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Goh Shou Xian has been the Assistant Manager, Policy Division at the Land Transport Authority since 2011. He is involved in private transport policy formulation and his work focuses on vehicle ownership and usage policies, as well as policies relating to land transport emissions.

The Land Transport Authority (LTA) is a statutory board under the Ministry of Transport that spearheads land transport developments in Singapore. 'To provide an efficient and cost-effective land transport system for different needs' is our mission statement.

International Forum on Economic Policies for Traffic Congestion and Tailpipe Emissions Control

Electronic Road Pricing in Singapore: Policy, Technology and Impact

GOH, Shou Xian
Land Transport Authority, Singapore

Singapore's Land Transport Master Plan 2013

- Continues 2008 Master Plan's focus of shifting more trips to public transport, especially rail-based transport
 - Aim of 75 percent of trips during morning and evening peak hours to be made on public transport by year 2030
- 3 key strategic thrusts:
 - More connections
 - Better service
 - Liveable & inclusive community



Singapore's Land Transport Master Plan 2013

- At the same time, we aim to reduce reliance on private transport by managing road travel demand:

Ownership Control

- Vehicle Quota System
- Additional Registration Fee
- Other ownership costs
 - Excise duty
 - Road tax

Usage Restraint

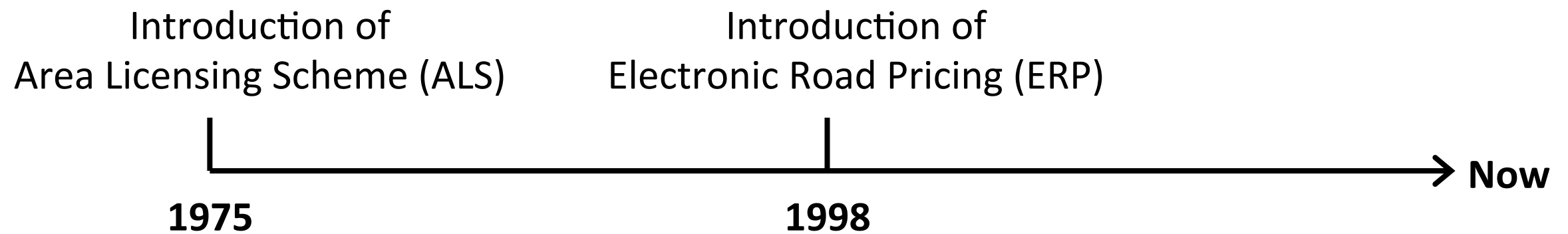
- **Electronic Road Pricing (ERP)**
- Off-Peak Car scheme
- Petrol duty
- Parking policies

Key Road Network Statistics

| | |
|--------------------|---------------|
| Land area | - 715.8 sq km |
| Road network | - 3,425 km |
| Expressway network | - 161 km |
| Vehicle population | - 972,676 |
| Car population | - 607,104 |

- 12% of land is used for roads compared to 15% for housing

History of Road Pricing in Singapore



Area Licensing Scheme (ALS)

- Introduced in Central Business District (CBD) in 1975
 - Cordon-based
 - Motorists required to purchase license to enter Restricted Zone (RZ)
 - Reduces congestion in CBD
 - Volume of cars entering CBD decreased by 44% during 1st year of implementation
- However, ALS required high manpower resources and lacked flexibility

