



Intelligent Transportation System for Smart City: Perspective of Research, Practice, and Asian Context



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About myself (Academics)



BEng (Honors) Civil Engineering
Associate Prof (2014 – current)



Associate Prof (2012-current)

Assistant Prof (2006-2012)



MSc (Distinction)

PhD

Senior Research Fellow (2002-2006)



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Visiting Fellow

About myself (Editorial)



Editor in Chief



Editor

Editorial board member



About myself (Prize)



About myself (Prize)

Congratulation to Dr. Agachai Sumalee for receiving the 2014 ASPIRE Prize from the APEC



Asia-Pacific Economic Cooperation



WILEY



About myself (Administrative)



Committee member (Road Safety Research)



Committee member (Network Modelling)

Committee on IT and Innovation



Board member HKSTS



Committee on Business Development



Committee on Land Development



Vice Chair & Committee on Railway System

Committee on Railway Engineering



Content

- Overview of ITS research
- Remarks on Asian-Oriented Research in ITS
- Remarks on Importance of Collaboration between Academics, Industries, and Policy Makers
- Case Study of Deployment of ITS Platform in Thailand: from research to practice



Smarter



ITS Taxonomy

Sensing Technology

- Fixed point sensor
- Probe sensor
- Crowd source sensor
- V2V, V2I

Application

- Traveler information
- Traffic management/control
- Pricing and Demand management
- Public transport
- Planning
- Vehicle control

Algorithm

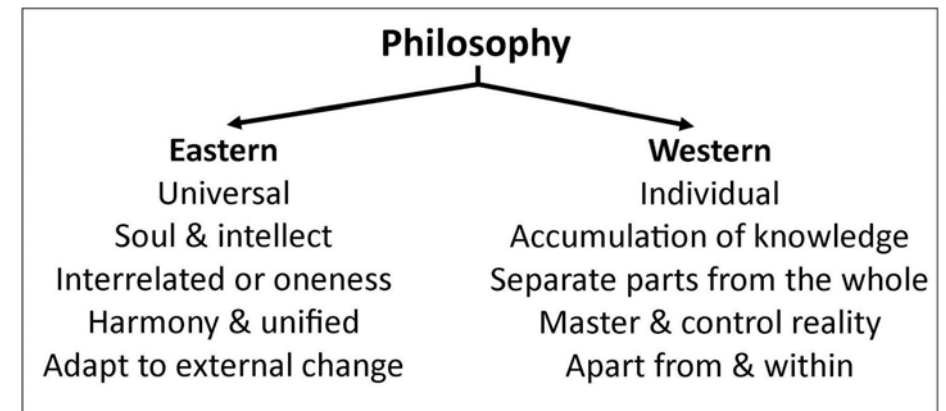
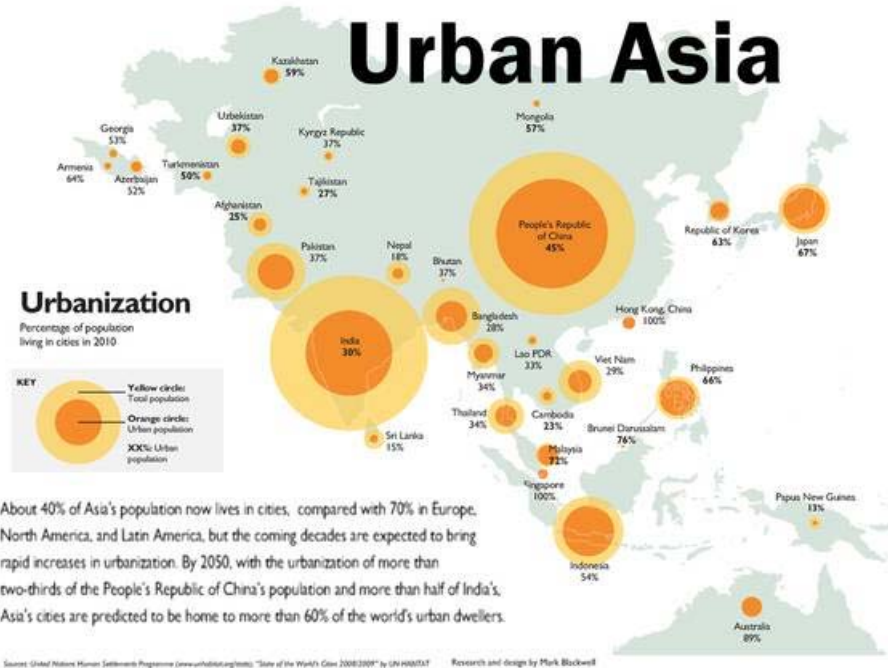
- Real-Time Estimation
- Real-Time Prediction
- Data Mining
- Data Fusion
- Data Inference
- Optimal/Feedback Control

Organization

- Government Initiative
- Private Initiative
- Public Private Partnership
- Social Network Driven

So What is the Asian Context of ITS Research?





Other Issues

- Organization structure
- Communication costs and readiness
- Technological oriented (not problem oriented)
- Lack of multidisciplinary development
- Unclear added value and market structure



Community



Taylor Made

Problem Oriented Knowledge Transfer

Cost Effective

Focus on Human



Crowd source data assimilation and mining for planning and information purpose





Need for Industrial, Academics, and Policy Collaboration

- ITS must be a part of Transport Policy package (thus policy maker must be involved)
- Taylor-made solution is the key (hence Academics and Industrial relationship will be advantage)
- Long-term operation will be crucial (therefore PPA will be critical)

Deployment of ITS Platform for Expressway Corridor in Bangkok



ITS-Corridor Project Information

Client: **Expressway Authority of Thailand**

Collaboration between: EXAT, PolyU, KMITL, ITS-Consultancy (Thailand)

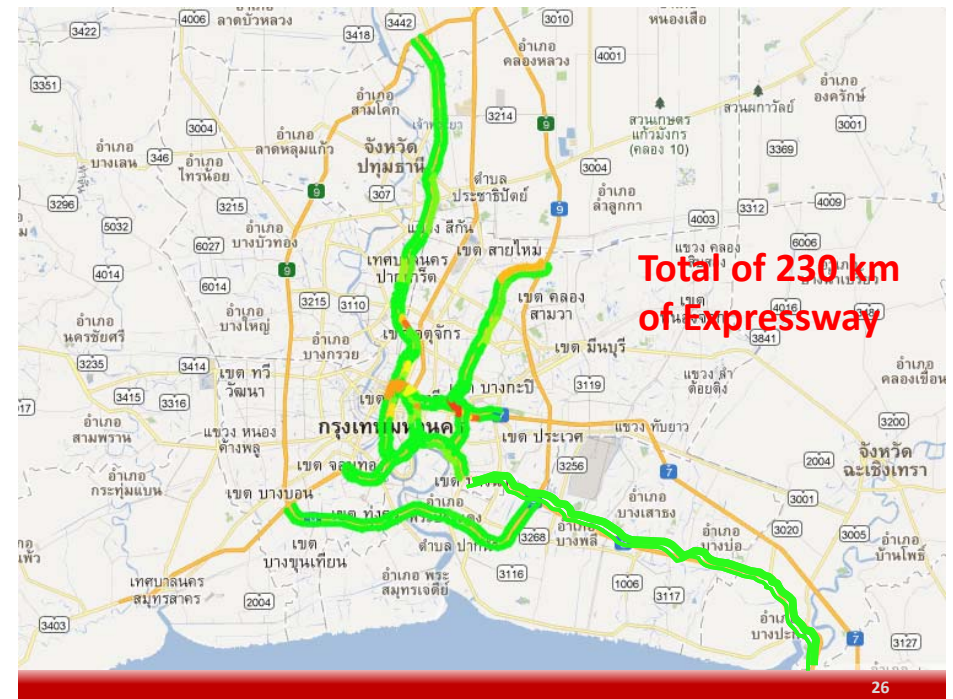
Contract Period:

