Monash–CityLink–West Gate Upgrade
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Active Traffic Management – A Case Study from the UK
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The importance of M1

The importance of the M1 route:
- A heavily trafficked and economically important transport connection
- Carries up to 160,000 veh/day, incl. 18-20,000 trucks
- Services freight, business & private travel within and across Melbourne
- A key freight link between the port and industrial areas, east & west of the city

The M1 Story

Traffic operating characteristics for M1 includes:
- Congestion or flow breakdown which occurs regularly during peak periods when demand is greatest, leading to:
  - Underutilisation of the freeway
  - Reduced level of service
  - Longer and less reliable travel times
  - Greater risk of incidents, reduced safety

Changes in traffic characteristics

Changes in traffic characteristics
Causes of Congestion

- High demand during commuter peak periods
- High levels of weaving and merging movements
- High demand during planned events such as football exit phase or roadworks
- Unplanned events such as incidents, crashes
- Bottlenecks caused by geometric design of road alignment

M1 upgrade project was developed to address these issues through a combination of civil and FMS improvement works

Monash-CityLink-West Gate Upgrade (M1)

- Project Completion 2010
- 160,000 vehicles every day
- Congestion = 30% reduction in freeway performance
- Reduce crashes by up to 20%
- Community benefits = $14.5 billion
Managed Freeways

- A Freeway Management System consists of:
  - In-field ITS devices (VMS, CCTV, data stations)
  - Communications System (fibre optic, routers)
  - Control System (software, computer hardware)

- This FMS will initially operate over 75km of the M1 however will be expandable to other freeways across the state.
- Will improve how we manage traffic and allow better utilisation of road assets.
- Eventually all existing ITS field devices will be migrated onto the FMS.

The Tools

- Good Design!
- Co-ordinated Ramp Metering System
  - To tackle congestion
    - Smoother flow
    - Increased throughput
    - Reduced bottle-necks
- Lane Use Management System
  - To manage incidents
    - Safe incident site management
    - Speedy recovery

Tackling Congestion - Design

- Lane Drops after exits create turbulence and induce flow breakdown
  - using Dedicated or Exclusive exit lanes
- Double Lane Exits - not double the capacity
  - using of Ghost Islands / Tiger Tails or 2 exclusive lanes (major fork) treatments
- Sections with high weaving/merging/diverging activity induce flow breakdown
  - using collector distributor lanes and separated carriageways

Upgraded conditions
Tackling Congestion – Freeway Ramp Signals

- It regulates freeway traffic by matching and balancing variations in demand at adjacent ramps along a route in order to:
  - maximise the throughput of the freeway
  - reduce the likelihood of bottlenecks forming
  - automatically respond to flow breakdown caused by unplanned incidents
  - facilitates faster recovery of flows after an incident; and
  - minimises impacts on arterial roads

Fundamental Diagrams

Flow vs Occupancy - Critical Bottleneck

Unmanaged Freeway - Flow Breakdown
- Reduced throughput
- Reduced speed
- Congestion
- Lost productivity

Managed Freeway with Coordinated Ramp Signals
- Prevents flow breakdown
- Maintains optimum throughput & speed
- Automates flow recovery

Incident Management

- Principles of incident management are:
  - Detection & Verification (visual)
  - Response (emergency access, shoulder)
  - Site management (lane closures, safe speeds)
  - Recovery (traveller information)

Incident Mgt – Detection & Verification

- Freeway Data Stations (FDS) are primarily used to provide input to ramp control and speed limit systems
- Can also be used to automatically detect changes in traffic patterns
- Good coverage is required to achieve greatest benefits, preferably not greater than 500m spacing

- Pan-Tilt-Zoom (PTZ) CCTV cameras are used to view & verify incidents prior to sending response resources

Incident Mgt – Lane Use Management System

- Improved management of traffic along the corridor
- Improved safety for road users
- Improved safety and operation during maintenance and emergency situations
- Provide a consistent road user experience (i.e. look and feel) along the corridor
- Improved coordination between CityLink and VicRoads
- Reduced recovery time following a traffic incident
DISCUSSION

