Special Introduction

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Mobility Systems Engineers Wanted to Create Beyond World Class Land Transport System Mobility 2030

1. Introduction
2. ERP
3. ERP2
4. Autonomous Vehicles
5. TRANSIM, Modelling & Simulation
6. Urban Mobility Research & Development
   Test & Evaluation & Demonstration

CDS&M Asia 2016
26th February 2016
Professor Lui Pao Chuen
Satellite-based ERP to be ready by 2020, with S$556m contract awarded

The Land Transport Authority awarded the tender to a consortium of NCS and Mitsubishi Heavy Industries, which beat two other consortia to the bid. Development for the new system will begin in the second quarter of this year.

By Justin Ong and Olivia Siong, Channel NewsAsia

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Dare to be Different, Dare to Lead

Future Economy: Driven by Knowledge + Innovation + Enterprise

A Copy Cat Strategy Is Not Sustainable

Attract Talent

Attract MNC

Capital Intensive

Technology Intensive

Knowledge Intensive

Skills Intensive

Labour Intensive

Industry sophistication & value-add

1960  1980  2000  2020
2006 Driving The Knowledge-Based Economy with Step Jump in Government Investment for RIE (Research, Innovation & Enterprise)

PUBLIC SECTOR R&D BUDGET $ BILLION

Dr Tony Tan  
Chairman NRF  
2006 to 2011
Our Urban Mobility System Evolves to Meet the Changing Needs of Our People

Conception to Retirement

More Babies

Happy & Healthy Seniors

Learn — Communicate — Live

Work — Play — Freedom from Fear & Want

Safety & Security & Resilience
Security, Safety and Resilience Are Our Strategic Needs

NATIONAL RESOURCES

- 2015 Defence Budget ~ $13.1 Billion
- 2015 MHA Budget ~ $5.0 Billion
- 2 years National Service
- 10 years Operationally Ready Service
- 20% Singapore’s Land
Breakdown of Total Expenditure by Sector (FY2014 and FY2015)

Transport Budget Grew > 80%

- **Defence**
  - FY2014 (Revised): 12.4
  - FY2015 (Budgeted): 13.1
- **Education**
  - FY2014 (Revised): 11.7
  - FY2015 (Budgeted): 12.1
- **Transport**
  - FY2014 (Revised): 6.0
  - FY2015 (Budgeted): 10.9
- **Health**
  - FY2014 (Revised): 7.2
  - FY2015 (Budgeted): 9.3
- **Home Affairs**
  - FY2014 (Revised): 4.5
  - FY2015 (Budgeted): 5.0
- **Trade and Industry**
  - FY2014 (Revised): 2.9
  - FY2015 (Budgeted): 3.1
- **National Development**
  - FY2014 (Revised): 2.2
  - FY2015 (Budgeted): 2.7
- **Culture, Community and Youth**
  - FY2014 (Revised): 1.9
  - FY2015 (Budgeted): 2.7
- **Social and Family Development**
  - FY2014 (Revised): 1.8
  - FY2015 (Budgeted): 2.1
- **Environment and Water Resources**
  - FY2014 (Revised): 1.5
  - FY2015 (Budgeted): 1.8
- **Manpower**
  - FY2014 (Revised): 1.3
  - FY2015 (Budgeted): 1.5
- **Communications and Information**
  - FY2014 (Revised): 1.2
  - FY2015 (Budgeted): 1.2
- **Finance**
  - FY2014 (Revised): 0.7
  - FY2015 (Budgeted): 0.9
- **Law**
  - FY2014 (Revised): 0.6
  - FY2015 (Budgeted): 0.5
- **Organs of State**
  - FY2014 (Revised): 0.4
  - FY2015 (Budgeted): 0.5
- **Foreign Affairs**
  - FY2014 (Revised): 0.4
  - FY2015 (Budgeted): 0.5
- **Prime Minister's Office**
  - FY2014 (Revised): 0.4
  - FY2015 (Budgeted): 0.5
Area Licensing Scheme (ALS) introduced in 1975

- Congestion Reduced
- 70 staff for sale of licenses
- 78 staff for enforcement
- Search for Electronic Toll System began in 1989

Transportation System Engineering Leaders

A P G Menon
Adjunct Associate Professor, NTU, since 1991

Dr. Chin Kian Keong
Group Director
Transportation & Road Operations Group
ERP Operational in 1998

First in the world to introduce an electronic road toll collection system for reduction of congestion

- $1.5m paid to each of 3 Tenderers to demonstrate their proposed system
- SQT(System Qualification Test) Dec 1996 to Aug 1997 with 4.8 million transactions
- New Smart Cards developed for high temperature operation
- ERP Led the deployment of Cash Cards by NETS
- ERP was a “Turn Key” project

LTA is Owner & Operator of ERP
LTA Became Very Knowledgeable about Electronics Road Pricing
Covering the Entire Life Cycle from Conception to Retirement
System Upgraded with EIFS (Enhanced Integrated Fare System)