Implementation: September 2012

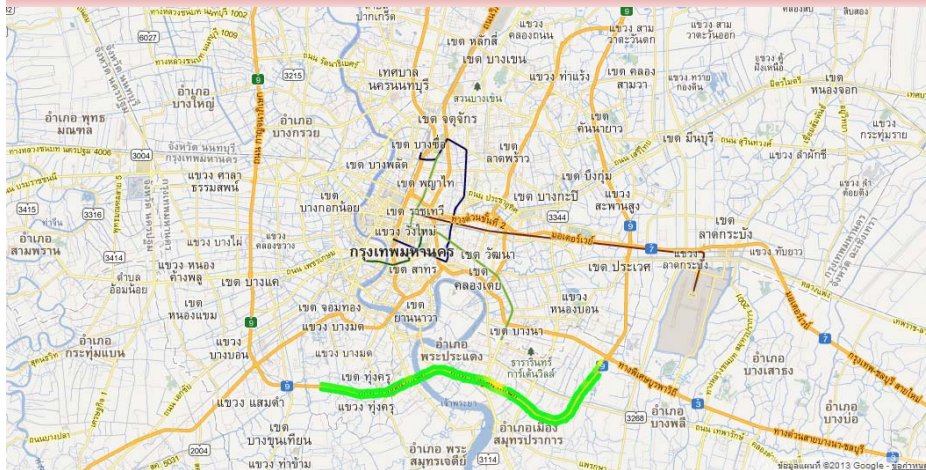
Launch of Service: **September 2013**

Defects Liability Period: 12 months

Operation & Maintenance: 3 years



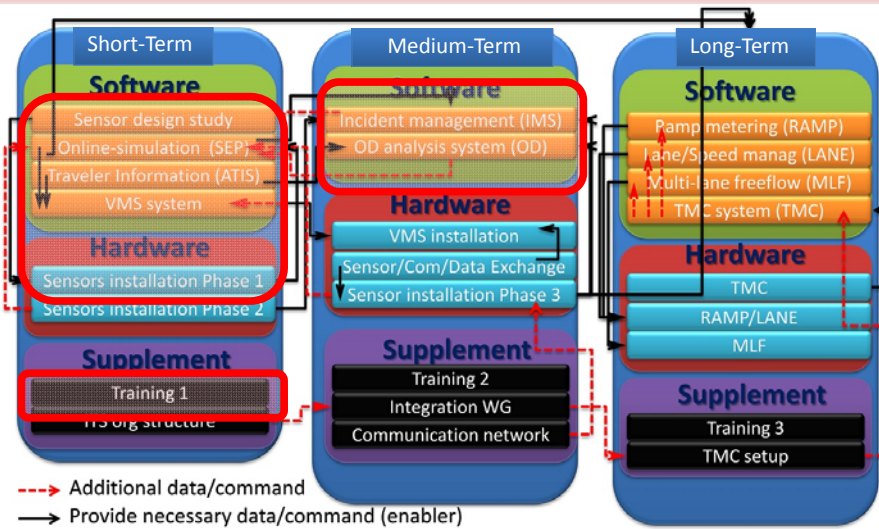
Kanchanapisek corridor



Current Traffic Condition

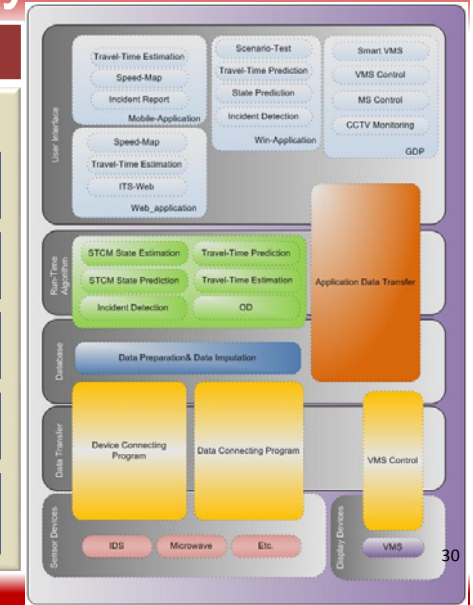
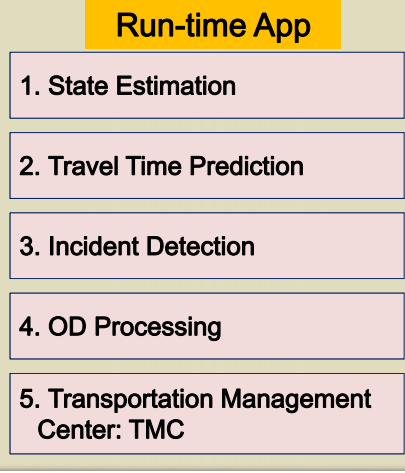


Master Plan

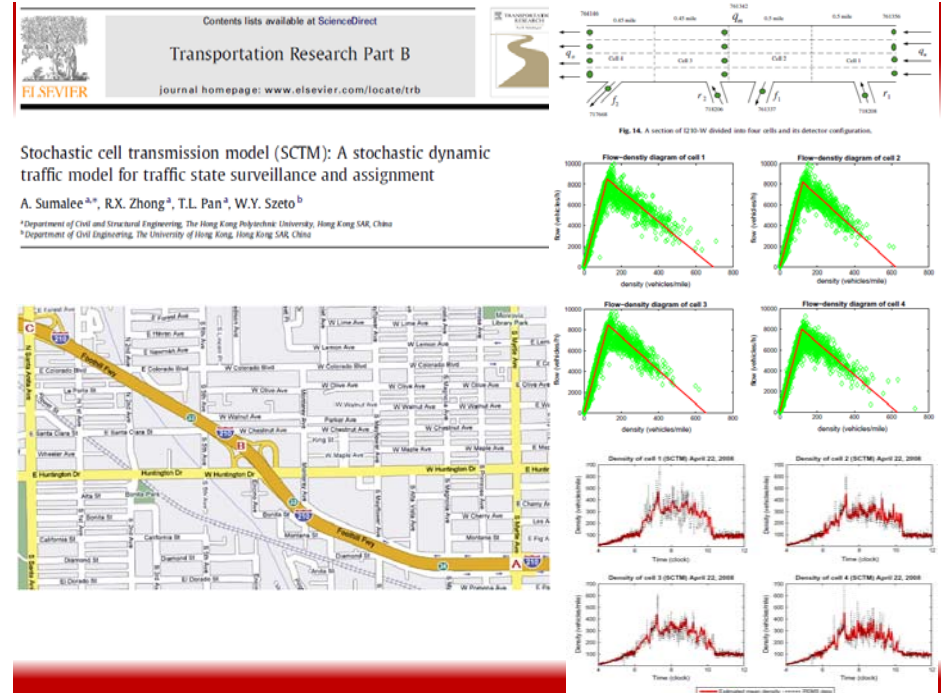


ITS System

System Architecture



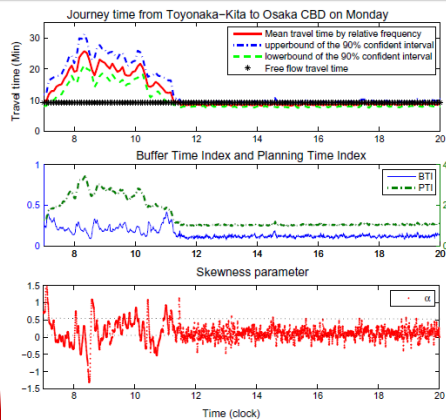
Real-time Stochastic State Estimation System (SCTM)