Preferred Option based on speed limit

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<th>Option</th>
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<tbody>
<tr>
<td>Option A</td>
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<tr>
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Reasons given:
- Opt A&D – drivers are used to looking for speed signs at side of road
- Opt B – positive indication of lane status, used to speed signs on either side of carriageway
- Opt BMC – all info in line of sight, easier to see above

LUMS display

- A LUMS sign integrates a variable speed limit and lane control sign into one
- LUMS signs are mounted overhead on gantries to control each lane of a carriageway
- Freeway speed environment determines size of sign:
  - For <90km/h, use Type B size
  - For >=90km/h, use Type C size
- Operational uptime and maintenance of LUMS signs is very important. Non display can impact road safety, traffic flow, enforcement and reputation
LUMS display

LUMS signs must display:
- Any numeral up to 110 in increments of 10 within a red annulus
- A red cross
- Diagonal arrows (left, right, both directions)
- Downwards pointing arrow

Incident Mgt – Lane Use Management System

- LUMS is used to manage the incident site, assist emergency services response and improve incident recovery times
- LUMS signs will allow us to close affected lanes and apply safe speed environment on approach and through the incident site
- LUMS can create an access lane for emergency service vehicles if shoulders cannot feasibly be provided

Spacing between LUMS signs:
- Uncomplicated freeways with good sight distance, use 30-60 secs travel time between signs
- Complex freeways environments with many horizontal or vertical curves, use 30-45 secs
- Maximum spacing should be no greater than 1000 m
- Minimum spacing of 200 m should be adopted between LUMS and other signs such as static directional or VMS
- Where geometric constraints exist, VMS or simple static signs may be mounted on a LUMS gantry

Siting Principles

For uncomplicated freeway with a higher operating speed environment, adopting a maximum spacing of 1000 m is suitable for 60-100 km/h (30-60 secs travel time)

For complicated freeway with a lower operating speed environment, adopting a 500 m spacing is suitable for 50-80 km/h (30-45 secs)
Legislative Consideration

- Electronic Enforcement of LUMS signs
  - Amendments to General Regulations
  - Draft General Regulations out now
  - Revised Regs likely to come into force in Nov 09

- Effect of Road Rules on operation of LUMS
  - Amendments to Road Rules
  - Draft Road Rules out now

Incident Mgt – Variable Message Signs

- Provides en-route traveller information
- Generally located in advance of exit ramps leading to the freeway's alternate arterial road route
- Generally located on approach to a LUMS environment to support lane closures or reduced speed limits
- National practice for display to consist of 3 lines of 18 characters
- M1 VMS will also include a pictogram display
Thank You
Active Traffic Management
A case study from the UK

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Topics for Discussion

Introduction to ATM
• What is it and how does it work?
• Examples of schemes
• Benefits of ATM
• What is the future?

Case Study: M4 Controlled Motorway
• Why use micro-simulation modelling?
• ATM model set up & operation
• Difficulties encountered & lessons learned

What is Active Traffic Management?

Variable Message Signs (VMS) control the flow of vehicles on motorways. ATM can be used to vary the methods of control.

Aims
• Reducing congestion.
• Smoothing the flow of traffic.

Operation
• Variable speed limits and queue protection (controlled motorway).
• Use of the hard shoulder. Operational during times of peak congestion.

How does ATM Work?

Motorway Sign (VMS)

Examples of Schemes

M25 Controlled Motorway
• Variable speed limit & incident detection control system operational on western section since 1995.
• Road widening & upgrade to controlled motorway technology J12 - J15 in 2005.
• Triggered by increasing traffic / detection of incidents/queues by preset thresholds.
• Difficulties implementing enforcement scheme.
• Further immediate work planned.
ATM on the M42

- First UK scheme involving controlled motorway and use of hard shoulder.
- Between junctions 3A and 7.
- Opened September 2006.
- 2 main operation regimes:
  - 3 Lane Variable Mandatory Speed Limits
  - 4 Lane Variable Mandatory Speed Limits
- Proven very successful.