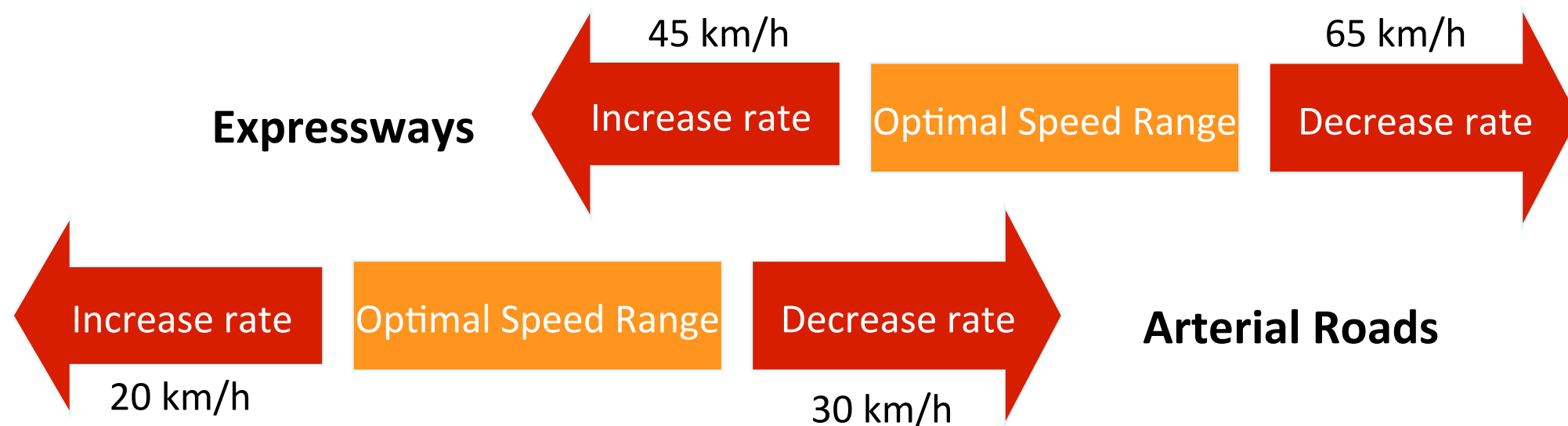


Electronic Road Pricing (ERP)

- Introduced in 1998 to replace Area Licensing Scheme
 - Caters to changing traffic patterns
- Aims to change driving behaviour and reduce congestion
 - ERP is not intended to generate revenue for the Government
- Cordon-based and point-based
 - Cordon-charging in 3 cordons: Bugis-Marina Centre Cordon, Shenton Way-Chinatown Cordon, Orchard Cordon
 - Point-charging along expressways and arterial roads

Electronic Road Pricing (ERP)

- ERP rates are determined based on local traffic conditions and time
 - 85th percentile speed measurement method
 - Reviewed every 3 months