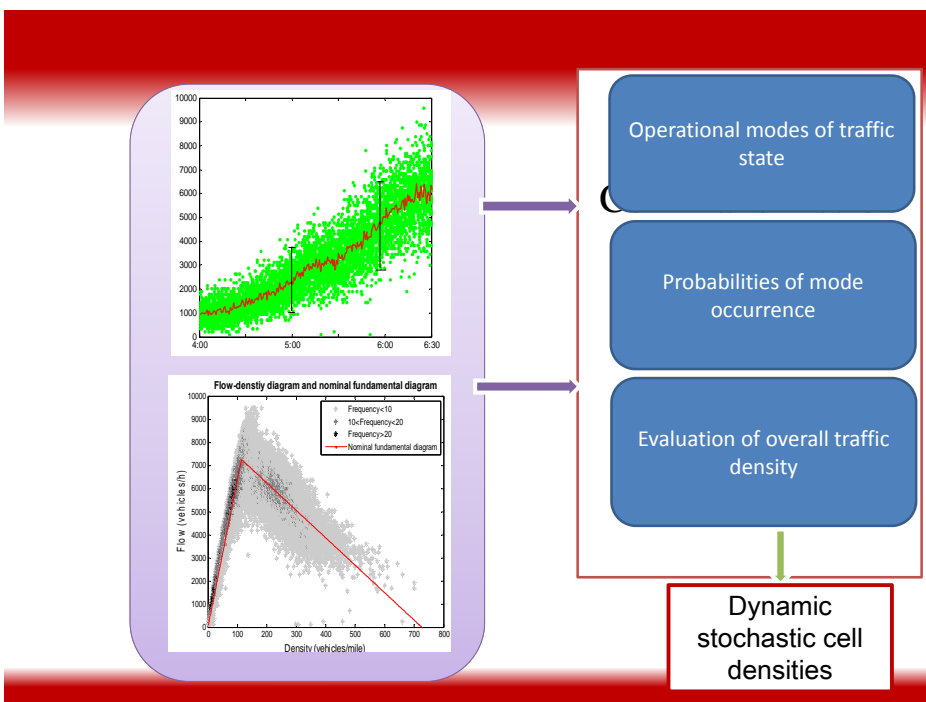
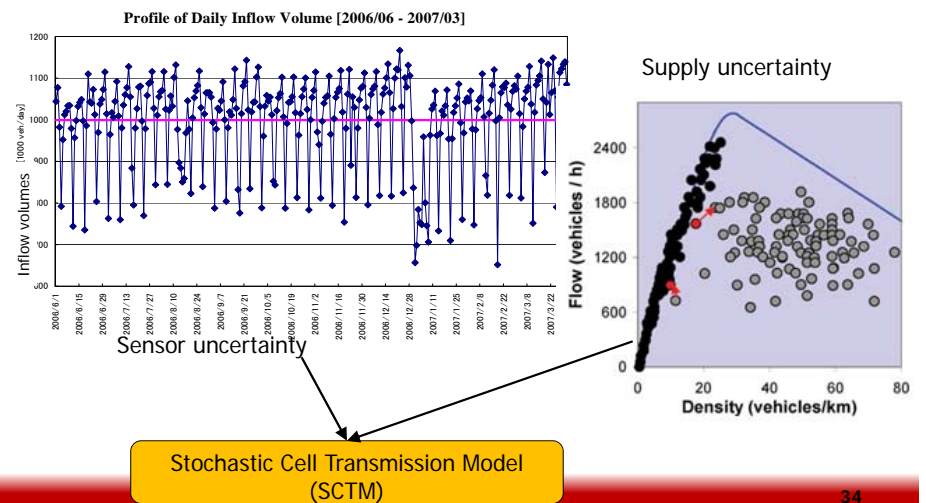
Dynamic stochastic journey time estimation and reliability analysis using stochastic cell transmission model: Algorithm and case studies

Agachai Sumalee^{a,*}, Tianlu Pan^a, Renxin Zhong^a, Nobuhiro Uno^b, Nakorn Indra-Payoong^c

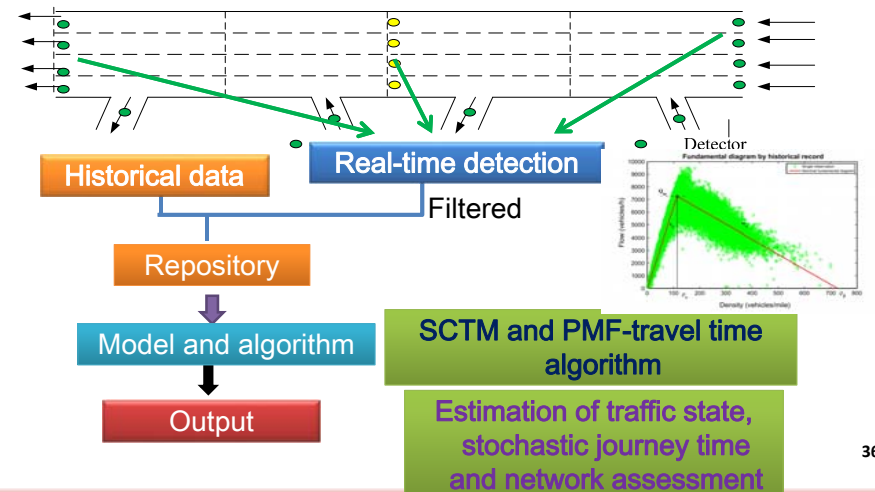
^aDepartment of Civil and Structural Engineering, The Hong Kong Polytechnic University, Hong Kong Special Administrative Region
^bGraduate School of Management, Department of Urban Management, Kyoto University, Kyoto, Japan
^cFaculty of Logistics, Kurayoshi University, Thailand



Highways normally operate under demand and supply uncertainties



Framework of SCTM



ITS System

1. Sensor Devices

2. Data Transfer

3. Data Base

4. Run-time Algorithm

5. User Interface

Devices

- IDS
- Microwave
- CCTV
- TAXI Data

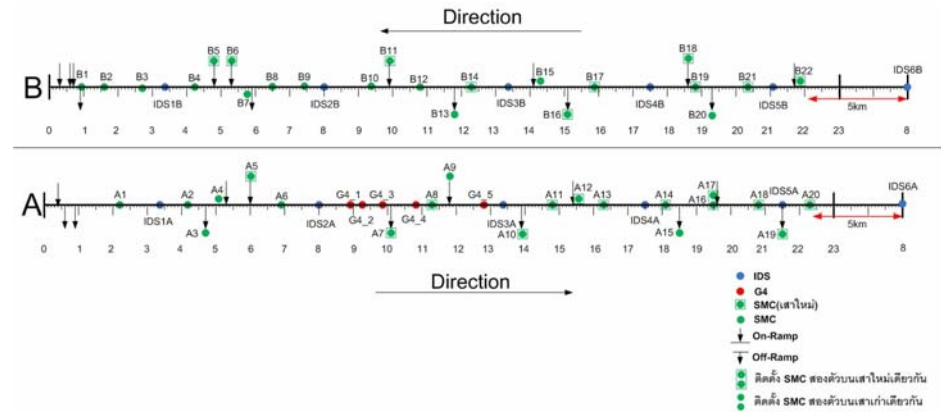
Display VMS or MS



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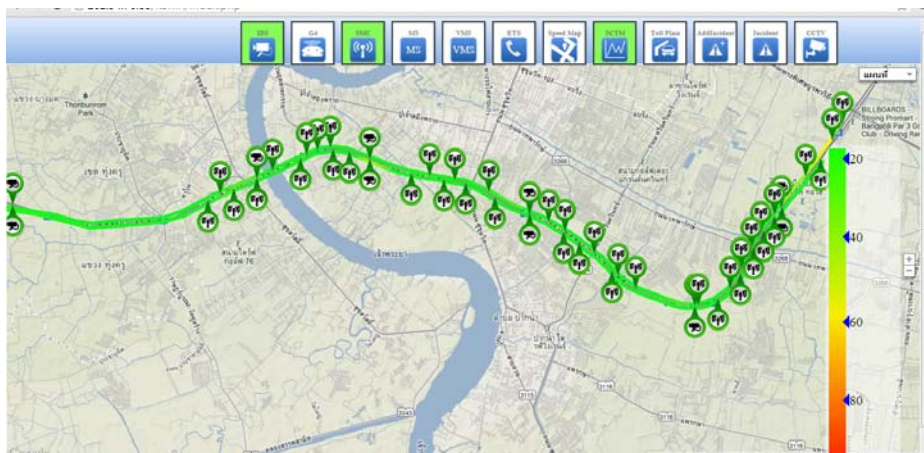
Deployment with ITS System

