Tweet 46   Share 1129   Share 566   Recommend 1k
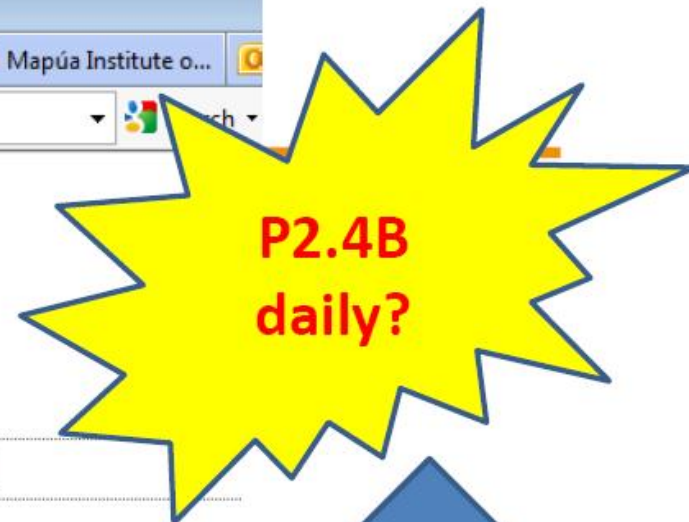
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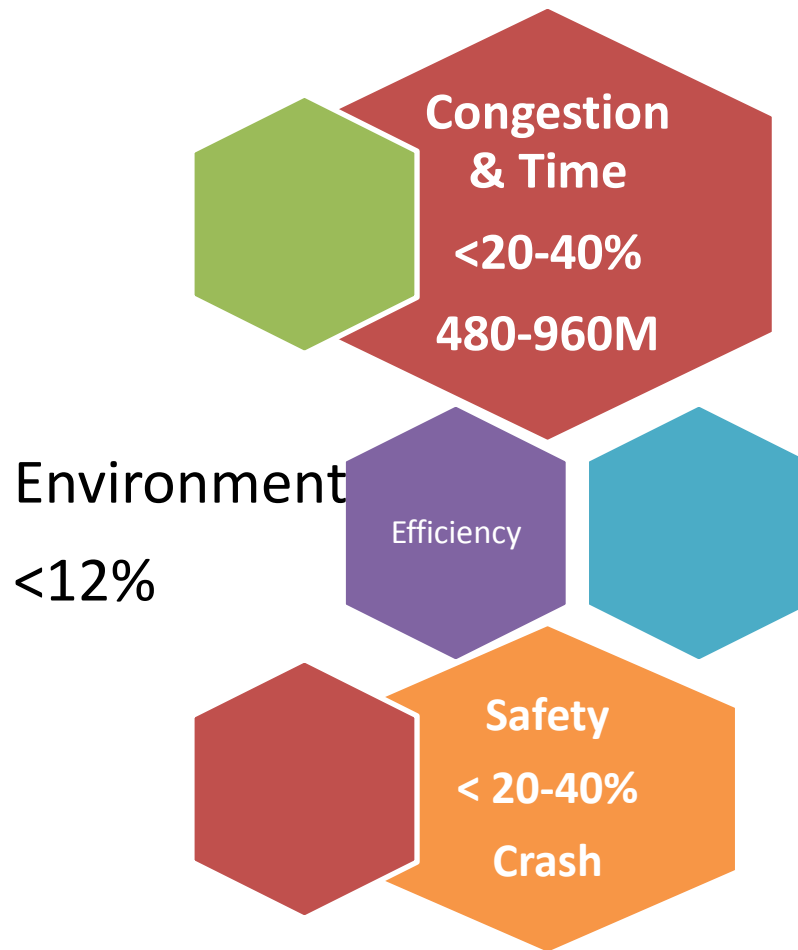
Balisacan, National Economic Development Authority (Neda) chief, was quoting a study by the Japan International Cooperation Agency (Jica) that the government has tapped to help come up with a transportation development road map for the country.