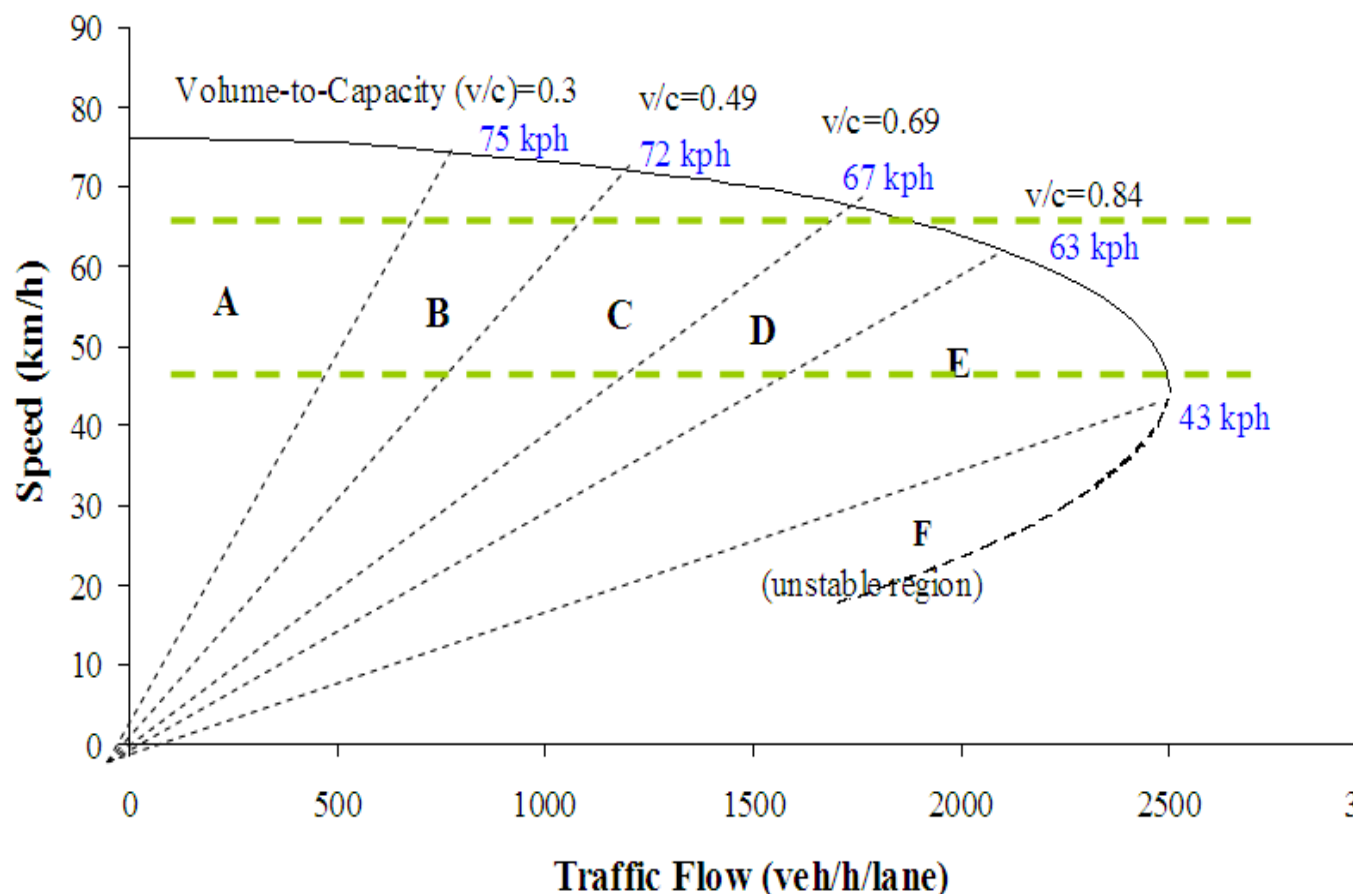


Maintaining Efficiency on Roads

