Developing an Integrated Transportation Infrastructure Decision Support Platform:

Big & Open Data Visualization

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What is a Decision Support System (DSS)?

DSS is a computer-based system that supports decision-making; usually aimed at less well-structured and underspecified problems that upper level managers typically face.

DSS attempts to combine the use of models and analytical techniques with traditional or advanced data access; focuses on features which make them easy to use by non-expert people in an interactive mode.

Source: Sprague (1980)
Fundamental Components of a DSS

Database

Model

User Interface
Current State-of-the-Art

Existing transportation models/decision support systems are mostly disconnected.

There is no fully integrated *unifying tool* for planning, operations, and management analyses.

Current major focus is on integration of supply and demand models (e.g. ABM-DTA integration).

*Examples*: POLARIS, MATSim, CMAP ABM-DTA integrated model, etc.
Vision: *Full Integration*

A fully integrated system goes beyond supply and demand models only. It integrates with **real-time data**, take advantage of **big data** and existing **ICT technologies**, and provide a fully **connected modeling environment**.
Developing a fully integrated decision support platform
@ITS MONASH, Australia

Integrated understanding of multimodal traffic, land use, urban form, transportation planning needs, public health, safety, welfare, social interactions, demographics and communities.
What’s special about our DSS?

- Developing a unifying tool with operational, planning, and management applications in many areas.
- Offline/online **data integration**, communication with a **network of sensors**, and utilization of advanced **ICT technologies**.
- Applying advanced **vizualisation, optimization** and **computational techniques** to tackle issues of tomorrow’s transportation systems.
- The goal is to assist in better management of complex integrated transportation and urban infrastructure systems in **Victoria, Australia** (as a starting point).
Schematic Illustration of our DSS

- Multimodal Transport Infrastructure Planning, Simulation, and Modelling Core
- Big Data Analytics
  - Machine Learning
  - Cloud & High Performance Computing
- Data Fusion & Integration
  - Offline/Online Data
  - Real-Time Sensor Network Data
  - Crowd-sourced Citizen Generated Data
  - Demographic data
  - Socio-Economic data
  - Census data
  - Road network data
  - Public transport data
  - Rail network data
  - Freight data
  - Land-use data
  - Crash data
  - Weather data
  - Bridge condition data
  - Pavement data
  - Traffic data
  - etc.

- Advanced Programming Interface (API)
  - ICT-enhanced Pavement Management and Optimisation Model,
  - Advanced Network Safety and Public Health Model,
  - Road Space Management and Optimisation Model,
  - Transport Network Resilience and Disaster Model, and etc.

- Web-based Interactive Visualisation
- Immersive Visualisation (CAVE)

Evaluation of current condition and prediction of future status of transport infrastructure system.

- Evidence-based policy making,
- What if scenario analysis,
- Economic impact,
- Environmental impact, and etc.
Real-Time Sensor Network Data
Bushfire is a big issue in Australia.

Australian National Bushfire Monitoring System

A network of sensors (for fire detection) are developed to collect and transmit data to the platform wirelessly.
Crowd-Sourced Data
Mobile App: “Victoria Connect”

- We’ve developed a mobile app which allows citizens to report various types of “usually un-reported” data.
- Crowd-sourced data are combined with authoritative data.
- Integrated data are visualized and shared publicly with citizens.
- Integrated data are used in optimizing transportation network operations and planning.
Cloud Data Integration

- Developing an online integrated database in a government-funded cloud (NECTAR). *(ongoing)*
- Developing online visualizations, accessing data from the cloud in real-time. *(ongoing)*
- Cloud computing. *(future)*
How does our database look like now?

No user interface yet.
We’re working on the back end.
Network Simulation and Modeling Core

- Developing a multimodal DTA model of Melbourne metropolitan area. (ongoing)
- Auto-calibration using various traffic counts and travel time data sources. (ongoing)
- Dynamic OD estimation. (ongoing)
- Integration with an ABM. (future)
Connected Modeling Environment

- Crash frequency prediction (ongoing)
- Network reliability and resilience; critical link identification (ongoing)
- Land use model (future)
- Public health model (future)
- and many more …

Advanced Programming Interface (API)
- ICT-enhanced Pavement Management and Optimisation Model,
- Advanced Network Safety and Public Health Model,
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Interactive Visualization

Web-based Interactive Visualisation
Visualizing Population Growth
Visualizing Ethnicity Distribution

Interested to see how Chicago and Washington D.C. look like?

**Washington D.C.**  [http://4.bp.blogspot.com/-_6KwMlIWucI/U8CEx39ydAI/AAAAAAAAl3U/MDUydp7Zk1g/s1600/DC.png](http://4.bp.blogspot.com/-_6KwMlIWucI/U8CEx39ydAI/AAAAAAAAl3U/MDUydp7Zk1g/s1600/DC.png)

**Chicago**  [http://www.wired.com/images_blogs/design/2013/08/chicago.jpg](http://www.wired.com/images_blogs/design/2013/08/chicago.jpg)
Visualizing Age Distribution
Visualizing Bicycles Crashes
Visualizing Housing Density
3D Immersive Visualization

Immersive Visualisation (CAVE)
What do we get out of the DSS?

Evaluation of **current condition** and prediction of **future status** of transport infrastructure system:

- Evidence-based policy making
- What if scenario analysis
- Economic impact
- Environmental impact, etc.
A second look at the bigger picture

Multimodal Transport Infrastructure Planning, Simulation, and Modelling Core

Data Fusion & Integration Offline/Online Data
- Demographic data
- Socio-Economic data
- Census data
- Road network data
- Public transport data
- Rail network data
- Freight data
- Land-use data
- Crash data
- Weather data
- Bridge condition data
- Pavement data
- Traffic data
- etc.

Real-Time Sensor Network Data
Crowd-sourced Citizen Generated Data

Big Data Analytics Machine Learning Cloud & High Performance Computing

Advanced Programming Interface (API)
- ICT-enhanced Pavement Management and Optimisation Model
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Web-based Interactive Visualisation

Immersive Visualisation (CAVE)

Evaluation of current condition and prediction of future status of transport infrastructure system.
- Evidence-based policy making,
- What if scenario analysis,
- Economic impact,
- Environmental impact, and etc.
Where we are today?

We’ve already developed the backbone of the DSS.

- **Wireless fire detection sensors** are developed and tested.
- **Mobile app** is developed and tested.
- **Cloud** instance is set up. We’re developing the database.
- **DTA model** of Melbourne is being developed.
- A few data **visualizations** are developed. More are coming.
- The network display at **CAVE2** is set up.
QUESTIONS

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