Technical Challenges of Urban Road Pricing

BAQ2007 Pre Seminar

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MITSUBISHI HEAVY INDUSTRIES, LTD.

Today's Presenter: Brief Introduction

- Takakazu TSUJI (辻貴和)
- Professional Experience
  - Acting Manager, ITS Business Unit, Mitsubishi Heavy Industries, Ltd.
  - Business Development and Project Management
  - Major projects and initiatives
    - Head of Integrated Urban Road Pricing Service (2005 to present)
    - Singapore Electronic Road Pricing (1999 to 2002)
    - Hong Kong ERP Field Trial (1998 to 1999)
- Academic Background
  - Master of City Planning (Transportation) in USA
  - MBA in Japan
  - BA (Economics) in Japan

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Three Aspects of Urban Road Pricing

- Urban Road Pricing can be used:
  - To improve accessibility
  - To finance new investments
  - To improve environment
- The system should encompass:
  - Effective deterrence force
  - Low operation cost
  - Trigger for modal-shift to public transport

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Technical Challenge for Urban Road Pricing

- Various Traveling Patterns of Vehicles on Roads
- Different Levies based on Vehicle Classes
- Proven Enforcement on Open Roads
- Secure Payment System
- Low Operation & Maintenance Cost
- Trigger for Modal-shift to Public Transport

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Various Traveling Patterns of Vehicles on roads

- High-speed and non-stop vehicles
- Multi-lane traveling vehicles
  - Close parallel travel
  - Close head-to-tail travel
  - Motorcycles sandwiched between two large vehicles
  - Diagnostic travel across lanes

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Various Traveling Patterns of Vehicles on roads

<Singapore's Experience>

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Different Levies based on Vehicle Classes

- Scheme-1: Charge on specific vehicle classes
- Scheme-2: Charge on same levy on all vehicles
- Scheme-3: Different Levy based on vehicle classes

	Advantages	Disadvantages
1	Simple Fare Policy	Less Effective Less Revenue
2	Simple Fare Policy	Less Effective
3	More Effective Maximized Revenue Equitable Levy	Vehicle Classification System

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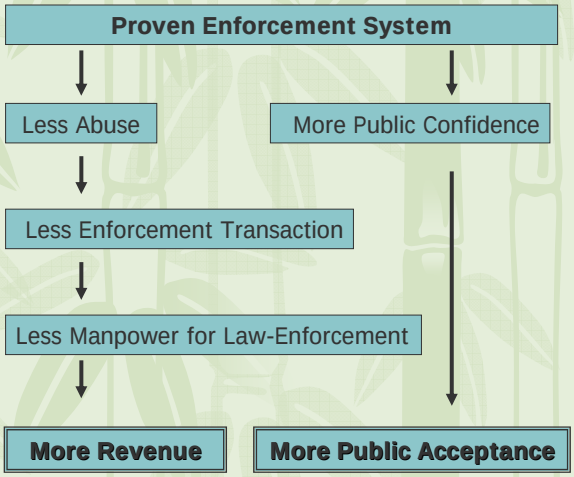

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Optical Vehicle Detector

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- Max 180 km/h
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Original Image Processed Image

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- Infrared-strobe Camera
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Payment System for Urban Road Pricing

Two major concepts to be considers:

- No cash handing at site to prevent fraud
- Proven payment system to minimize leakage

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Payment System for Urban Road Pricing

- Senario-1: Post-paid via banks, credit card, mobile phone, etc.
- Senario-2: Pre-paid via smartcard in OBU

	Advantages	Disadvantages
1	❖Simple OBU (Tag) ❖No need to issue smartcard ❖Easy to use	❖Billing work ❖Recurring collecting debts for small amount ❖Privacy issue ❖Account tied to Vehicle Owner
2	❖Minimum billing work ❖No bad debt ❖Multiple purpose payment ❖Not tied to personal account ❖Payment by user ❖Cash in hand	❖Capital investment for smartcard clearinghouse system ❖Cost of smartcard

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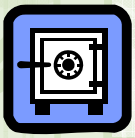

Low Operation Cost

- Minimized operation cost to finance new investment on transport network.
- Major Operation Cost:
  - System Operation (Monitoring)
  - Maintenance (Prevent and Correct)
  - Law Enforcement on Violators
- Reduce the number of recurring enforcement-related manpower at the back-end office.