"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

M3 project will cost approx. 8-9% of the daily traffic cost!

CALIFORNIA
PATH

Benefits of ITS

Key strategies on ITS Development

Ensure Interoperability & International/National Standard

Create a National Institutional Framework

Improve Public and Industry Awareness

Foster a Competitive Philippine based ITS Industry
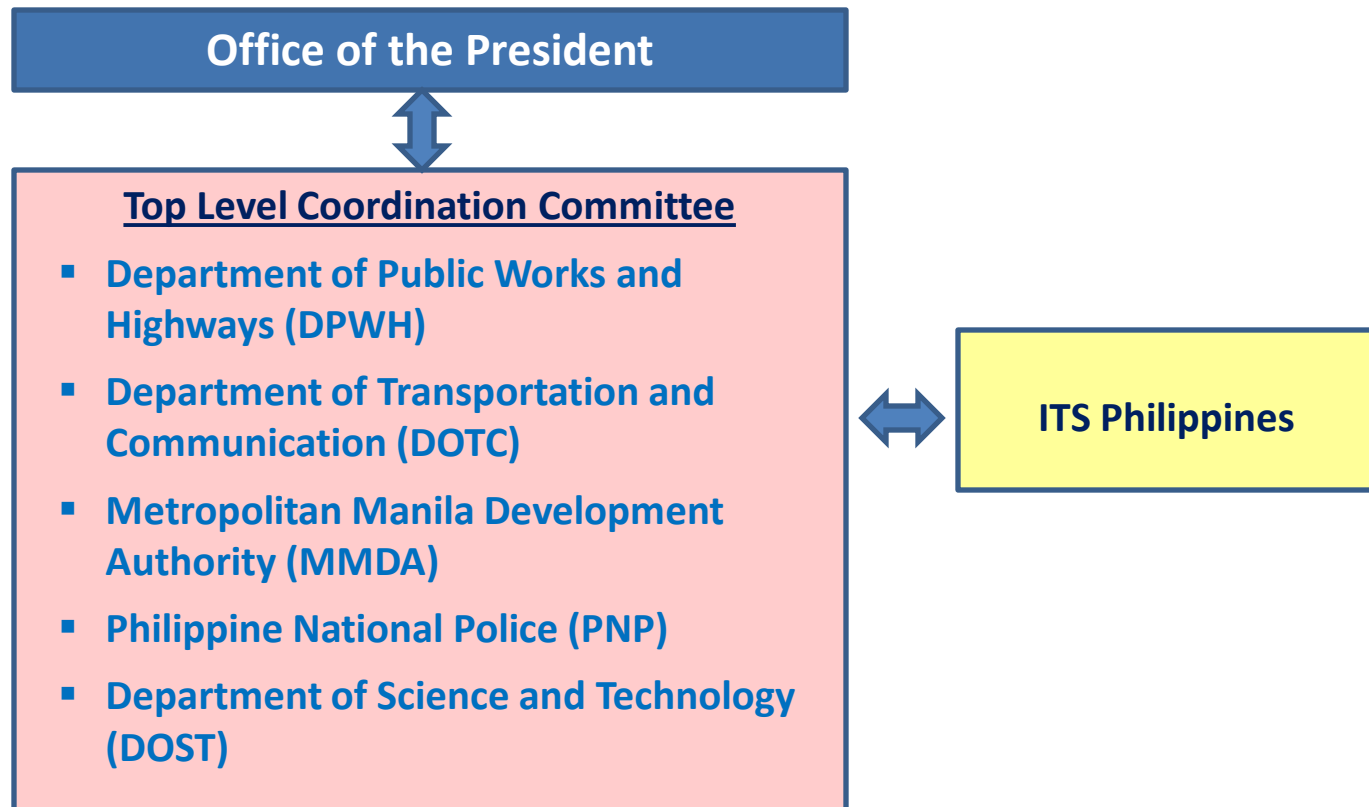
Promote International Cooperation

Establish and Monitor Demonstration Projects

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!