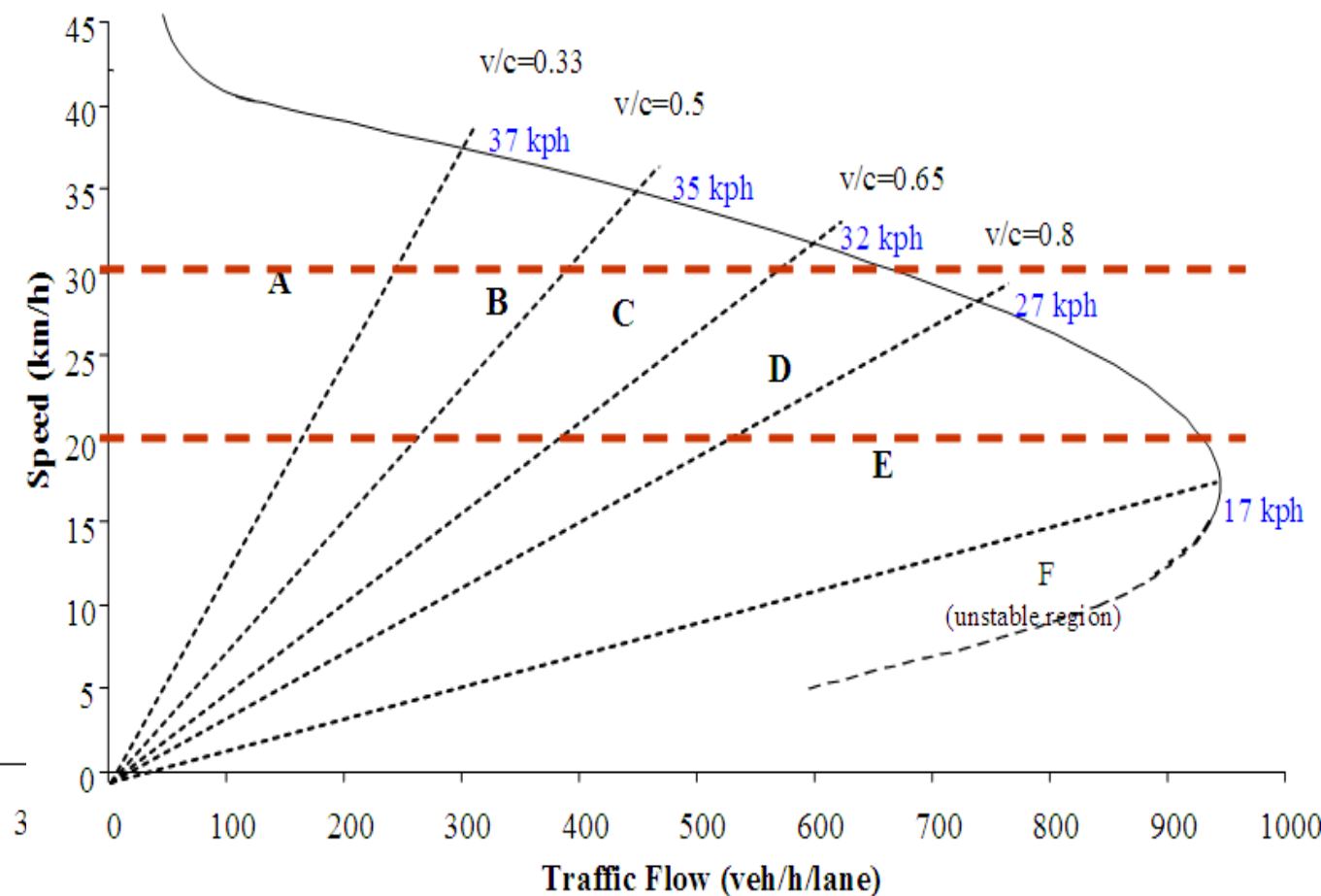
- ERP maintains optimal speed range on expressways & arterial roads