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Trigger for Modal-shift to Public Transport

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  - Fares of alternative public transport
  - Sensitivity analysis based on survey
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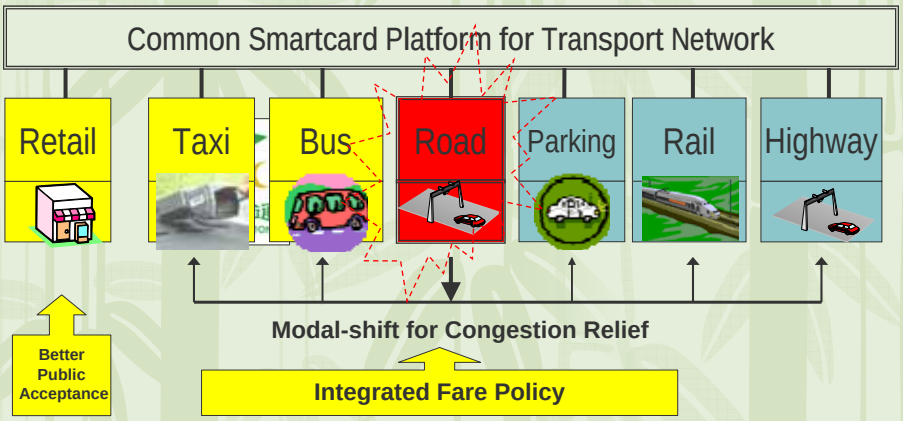

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Thank you.

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Clearing the Way for the Future

Implementing Electronic Road Pricing in Jakarta

13 December 2006

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To be the preferred provider of Integrated Urban Road Pricing solutions worldwide

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Outline of Today's Presentation

<<<Today's Goals>>>

1. Not promoting specific countries, technologies, companies into Jakarta
2. Providing knowledge and experience related to technology, system and O&M of urban road pricing in Asia, so that you can deepen understanding on implementation in Jakarta
3. Getting information of Jakarta contexts so that ITDP Experts Team can support Jakarta more effectively and efficiently

What is Urban Road Pricing?

- Urban Road Pricing can be used: >>> *Political Issues*
  - To improve accessibility
  - To finance new investments
  - To improve environment
- The system should encompass: >>> *Technology Issues*
  - Effective deterrence force
  - Low operation cost
  - Trigger for modal-shift to public transport

The system must satisfy political changes and needs. Road Pricing Scheme should be studied concurrently from the feasibility study phase.

What is Urban Road Pricing?
From the system's point of view

- Multi-lane and free-flow System for Congested Urban Area (Jakarta)
  - Singapore (1998): DSRC / Smartcard
  - London (2003): Camera / Central Account
  - Stockholm (2006): DSRC & Camera / Central Account
- Others Systems in the world (why not in Jakarta)
  - HOV on expressway in USA (3-in-1)
  - GPS for nation-wide highway in German (High-cost On-board Unit)
  - Single-lane ETC in Oslo (Additional structure will cause additional congestion)

Historical Background in Asia:

Sample of Large-scale Urban Road Pricing in Asia

- Hong Kong: *Not implemented*
  - The first 21-month trial (1983 to 1985)
  - The second trial (1998 to 1999)
  - The third study (2006 to 2007)
- Tokyo: *Not implemented*
  - The intensive study (2000 to 2002)
  - Diesel Retrofit Program took to improve air quality in 2003
- Bangkok: *Not implemented*
  - The feasibility study was done (early1990s), but no proven technology at that time
- Singapore: *Successfully implemented*
  - Area Licensing Scheme: 1975 to 1998
  - Electronic Road Pricing : 1998 to present

Singapore's Experience

- Land Area: 678 km^2
- Population: c.a. 4.8 million (2006)
- Registered Vehicles: c.a. 0.78 million (2006)