CEPAS (Contactless e-Purse Application) Rollout in 2009

Daily usage

Transit Operators

Account

Transferred to Operators’ account, based on daily usage

Daily apportioned transaction

TransitLink

CARD MANAGER

Instructs bank to transfer

Trustee Bank (Card Issuer)
Manages Float and disburses daily revenue

Non-Transit Merchants

Account

Opted daily

Apportion Daily

Float

Sales Offices
Card sales and top-ups

Cash collected, counted and deposited by security company within 24 to 48 hours

Nets

Amount deposited overnight

Payphones

GIRO

Amount deposited overnight

Silvester Prakasam
Director
Fare System

Legend

Revenue
Transaction Data
Urban Mobility Engineering Capability Grew With ERP

Grace Ong
ERP2 Project Director

Self Confidence Grew with Successful Operation
LTA Took System Responsibility for ERP2
Did Not Pass Responsibility to Consultants

Being Innovative, dare to dream, take ownership

SOR On Board Unit
SOR Comms System
SOR Computer System
SOR Enforcement System

CONOPS
OMP
EMP

Conception to Retirement
“ERP 2 Will Help to Maximize Utilization of Roads Solution Must be Trains and Integrated Cities”

Chew Men Leong
CE LTA

Making Sense of our Roads
And Dynamic Allocation of Resources & Services

LTA ERP2 Project Team Responsible for System Architecting & System Engineering
MRT Lines in 1999
Continuous Development of the MRT Network
$5 Billion per year
Rail Network Expansions in LTMP 2013
Will Transform the Way We Live

There is a Missing Piece! First Mile/Last Mile Transportation
Autonomous Vehicles Will Be One of the Solutions to “First Mile/Last Mile” Problem
Committee on Autonomous Road Transport for Singapore (CARTS)
Guiding R&D And Deployment

Goal: Not to replace cars with driverless cars but to develop new cities that will not need personal cars

PS Pang Kin Keong

SMART+ NUS

ASTAR + I2R

ST Kinetics
Since 2000 New Vehicles Were Developed with “Drive by Wire” to be Ready for Autonomous Driving when Technology Matures and Affordable
Leveraged on SIM Tech “Institute of research excellence, creating intellectual capital through the generation, application and commercialization of innovative research outcomes” Dr Lim Khiang Wee, ED SIM Tech (2002-2005)

DEFINING THE FUTURE

SIMTech completes its first decade as a research institute at a significant point in Singapore’s industrial development. The challenges facing the manufacturing industry and hence SIMTech now drive the need to develop intellectual and human capital to create a high value manufacturing sector in an increasingly globalised economy.

To meet these challenges, SIMTech is reinventing itself. The Institute now calls itself the Singapore Institute of Manufacturing Technology. This reflects its national role in research on advanced manufacturing technology. It will grow competencies in manufacturing processes, enabling technologies and manufacturing information technology to ensure a steady stream of relevant emerging technologies for the Singapore industry.

As part of a family of research institutes in A*STAR, the Institute will draw upon opportunities for synergy and intellectual cross fertilisation. It will have access to the intellectual expertise and network of a Scientific Advisory Board. The Board consists of eminent research and technology leaders from USA, Europe and Japan, and will provide guidance on scientific directions and research programmes.

SIMTech will build upon its track record of reaching out to the industry, and of working with companies, big and small, in consortia or with specific organisations. We continue to partner multinationals such as Philips and HP in joint development efforts that serve to increase the value of Singapore manufacturing. We reach out to growing

10th Anniversary Commemorative Book 1993 to 2003

Lead PI Dr Javier Ibanez-Gusman led technology development for assisted and autonomous driving for the Singapore Armed Forces
From SIMTech to Renault

Dr Javier Ibanez-Gusman
SIMTech 1997-2005
Ulysses: A great adventure, thanks!

Purpose:
To develop a vehicle system capable of operating autonomously and remotely, day and night in natural environments. Develop local competencies.

Capabilities:
- Conversion of an APC, M113 into drive-by-wire
- Autonomous driving in natural environments, daylight
- Vehicle Following
- Tele-operation day and night

Partenaires:
- Singapore: NUS, NTU, ST-Kinetics
- International: University of Sydney
- Project Lead: SimTech – A*

Outcomes:
- Demonstrations: Singapore Armed Forces, DSTA, US-Army TARDEC, DGA-Thales France, German Army
- Several PhD thesis, post docs at local universities
- A spin-off
R&D Platforms: Saloon type Electric Vehicles

Features

- Modes: Unmanned, Manual
- Function: Valet Parking Service
- Capabilities: Tested up to 30 km/h, robotic platform architecture, can evolve in tight roads, etc.
- Particularity: Uses only automotive type sensors for all functions.
- Connectivity: Tracking by a control centre using WiFi or DSRC