— Rates are adjusted to keep traffic within Level of Service (LOS) E

Speed-Traffic Flow Curve for Expressways



Speed-Traffic Flow Curve for Arterial Roads





Gantry 1

Controller Housing

Gantry 2

Antenna

Vehicle Detector



Line Detector Array

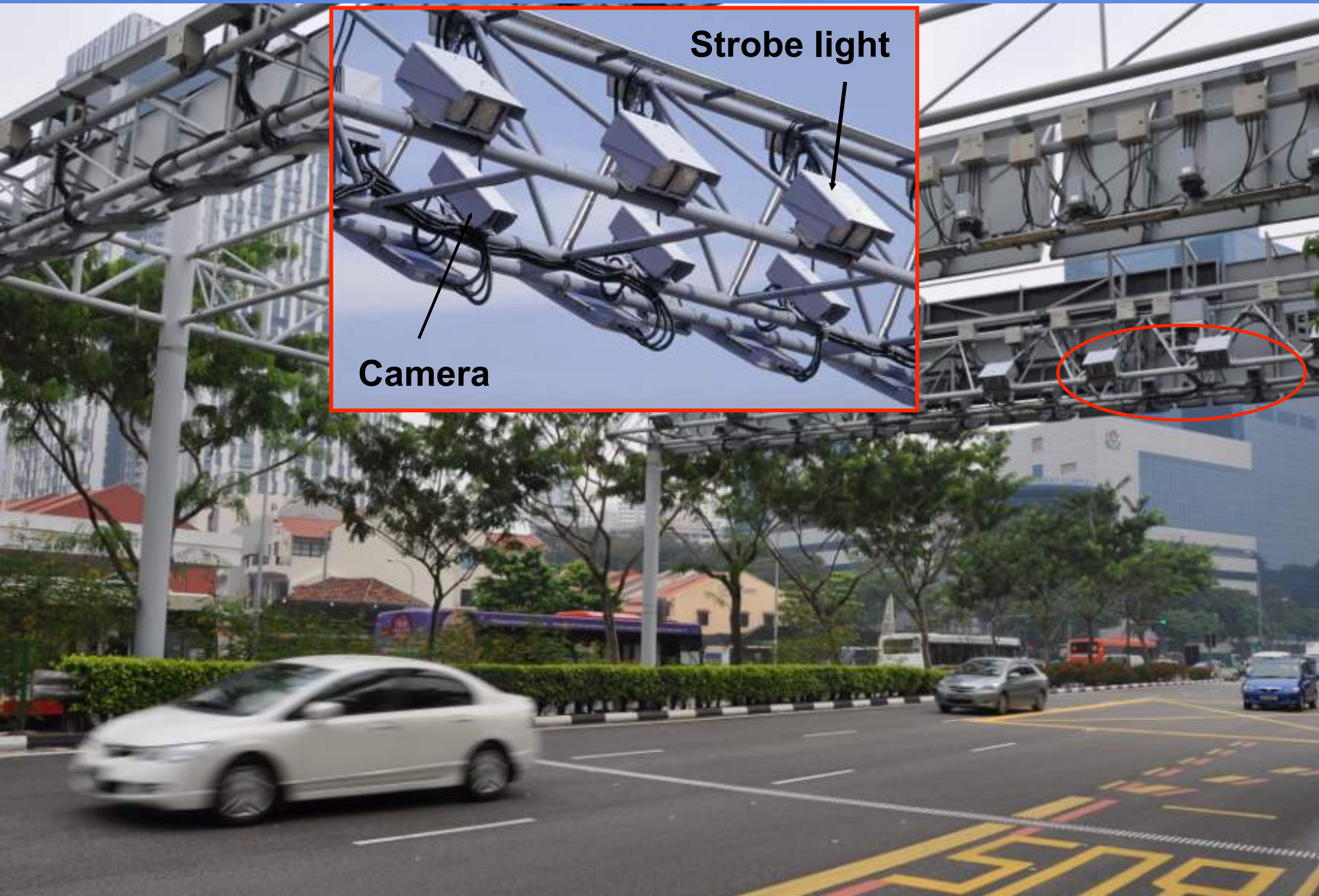


Detector Strip

DSRC Antenna



Enforcement Camera

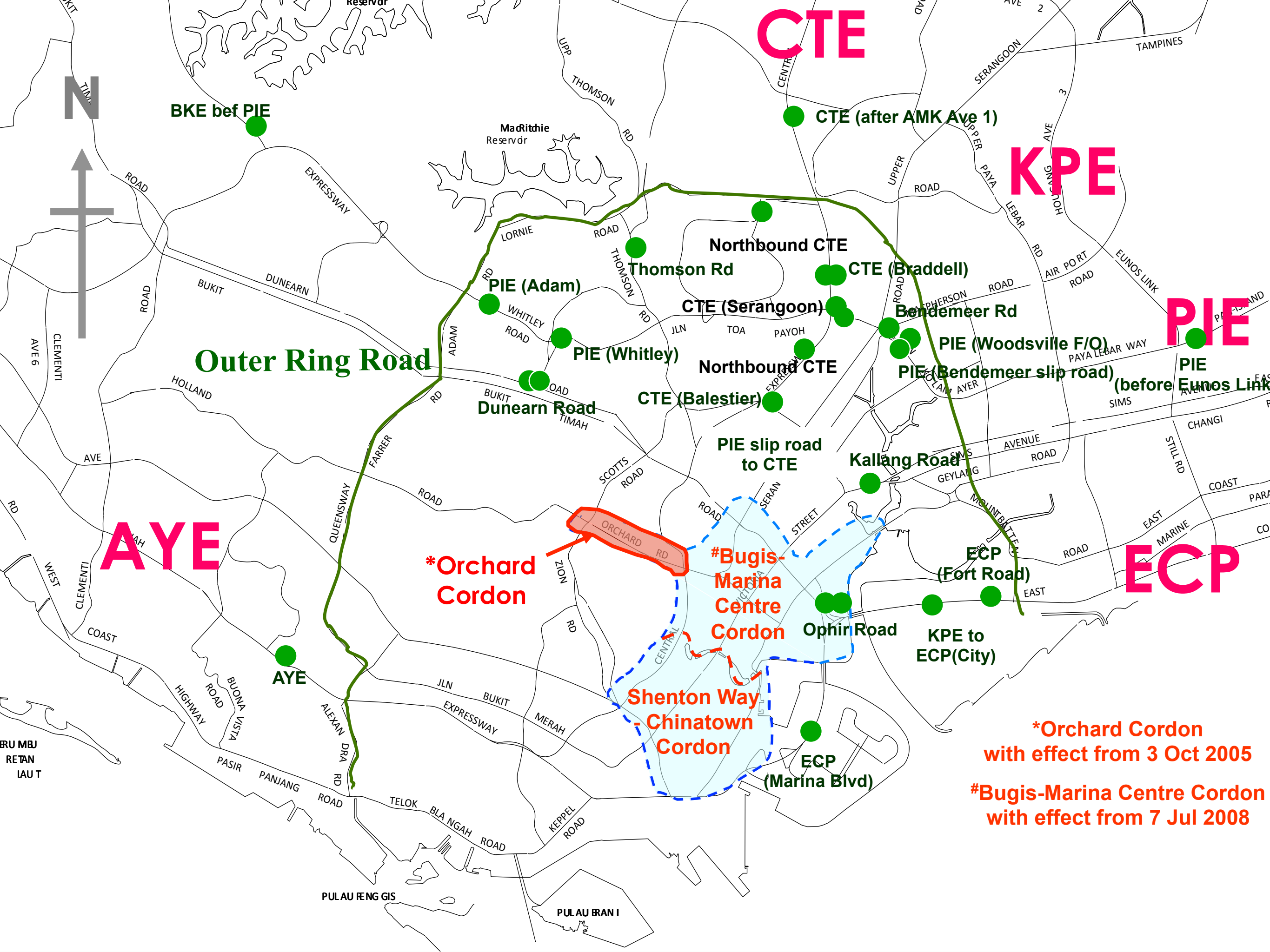


Central Control System

24/7 operations:

- Monitors equipments
- Processes financial transactions
- Enforcement of violations





CTE

KPE

PIE

AYE

ECP

BKE bef PIE

CTE (after AMK Ave 1)

Northbound CTE

Thomson Rd

CTE (Braddell)

PIE (Adam)

CTE (Serangoon)

Bendemeer Rd

Outer Ring Road

PIE (Whitley)

Northbound CTE

PIE (Woodsville F/O)

PIE (Bendemeer slip road)

(before Eunos Link)

Dunearn Road

CTE (Balestier)

PIE slip road to CTE

Kallang Road

*Orchard Cordon

#Bugis-Marina Centre Cordon

ECP (Fort Road)

KPE to ECP(City)

AYE

ECP (Marina Blvd)

Shenton Way Chinatown Cordon

*Orchard Cordon with effect from 3 Oct 2005
#Bugis-Marina Centre Cordon with effect from 7 Jul 2008

Setting of ERP Charges

- Charges vary by vehicle type, location of gantry, time of day
 - Ranges from SGD 0.50 to SGD 6 for cars per pass
 - Total of 71 gantries (32 gantries serving expressways and arterial roads, 29 gantries serving 3 cordons)
 - Rates are graduated to prevent motorists from speeding/slowing to avoid charges
- Charges are set based on Passenger Car Unit (PCU) principle
 - Vehicles which take up more road space pay more for congestion
 - Cars have a PCU of 1