Sensor locations



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Sensor locations



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Sensor installation



Server setup



OD Server



SMC Front End & Gateway Server

Server at CCB6



ITS Gateway & ITS Database
ITS Center

ITS System

1. Sensor Devices

2. Data Transfer

3. Data Base

4. Run-time Algorithm

5. User Interface

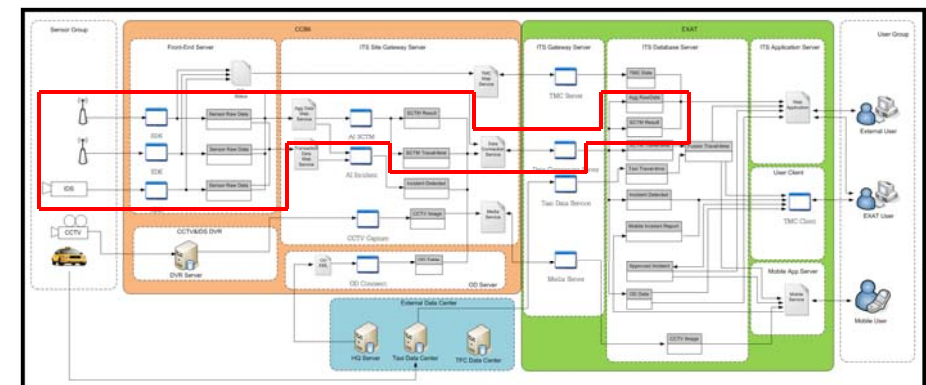
Database of ITS is on Microsoft SQL Server

- Data from Sensor
- Outputs from State Estimation, Travel Time Estimation, Incident Detection, etc.

- SCTM State Estimation
- Travel Time Prediction
- SCTM State Prediction
- Incident Detection
- Travel Time Estimation
- OD

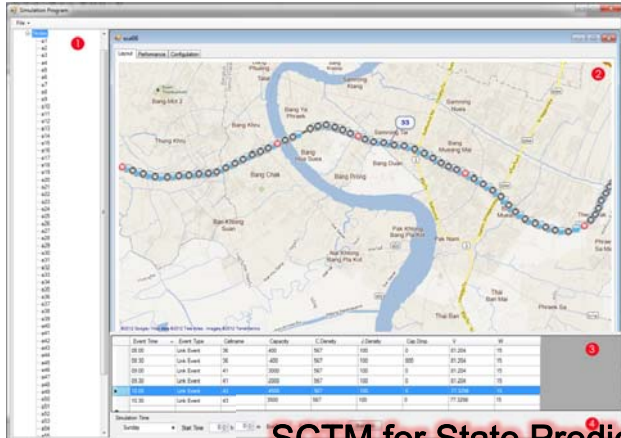
- via Web Application
- via Mobile Application
- via Window Application
- Application for TMC

State Estimation System



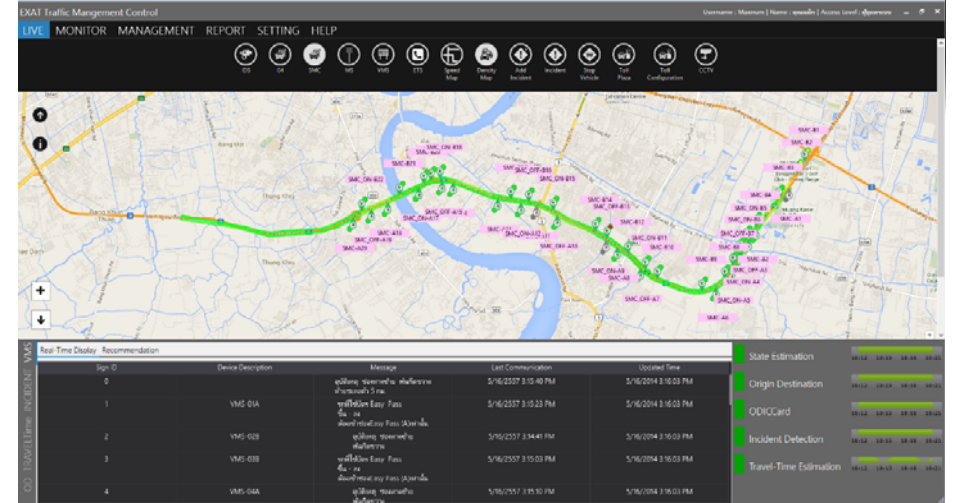
Run Time Algorithm of ITS System

Shape-File Input

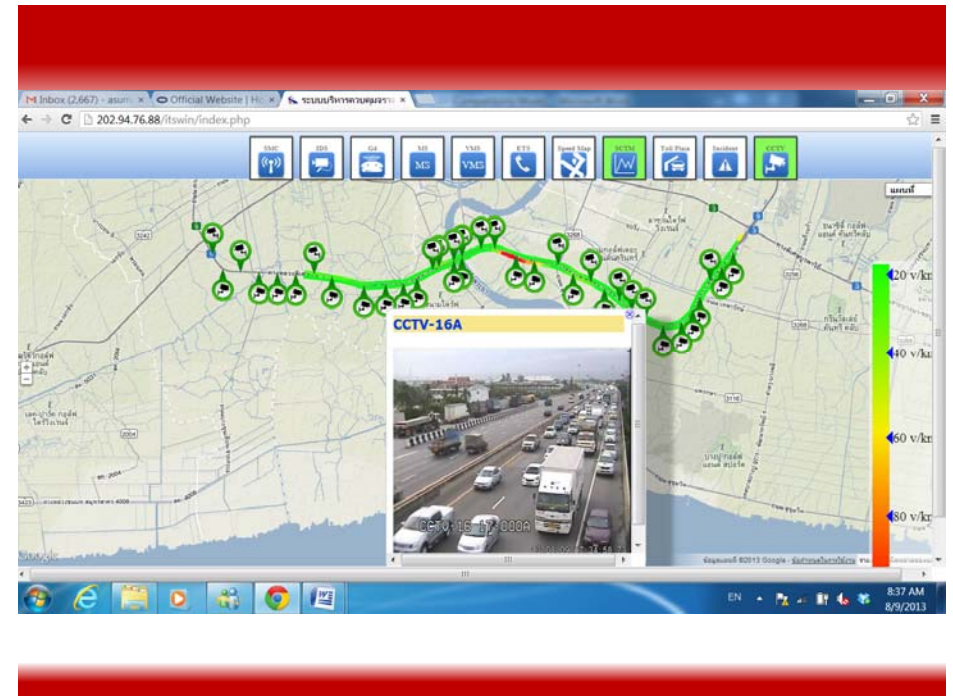
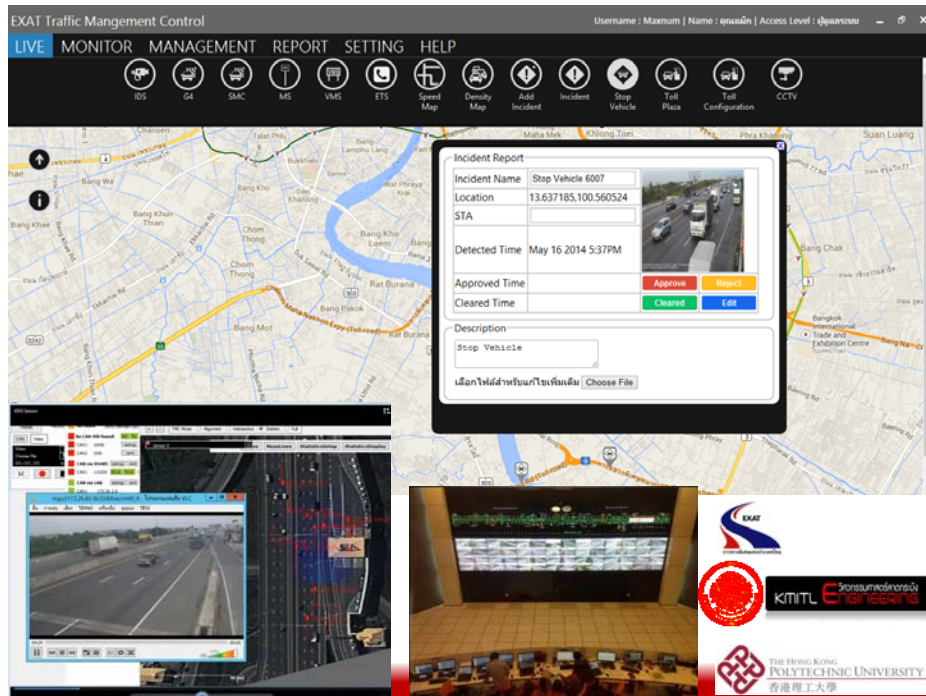