- Central Business District
- Outer Ring Roads
- Expressways

Area Licensing Scheme in Singapore

- Manual road pricing introduced in Central Business District (CBD) since 1975
- High manpower needs, inconvenient, limited in varying road pricing charges (16 types of license)

Urban Road Pricing in Singapore
ERP since 1995

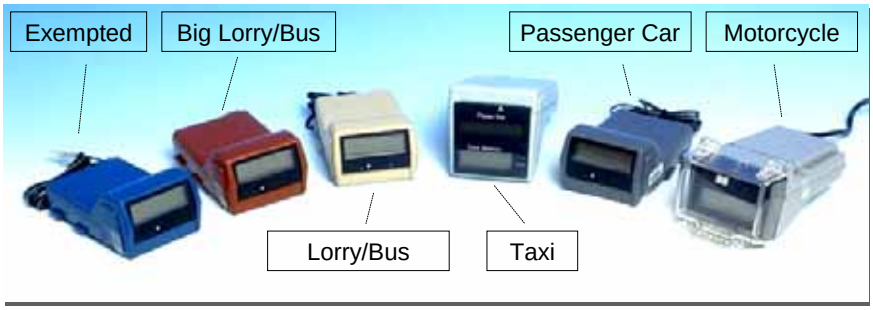
Gantry	48
Capital Investment	S$200(US$125) Mil (1995)
Revenue	S$80(US$50) Mil/Year
Operation Cost	S$16(US$10) Mil/Year
Transaction	7 Mil/month
Violations and Errors	0.49% (1,200/day)
System Availability	99.90%
On-board Unit	99% installed
Range of Levy	S$0.25--8.00 (US$0.15 -5.00)
Optimal Speed	20-30Km/h (Ordinary Road)
	45-65Km/h (Expressway)

Remark: US$=1.6S$

Major Components for Urban Road Pricing

- On-board Unit:
  - 1-pc OBU (just a ID badge) or 2-pc OBU (accepting smartcard)
  - Wide spread of OBU is essential to operate road pricing successfully for all aspects
  - Authority to consider distribute to motorist for free as social cost.
- Roadside Equipment
  - Antenna
  - Vehicle Detector
  - Enforcement Camera
- Central Computer System
  - Monitoring
  - Payment
  - Enforcement

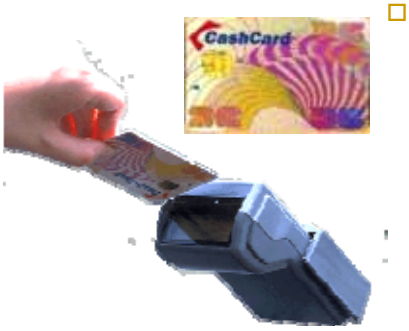
ERP: Types of On-board Unit



Vehicle Type	Passenger Car Unit
Cars	1.0
Motorcycles	0.5
Lorries/Buses	1.5
Big Lorries/Buses	2.0

ERP: CashCards (Smartcard)

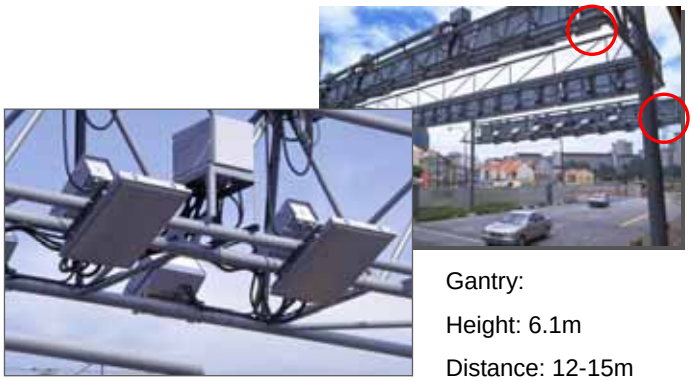
- A smart card marketed by a consortium of local banks for multiple uses



- Top-up at Automated Teller Machines (ATMs), petrol stations and many other outlets

ERP: Gantry Equipment

- Antennae



Gantry:

Height: 6.1m

Distance: 12-15m

ERP: Gantry Equipment

- Antennae
- Vehicle Detectors

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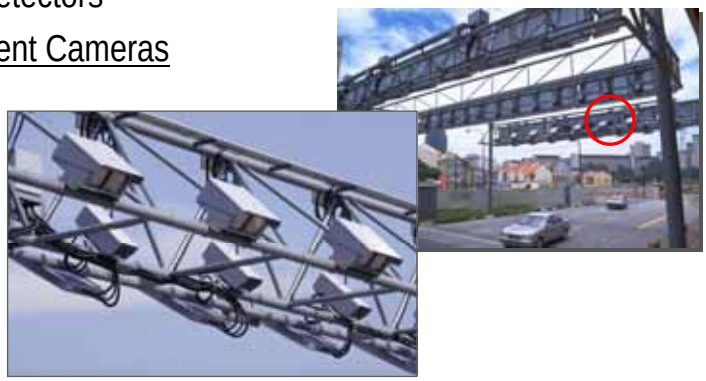
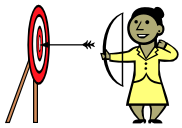
- Antennae
- Vehicle Detectors
- Enforcement Cameras



What we learnt from ERP: Tangible Benefit

- Road Pricing is a effective tool for traffic demand management.
  - Area License Scheme (1976): reduced by 31-44%
  - ERP(1998): reduced by about 10-15%
- Automated Road Pricing can generate revenue for further investment related to public transport.
  - Capital Investment: US$125 million
  - Annual Revenue: US$50 million
  - Annual Operation Cost: US$10 million
- Less traffic and less congestion equal less air pollution.

What we learnt from ERP: Critical Success Factors



- Public Acceptance
  - Improvement of public transport as alternative mode
  - Irrefutable enforcement system
  - Privacy issues addressed
  - Equitable Pricing Framework
- Strong Political Will
- Reliable System Integrator, OBU Distributors and Inspection Center
- Fund-raising for Capital Investment
- Strong Development, Implementation, Operation and Maintenance Experience

Technical Challenge for ERP System Requirements:

- To cope with various traveling patterns of vehicles on open road
- To reliably enforce violators without barrier on roads
- To charge different levies based on vehicle classes
- To securely collect fee via pre-paid fare system
- To keep recurring operation and maintenance cost low
- To establish an integrated fare policy for use in other applications

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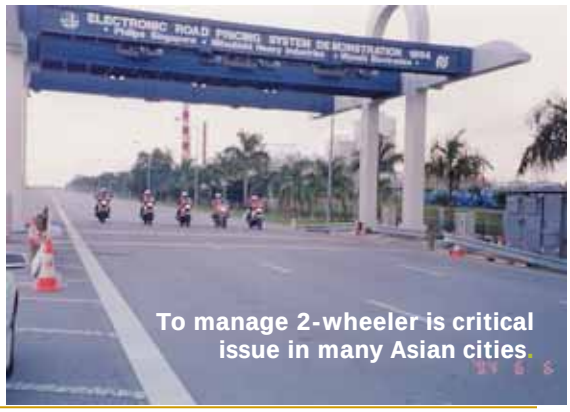
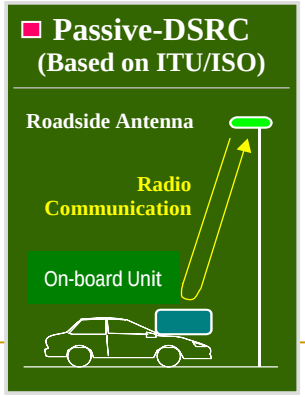
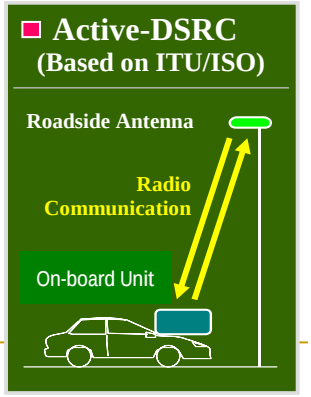