Examples of ERP Charges

| Expressways | | | | | | | | | | | | | | | |
|-------------------------------------|---|--|--|-------------------------------|---------------------|----------------------------------|---|---|------------------------|---------------------------------|--|--|--|--|-----------------|
| Weekdays | | | | | | | | | | | | | | | |
| BKE between Dairy Farm Road and PIE | CTE after Braddell Road, Serangoon Road and Balestier slip road | CTE slip road to PIE (Changi) / Serangoon Road | CTE between Ang Mo Kio Ave 1 and Braddell Road | ECP after Tanjong Rhu Flyover | ECP from Ophir Road | KPE slip road into westbound ECP | PIE after Kallang Bahru exit, PIE Slip Road into Bendeemer Rd | PIE eastbound after Adam Road and Mount Pleasant slip road into the eastbound PIE | PIE slip road into CTE | PIE westbound before Eunos Link | CTE northbound between Jalan Bahagia and PIE | CTE northbound between PIE and Braddell Road, PIE to CTE northbound before Braddell Road | ECP eastbound before exit to Rochor Road, entrance from Ophir Road | For Orchard Cordon and Rest of CBD, please view page 3 | Time |
| 54 | 31, 33, 34 | 68 | 35 | 30 | 29 | 80 | 32,45 | 37, 38 | 42 | 65 | 51 | 46, 67 | 52, 53 | | Gantry No. |
| \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | | | | | 7.00am - 7.05am |
| \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | | | | | 7.05am - 7.25am |
| \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | | | | | 7.25am - 7.30am |
| \$1.00 | \$2.00 | \$0.50 | \$0.00 | \$1.50 | \$0.00 | \$1.50 | \$0.00 | \$0.50 | \$2.00 | \$0.00 | | | | | 7.30am - 7.35am |
| \$2.00 | \$4.00 | \$1.00 | \$0.00 | \$3.00 | \$0.00 | \$3.00 | \$0.00 | \$1.00 | \$4.00 | \$0.00 | | | | | 7.35am - 7.55am |
| \$2.00 | \$3.50 | \$1.00 | \$0.00 | \$2.50 | \$0.00 | \$2.50 | \$0.00 | \$1.00 | \$3.50 | \$0.00 | | | | | 7.55am - 8.00am |
| \$2.00 | \$3.00 | \$2.00 | \$0.50 | \$2.00 | \$0.00 | \$2.00 | \$0.00 | \$1.50 | \$3.00 | \$0.00 | | | | | 8.00am - 8.05am |
| \$2.00 | \$3.00 | \$3.00 | \$1.00 | \$2.00 | \$0.00 | \$2.00 | \$0.00 | \$2.00 | \$3.00 | \$0.00 | | | | | 8.05am - 8.25am |
| \$2.00 | \$3.00 | \$3.00 | \$0.50 | \$2.00 | \$0.00 | \$2.00 | \$0.00 | \$2.00 | \$3.00 | \$0.00 | | | | | 8.25am - 8.30am |
| \$2.00 | \$4.50 | \$3.50 | \$0.00 | \$4.00 | \$0.00 | \$4.00 | \$0.80 | \$2.00 | \$4.50 | \$0.50 | | | | | 8.30am - 8.35am |
| \$2.00 | \$6.00 | \$4.00 | \$0.00 | \$6.00 | \$0.00 | \$6.00 | \$1.50 | \$2.00 | \$6.00 | \$1.00 | | | | | 8.35am - 8.55am |
| \$1.00 | \$4.00 | \$2.50 | \$0.00 | \$3.00 | \$0.00 | \$3.00 | \$0.80 | \$1.00 | \$4.00 | \$0.50 | | | | | 8.55am - 9.00am |
| \$0.00 | \$2.00 | \$1.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$2.00 | \$0.00 | | | | | 9.00am - 9.05am |
| \$0.00 | \$2.00 | \$1.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$2.00 | \$0.00 | | | | | 9.05am - 9.25am |
| \$0.00 | \$1.00 | \$0.50 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$1.00 | \$0.00 | | | | | 9.25am - 9.30am |

ERP Operating Hours

- Bugis-Marina Centre Cordon (9 gantries)
 - 8 am to 10 am, 12 pm to 8 pm on weekdays & 12.30 pm to 8 pm on Saturdays
- Shenton Way-Chinatown Cordon (11 gantries)
 - 8 am to 10 am, 12 pm to 8 pm on weekdays
- Orchard Cordon (9 gantries)
 - 12 pm to 8 pm on weekdays, 12.30 pm to 8 pm on Saturdays
- Expressways & arterial roads (32 gantries)
 - 7 am to 9.30 am (5.30 pm to 8 pm for ECP and CTE) on weekdays

Introduction of Evening and Weekend ERP

- August 2005 – ERP extended to manage evening peak hour congestion for home-bound trips
 - Congestion causes externalities, regardless of the time
- October 2005 – Orchard Cordon introduced, with ERP on weekdays and Saturdays
 - Aim is to reduce through traffic in Orchard corridor

Modes of Payment for ERP Charges

- NETS CashCard
- Contactless E-Purse Application Standard (CEPAS)
 - National standard for Contactless Smart Card (CSC)
 - Card can be used on public transport, ERP, parking charges and at participating retail merchants
- Cardless payment
 - Automatic billing via credit card
 - Motorists need not perform credit top-ups or worry about violations



In-Vehicle Unit (IU)

- 6 different types of IU:
 - Allows variable pricing for different types of vehicles
- Current 2nd generation IU is compatible with both NETS CashCard and CEPAS card
 - Improvement over 1st generation IU which is compatible with only NETS CashCard