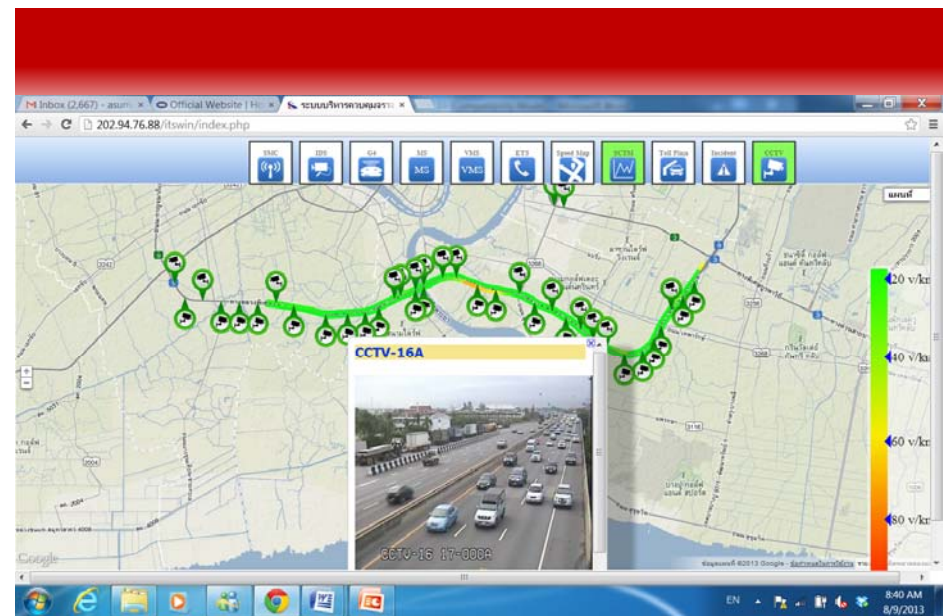
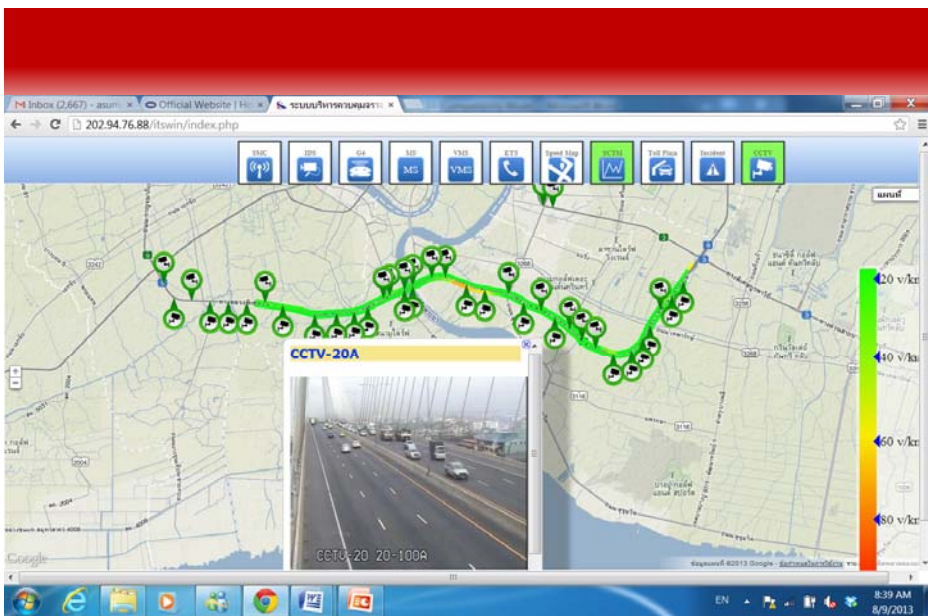
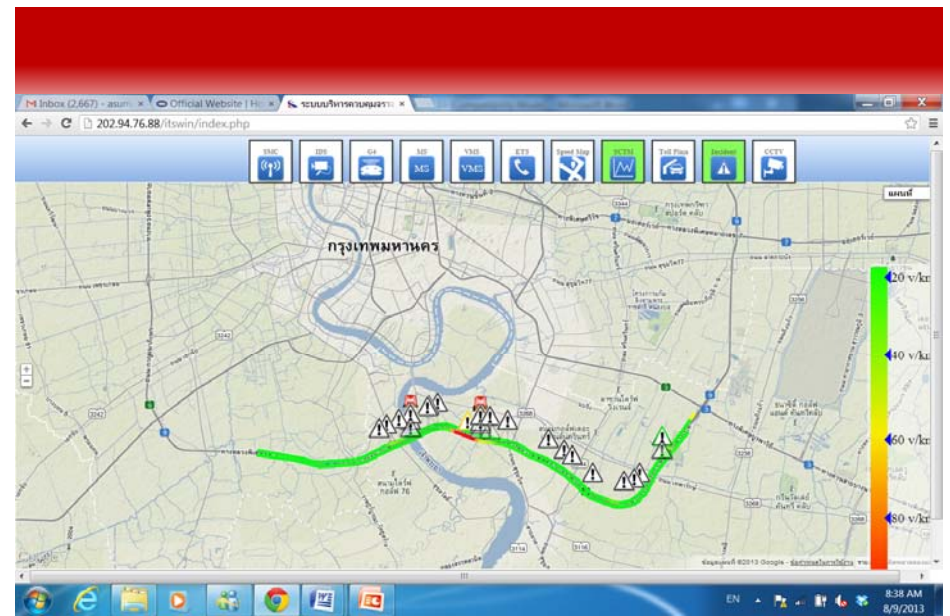
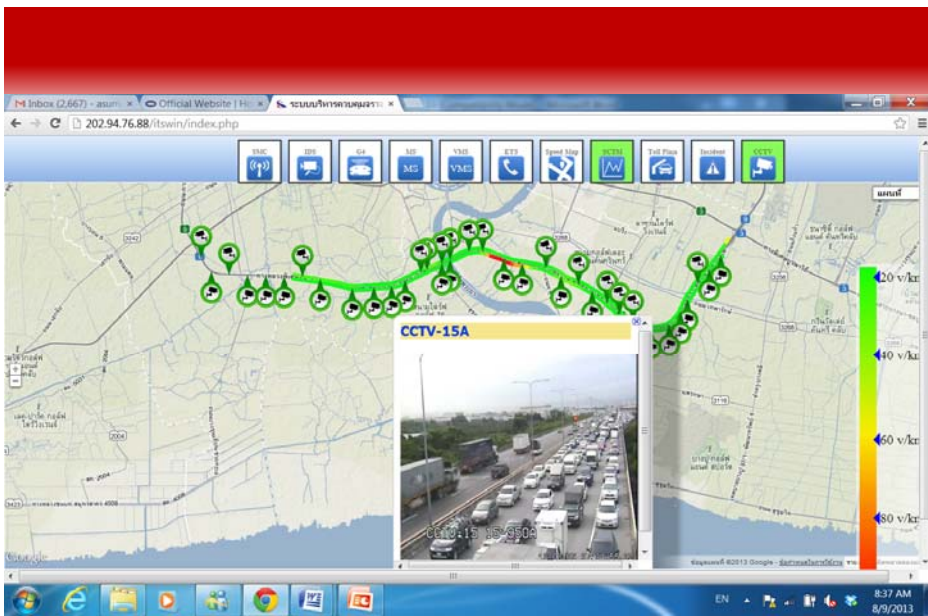
SCTM for State Prediction and Scenario Test