Architecture has the genes in Ulysses
TRANSPORTATION ANALYSIS AND SIMULATION SYSTEM

Part of Travel Model Improvement Program (TMIP) sponsored by the U.S. Dept. of Transportation, Environmental Protection Agency and Department of Energy

- Underway since 1992 to remedy current model deficiencies
- Motivated by the Clean Air Act Amendments of 1990 and Intermodal Surface Transportation Efficiency Act of 1991
- Four tracks: Outreach, Near Term Improvements, Long Term Improvements (e.g. TRANSIMS), Data Collection
- Project objective is to develop new, integrated transportation and air quality forecasting procedures
- Models will be used to determine the effect of transportation improvements on congestion, air quality, and land development
- TRANSIMS creates a complete representation of individuals, their activities, and the transportation infrastructure
- Trips are planned to satisfy activities
- Simulates movements of travellers across network

In 2000 Los Alamos Collaborated with Singapore in Transport Simulation with Transfer of TRANSIMS
TRANSIM Software Modules

- Population Synthesizer
- Activity Generator
- Intermodal Route Planner
- Microsimulator
- Emissions Estimator
- Selector
- Output Visualizer

IHPC (Institute of High Performance Computing) & NUS Researchers and LTA Traffic Engineers Were All Excited About Implementing TRANSIM for Planning

Project Failed Why?

We Did Not Have the Data Needed by TRANSIM
Data Collection & Data Reduction & Data Analytics Needed
Unlike 2000 Singapore Will Have a Deluge of Data by 2030. Great Employment Prospects for Data Analysts

Smart Mobility 2030: Vision for the Future

“Moving towards a more connected and interactive land transport community”
URA Leveraging on Big Data Analytics in Planning

ePlanner introduced in 2012 to enable Integrated Urban Planning

One-stop geospatial planning analytics portal for planners
- multi-platform and device
- Make GIS/data analytics easy for everyone
“Virtual Singapore” ~ Tool of Urban System Engineers
A dynamic & very high resolution 3D city model and collaborative data platform with 3D maps

“We will capture the virtualized life of Singapore …
“We need to give the right data to the right people at the right level at the right time.”

George Loh
Director Programmes Directorate, NRF
Many Sources of Data, ERP, EZ-LINK & Bus Tracking

Many More Data Analysts Needed!
Smart Phones Will Enable Users to Determine Optimal Modes of Travel
FUTURE URBAN MOBILITY

A proposal to the Singapore- MIT Alliance for Research and Technology (SMART)
Professor Amedeo Odoni
October 3, 2009

MIT Schools of Architecture and Planning, Engineering and Management
Future City Laboratories Multi-agent Transport Simulation (MATSim) of Singapore

- The Singapore-ETH Centre for Global Environmental Sustainability (SEC) established in 2010 between ETH Zurich & National Research Foundation (NRF).

- Programmes of SEC
  - Future Cities Laboratory (FCL)
  - Future Resilient Systems (FRS).
20 Years of Capability Development in Urban Mobility Systems
From Test & Evaluation to Systems Engineering to Research & Development

- ERP
  - Turnkey Project
  - Project Demonstration, Test & Evaluation, Implementation & Deployment
  - Operations & Maintenance + Mid-life Upgrading
- ERP 2
  - System Architecting & System Engineering
  - Life Cycle Management
- Autonomous Vehicles
  - Research & Development & Demonstration
- Modelling & Simulation
- Data Analytics
- Future Urban Mobility + Future Cities
Tight Integration of People, Concepts, Technology & Systems Needed for Mobility 2030

Lew Yii Der, Group Director, Corporate Planning & Development Group leading the integration of Policy Planning, Research & Development and Corporation Transformation

Integration of R&D and Strategic Planning & Project Development
Realizing the Vision of Integrated Development

Marina South

Vision of a Car-Lite Singapore Will be Realized
Tribute to Dr Goh Keng Swee Who Created Systems Engineers at MINDEF in 1970

The only way to avoid failing is not to do anything. That will be the ultimate failure.

“DREAM
STOUT & CARING HEART
DO
DELIVER
DECIDE

Trusted with Authority and Resources to Plan Design & Implement Large Scale Systems

IN TAKING THE STRATEGIC PATH.

IN REMEMBRANCE OF THE STRATEGIC PATH.
More Urban Mobility Systems Engineers Wanted!

- Policy & Planning
- Research & Development
- Concept Development
- Demonstration & Deployment
- Operations & Maintenance & Upgrading.

- R&D needed to create technologies & systems
- Integration of dual-use defence technology into non-defence systems
- Life Cycle Management From Conception to Retirement
- Imagination + Daring + Action => Beyond World Class Mobility 2030

Thank You

WE ❤

2065 TREASURE CHEST of COLLECTIVE WISDOM
MANY SUCCESSFUL URBAN MOBILITY SYSTEMS