DSRC for Urban Road Pricing

Dedicated Short Range Communication

- International Trend in DSRC
- ITU-R. M.1453 (International Telecommunication Union)
- Active (Transponder) or Passive (Transceiver)





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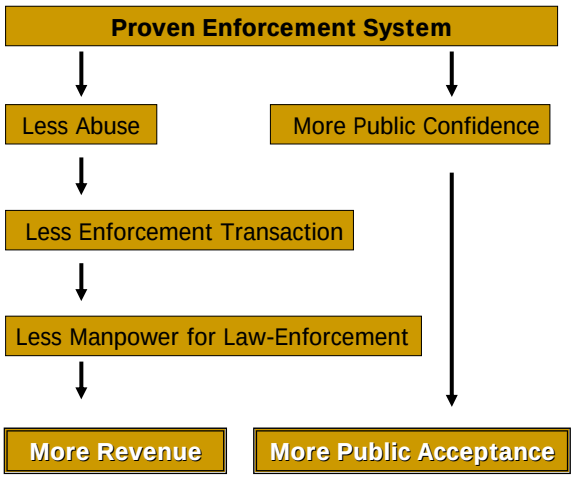

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- Infrared-strobe Camera
- Only Violation Captured

Well organized and neat license plate is essential to realize effective enforcement process.

Payment System for Urban Road Pricing

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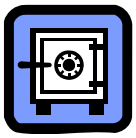
Low Operation Cost



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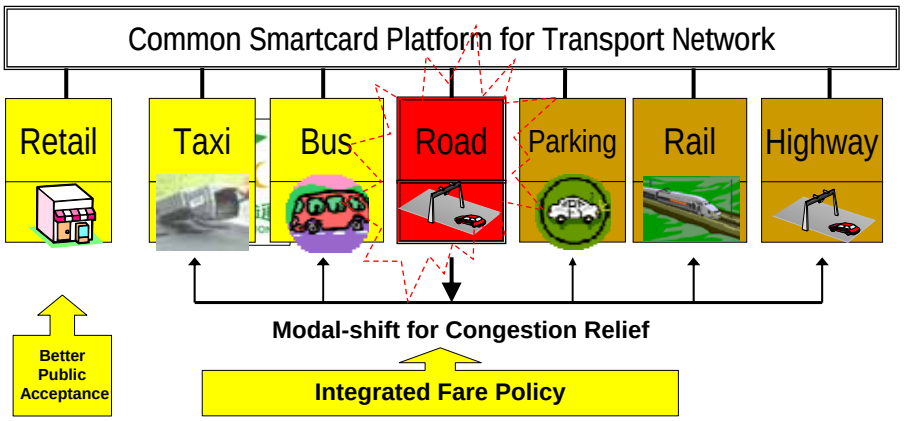


Three major smartcards: Philips "Mifare", Sony "Felica", ISO14443B "Type-B"

What's to be tolled? Various Urban Road Pricing Schemes

- Cordon Pricing: Singapore and Stockholm
  - To charge vehicles passing a virtual border line around a congested area. The charging points are provided at the entry or exit on the border line.
  - The levy is variable according to the place, time and vehicle classes.
- Area Pricing: London
  - To charge vehicles passing a virtual restricted area. The motorist is charged to travel in it. The time and place of traveling is not counted once the motorist pay.
  - The levy is variable according to vehicles classes.
- Zone Pricing: (no city)
  - Area Charging is a method of charging even to vehicles traveling inside the borders. Area Pricing is different from Cordon Pricing in charging to the vehicle traveling within the border.
  - The levy may be priced according to distance of travel or hours each vehicle stays in the zone.
- Point Pricing: Singapore (Expressways), 3-in-1 Scheme?
  - Point Pricing is to charge vehicles passing a specific point on existing roads, bridges or tunnels.
  - Effective for the traffic passing through congested area

Legal issues for Urban Road Pricing

- Legislation for pricing of road usages
- Legislation for enforcement of non-payment of road usage charges
- Legislation on the use of electronic evidence for enforcement actions
- Legislation on electronic payments
- Installation of on-board units
- Privacy issues

Vehicle Classification

- Weight of vehicle
- Number of axles
- Physical size
- Engine capacity
- Fuel type
- The number of passengers on board
- Passenger Car Unit

<Passenger Car Unit in Singapore>

Vehicle Type	PCU Ratio
Passenger Cars	1.0
Motorcycles	0.5
Lorries/Buses	1.5
Big Lorries/Buses	2.0

➢Simple and less controversial way is to classify the vehicle class on exiting toll roads.