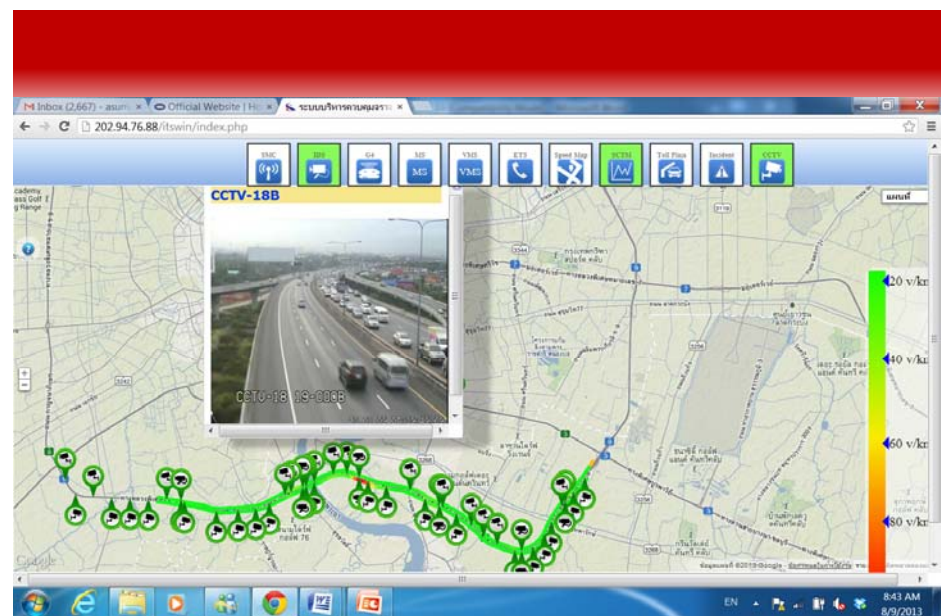
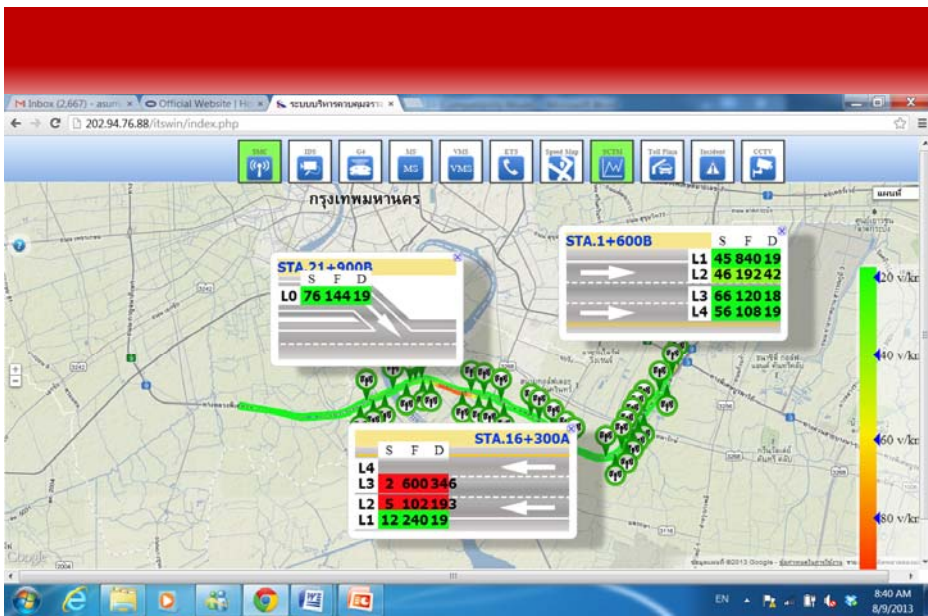
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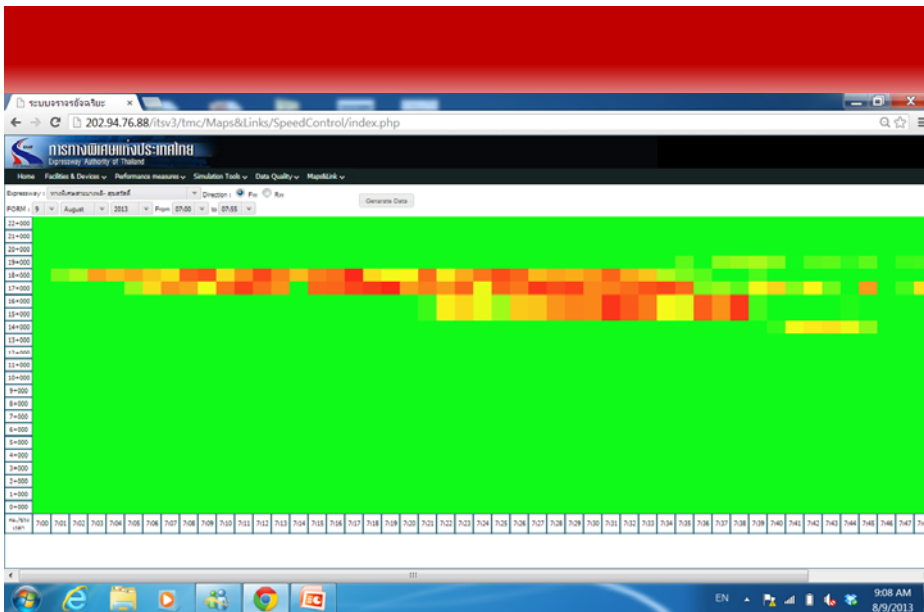
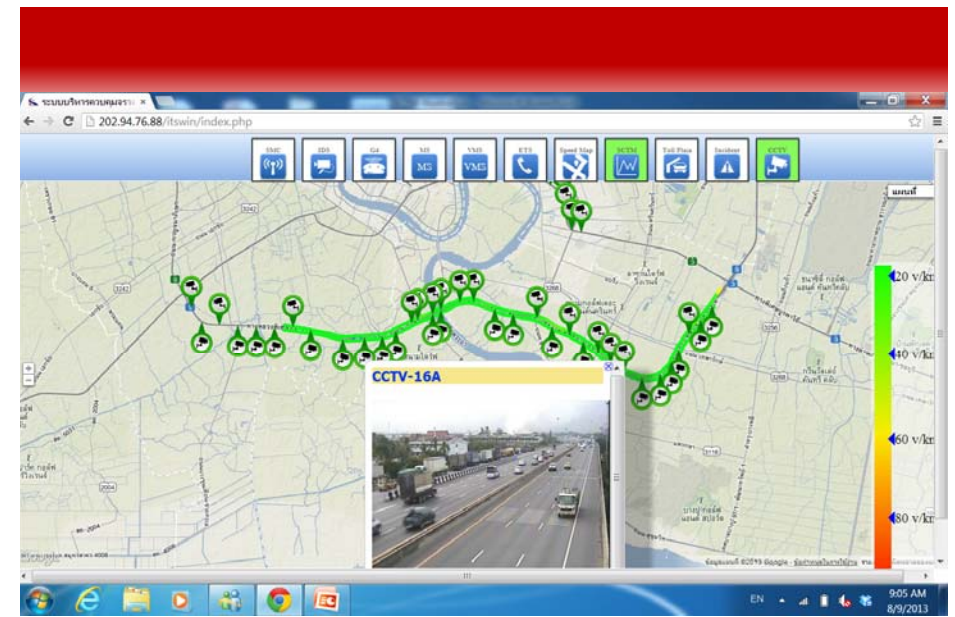
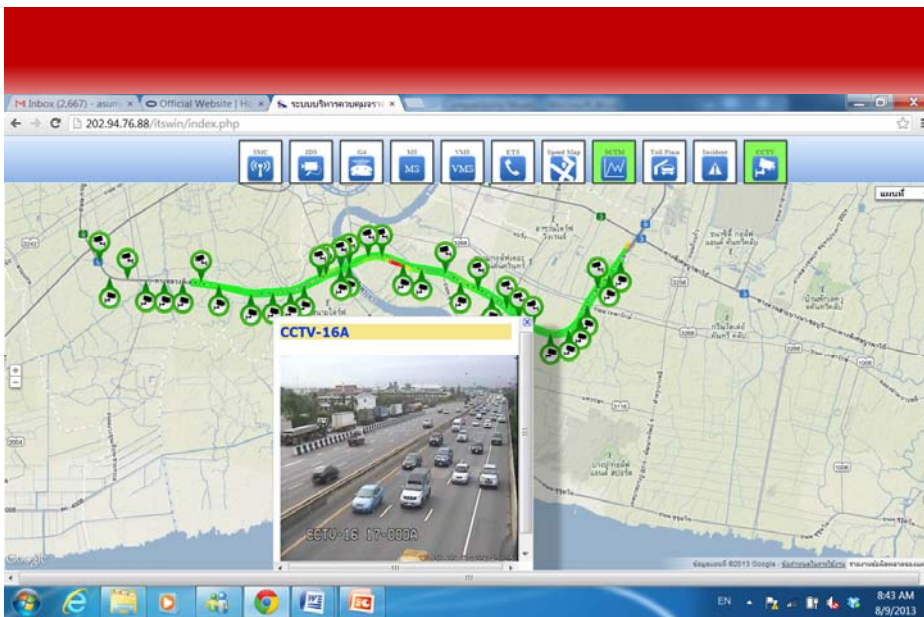