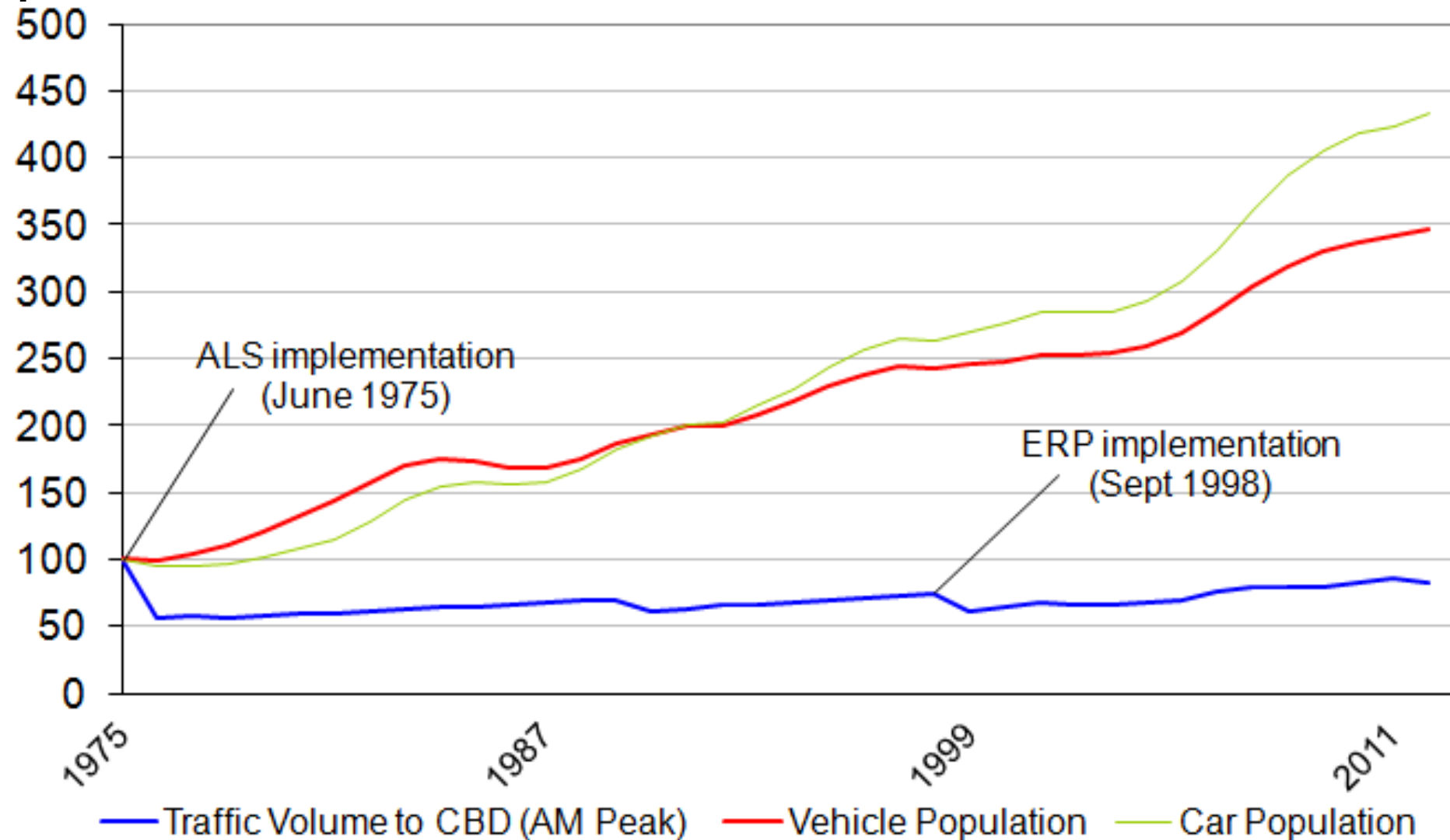


Implementation Process for ERP (1998)

- Policy changes
 - Lower vehicle tax rates
 - Road tax rebates
 - Reducing impact for commercial vehicles
- Fitting of In-Vehicle Unit
- Publicity
- Testing for motorists

Impact of ERP

- Between 1998 and 2012, traffic volume to CBD increased only by 0.8% p.a. despite an increase in vehicle population of 3% p.a.



Future of Road Pricing in Singapore

- Singapore is studying next generation ERP:
 - System Evaluation Test (SET) to identify suitable technology
 - Use of Global Positioning System (GPS) allows us more flexibility and makes possible distance-based road pricing



Summary

- Pricing strategy should be flexible and relevant
- Continue to shift more trips to public transport, especially rail-based transport
- Manage car-based travel demand , through car ownership and usage restraint measures
 - ERP is a key policy tool for restraining usage and complements other policy tools

Thank You!