Benefits of ATM

- Increased highway capacity
- Reduced congestion
- Reduced journey times
- Increased journey time reliability
- Reduced impact of accidents/incidents
- Reduced emissions
- Reduced fuel consumption
- Increased information for the driver
- Maintaining current safety levels
- Reduced driver stress.

What is the Future for ATM Schemes?

DfT Feasibility Report 2008

- Successful alternative to road widening schemes.
- Identifies additional stretches of motorway across England that could benefit from active traffic management-type technology.
- Work is now underway to develop proposals for these locations, including:
  - Birmingham Box and M62.
- Induced traffic effects diminish environmental benefits medium to longer term.

M4 Controlled Motorway

- Junctions 24 - 28 near Newport, South Wales.
- Section of old & substandard motorway.
- Suffers severe congestion & poor safety record.
- Potential to upgrade existing MIDAS system.
- Variable speed limits & queue protection.
- Not using hard shoulder running due to tunnelling limitations.
- Traffic modelling of controlled motorway.
- S-Paramics Micro-Simulation software used with additional ATM Module.

Why Micro-Simulation?

- Model individual vehicles start to finish.
- Disaggregated detailed traffic flow & detailed stats.
- Realistic representation of actual driver behaviour:
  - Lane changing and overtaking
  - Network performance such as blocking back at junctions.
- Only modelling tools available with the capability to realistically examine certain complex traffic issues such as:
  - ATM, closely-linked traffic signals etc.
- Powerful animations show individual vehicles traversing networks including:
  - Number of road categories
  - Junction types.

Setting up the ATM Module

- ATM controller is a software application that links to an S-Paramics simulation to control VMS in the simulation.
- Additional license required.
- The ATM Controller detects queuing in the simulation model and automatically acts to set the signs to reduce it.
- Simulates incidents in the model & sets signs using the MIDAS protocol.
- Combination, of ATM controller and S-Paramics, allows the investigation of the effects of different ATM control strategies.
Analysis of ATM Results

Numerical Comparison of Traffic Flows / Journey Times
- Compare base / forecast / ATM / emergency response scenarios.

Economic Assessment
- Compare base / forecast / ATM / emergency response scenarios.

Journey Time Reliability
- In UK no current guidance.
- Guidance expected to be released this year.

Video clips
- Preferable to running a model live, helps non-technical stakeholders/public to understand scheme operation.

MTV Flow Breakdown Plots

- Traffic analysis tool allows identification of areas that have recurrent congestion.
- Enables the development of new strategies and solutions.

MTV Plots Extracted from Paramics ATM Model
- Comparison with base / forecast / ATM scenarios.

- Understanding the MTV Plot
  - Time in hours on the horizontal axis.
  - Junctions (distance) marked on the vertical axis.
  - The background colour, black to white, represents traffic speed:
    o Slow speeds are in white, fast speeds are in black.

Difficulties Encountered

Aggression & Awareness
- Drivers in the model illustrate a range of aggression and awareness levels:
  - Difficult to replicate extreme driver behaviour such as near misses / incidents.

Paramics ‘Timetests’
- Calculations and decisions made for each vehicle in the simulation.
  - Default is twice per second – these are called ‘timetests’.
  - Following advice from SIAS a non-default time step of 3 was adopted due to the high speed motorway application represented in the model.

Coding of Paramics ‘Ramps’ (on-slips)
- The mainline link immediately approaching the merge point requires very careful planning and location in the Paramics model.

Summary

- ATM / Controlled Motorways have been successfully implemented on the M25 and M42.
- M42 Post Implementation studies suggest considerable benefits to ATM.
- Shift in Govt policy in England to develop ATM as alternative to conventional road widening schemes.
- Work underway to identify additional stretches of motorway.
- ATM / Controlled Motorways can be modelled effectively.
- Allows testing and refinements to be made to the design prior to implementation.

Thanx

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