KMITL วิศวกรรมศาสตร์









Acceptance Test for State Estimation and Prediction System

- We compare the traffic density from the SCTM model and sensor. Tested in the same cell and the same time.
- The accuracy of the traffic density is to be compared according to the prescribed range. The density range is divided into 3 sections and the accuracy is compared by percentages (Accuracy %).

Density (veh/km/lane)	Range of density	
$d \leq 11$		1
$11 > d \leq 22$		2
$d > 22$		3

$$\text{Accuracy (\%)} = \frac{N_{\text{match}}}{N_{\text{total}}}$$

Level of Service	Density (passenger car/mile)	Traffic Flow Characteristics
A	≤ 11	Free flows operation, vehicles are almost completely unimpeded in their ability to maneuver within the traffic stream.
B	$> 11 - \leq 18$	Reasonably free flow, vehicles maneuver within the traffic stream is only slightly restricted.
C	$> 18 - \leq 26$	Freedom to maneuver within the traffic stream is noticeably restricted.
D	$> 26 - \leq 35$	Freedom to maneuver within the traffic stream is more noticeably limited, and the driver experiences reduced physical and psychological comfort level.
E	$> 35 - \leq 45$	Vehicles are closely spaced, leaving little room to maneuver within the traffic stream at speed that still exceed 49 mph.
F	> 45	Breakdowns in vehicular flow.

Source: Highway Capacity Manual (HCM), 2000

Sensor Sta.	Sensor ID	Sensor Density	SCTM Density	Range of density		Result
		(Veh/km/ln)	(Veh/km/ln)	Sensor	SCTM	
A1	6001	0	10.63	1	1	1
A2	6002	6.06	7.29	1	1	1
A6	6003	11.54	13.35	2	2	1
A8	6004	6.27	8.22	1	1	1
A11	6005	12.67	14.32	2	2	1
A13	6006	12.23	7.03	2	1	0
A14	6007	8.16	9.35	1	1	1
A16	6008	4.1	5.52	1	1	1
A18	6009	6.74	8.32	1	1	1
A20	6010	2.2	4	1	1	1
B1	6011	68.2	63.22	3	3	1
B2	6012	52.4	53.97	3	3	1
B3	6013	11.1	17.91	2	2	1
B4	6014	15.42	17.21	2	2	1
B7	6015	8.28	9.79	1	1	1
B8	6016	13.87	14.96	2	2	1
B9	6017	11.38	19.63	2	2	1
B10	6018	13.08	14.96	2	2	1
B12	6019	5.24	6.65	1	1	1
B14	6020	11.5	12.75	2	2	1
B17	6021	8.44	9.66	1	1	1
B19	6022	7.79	8.98	1	1	1
B21	6024	12.44	13.79	2	2	1
B22	6025	8.15	10.06	1	1	1

Examples of test results August 8, 2013 07:30 am.