➢Vehicle classification should be processed automatically without human intervention due to multi-lane and free-flow operation on open roads.

Initial and Recurring Costs
Singapore's ERP case

- Initial Costs
  - Roadside Equipment
  - On-board Unit
  - Central Computer System
  - Publicity and Public Education Program, etc
- Recurring Costs
  - Operation
  - Maintenance
  - Law-Enforcement

Estimating "Correct Prices"
Pricing Models

- Price for negative externalities, e.g., air pollution, noise pollution and congestion
- Price for distance traveled, e.g., per km pricing
- Price for time spent in a zone
- Price for entering a zone

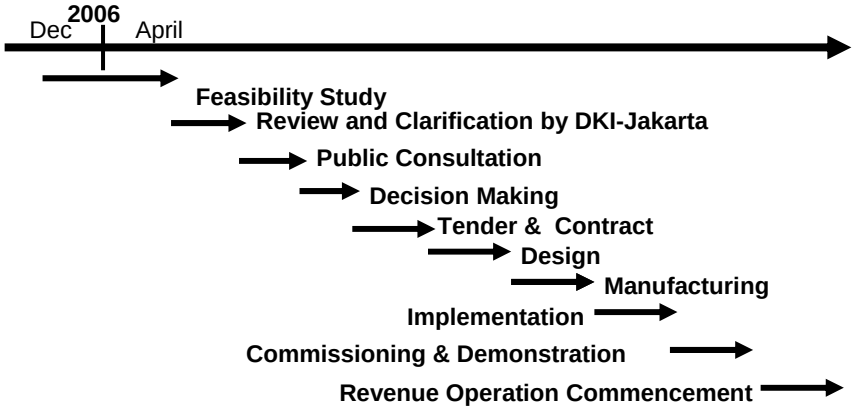
Public Relation and Education

- Explain rationale of road pricing and its benefits
- Formulate clear pricing framework
- Educating on the use of the system
- Reach out via mass media
- Prepare and distribute education materials
- Establish customer service hot line

Players to implement ERP in Jakarta

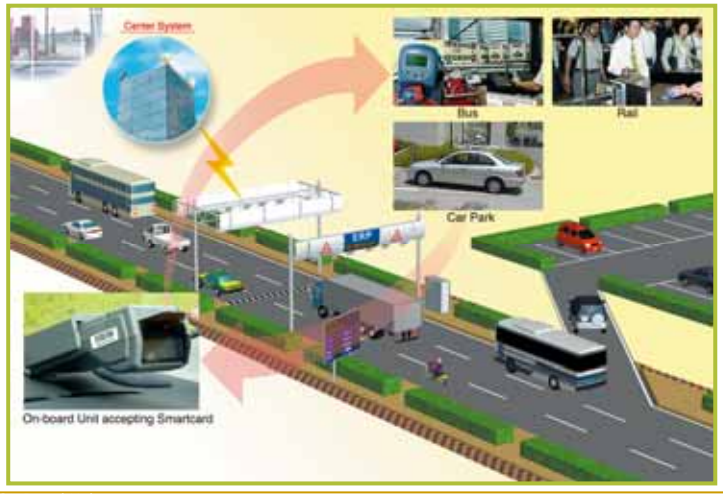
- Owner (who own the system)
- Operator (who is responsible for daily operation)
- Contractor to manage the project
- System Integrator and Manufacturers
- System Implementation
- OBU distributors & Inspection
- Banks and/or Financial Institutions
- Smartcard Operator
- Law-enforcement entity against violators
- Experienced O&M Contractor

Proposed Organization to implement ERP in Jakarta



System Proposal

High-Speed, Multi-lane & Free-flow System with Multi Purpose Smartcard



Thank you.
We are always here.

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