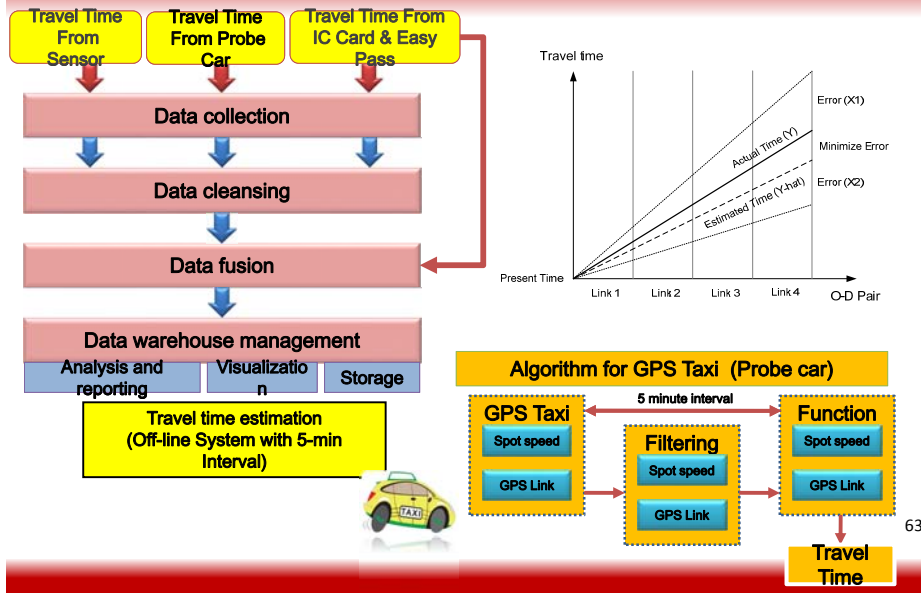
N total =24
N match=23
Accuracy=95.83 %

1. State Estimation and Prediction System (cont.)

Summary of test results
12 July to 14 August 2556

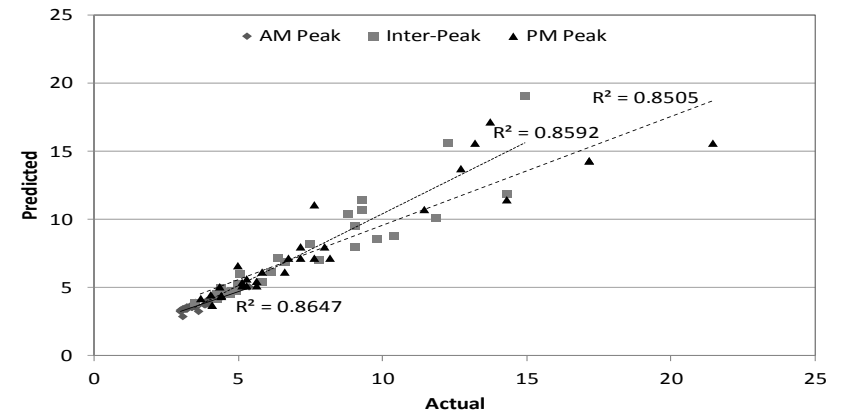
item	date	Ntotal	Nmatch	Accuracy %	item	date	Ntotal	Nmatch	Accuracy %
1	12/7/2013	24	22	91.67	18	29/7/2013	24	24	100
2	13/7/2013	24	22	91.67	19	30/7/2013	24	17	70.83
3	14/7/2013	24	24	100	20	31/7/2013	24	24	100
4	15/7/2013	24	22	91.67	21	1/8/2013	24	24	100
5	16/7/2013	24	21	87.5	22	2/8/2013	24	20	83.33
6	17/7/2013	24	22	91.67	23	3/8/2013	24	18	75
7	18/7/2013	24	19	79.17	24	4/8/2013	24	18	75
8	19/7/2013	24	24	100	25	5/8/2013	24	18	75
9	20/7/2013	24	23	95.83	26	6/8/2013	24	23	95.83
10	21/7/2013	24	22	91.67	27	7/8/2013	24	21	87.5
11	22/7/2013	24	23	95.83	28	8/8/2013	24	23	95.83
12	23/7/2013	24	21	87.5	29	9/8/2013	24	21	87.5
13	24/7/2013	24	19	79.17	30	10/8/2013	24	21	87.5
14	25/7/2013	24	17	70.83	31	11/8/2013	24	24	100
15	26/7/2013	24	23	95.83	32	12/8/2013	24	22	91.67
16	27/7/2013	24	24	100	33	13/8/2013	24	23	95.83
17	28/7/2013	24	24	100	34	14/8/2013	24	21	87.5
		Avg.	816	794	89.95				

Travel Time: Data Fusion



Acceptance Test: Travel Time Estimation and Prediction System

In the evaluation of the accuracy of the travel time estimation and prediction system. We have collected and compared the travel time data from the estimation and prediction system using the data from Easy Pass.



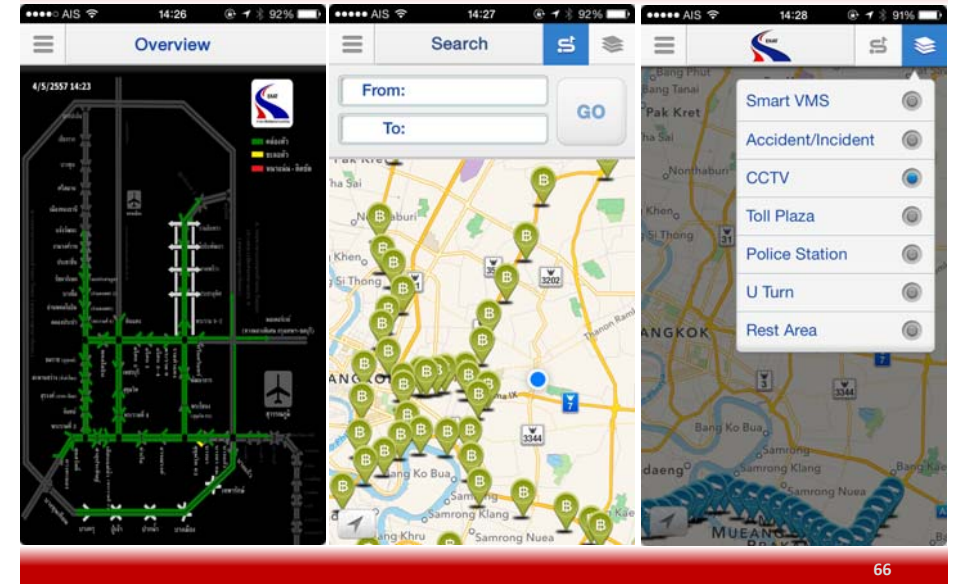
Acceptance Test: Travel Time Estimation and Prediction System (cont.)

Results from the Travel Time Estimation Model Collected from 11 July 2013 to 9 August 2013

Route	Diff	%MAPE	R ²
Bangkhunthian (11) - Bangkaew (64)	2.9	8.19	0.54
Bang Khru (21) - Thepharak (55)	1.76	14.92	0.28
Bang Khru (21) - Paknam (33)	1.04	19.64	0.34
Bangkaew (61) - Bangkaew (13)	2.97	8.39	0.54
Thepharak (51) - Bang Khru (22)	1.66	12.38	0.19
Bang Mueang (41) - Bang Khru (22)	1.16	18.92	0.12
Bangkhunthian (11) - Thepharak (53)	2.43	7.97	0.37
Bangkhunthian (11) - Bang Mueang (43)	2.57	10.29	0.56
Bangkhunthian (21) - Paknam (33)	3.14	15.25	0.46
Bangkaew (61) - Bang Mueang (44)	1.74	16.62	0.67
Bangkaew (61) - Paknam (35)	2.17	14.62	0.46
Bangkaew (61) - Bang Khru (22)	2.71	12.98	0.24
Avg	2.19	13.35	0.35

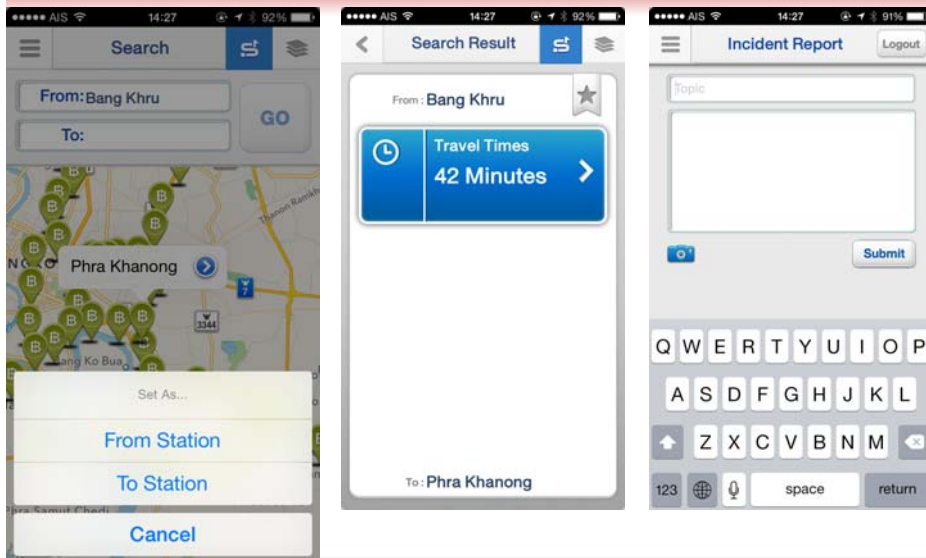
86.65%

Data Dissemination: Mobile App



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Data Dissemination: Mobile App



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Other implemented system

- Automatic Incident Detection
 - ◆ Congested case
 - ◆ Free-flow case
- Real-Time OD Estimation System
- Web Service for Data Exchange and Access



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Conclusions

- We have **perfectly transferred the R&D works** on SCTM and Travel Time Estimation to the real case
- The SCTM and Travel Time Estimation systems are proven to **work well under the validation data** and well received by users and travelers
- The overall ITS system is now **the backbone** of EXAT Traffic Control System
- **Further works** are to follow up the actions listed on the Master Plan

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Knowledge transfer
COLLABORATION
EXPERIMENT
IDEA
Industry

