



Austroads

Best Practice in Smart Motorways Operations

Guideline AP-G99-22



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Best Practice in Smart Motorways Operations

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Abstract

The *Best Practice in Smart Motorways Operations* report provides transport agencies with a set of guidelines and supporting information for motorway integration, operations and management capabilities.

The document serves to promote best practice, centred around capabilities in:

1. Integration planning and transition to operations of new motorways and enhanced motorways.
2. Operation of existing motorways.
3. Motorway management (which includes infrastructure planning, operational planning and operations) and resource capability planning.

Keywords

Smart motorways management, smart transport technology, smart motorways capabilities, smart motorways integration, smart motorways operations.

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This report has been prepared for Austrorads as part of its work to promote improved Australian and New Zealand transport outcomes by providing expert technical input on road and road transport issues.

Individual road agencies will determine their response to this Guide following consideration of their legislative or administrative arrangements, available funding, as well as local circumstances and priorities.

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About Austrorads

Austrorads is the peak organisation of Australasian road transport and traffic agencies.

Austrorads' purpose is to support our member organisations to deliver an improved Australasian road transport network. To succeed in this task, we undertake leading-edge road and transport research which underpins our input to policy development and published guidance on the design, construction and management of the road network and its associated infrastructure.

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- Department of State Growth Tasmania
- Department of Infrastructure, Planning and Logistics Northern Territory
- Transport Canberra and City Services Directorate, Australian Capital Territory
- Department of Infrastructure, Transport, Regional Development, Communications and the Arts
- Australian Local Government Association
- Waka Kotahi NZ Transport Agency.

Summary

This document has been developed to provide transport agencies with a set of best-practice guidelines and supporting information for smart motorway operations and management capabilities as well as the integration of new projects with smart motorway components. A key focus of the guidelines is on human resource capabilities for core tasks and processes across the full project lifecycle to support smart motorway operations.

The document is centred around capabilities in and inputs to support TMC decision making across:

1. Integration planning and transition to operations of new motorways and enhanced motorways
2. Operation of existing motorways
3. Motorway management (which includes infrastructure planning, operational planning and operations) and resource capability planning.

These guidelines pick up where information and guidance on pre-operational phases (such as infrastructure investment, network operations planning and motorway design) finish. The document complements the *Austrroads Guide to Smart Motorways* (AGSM, Austrroads 2016a), which provides operations-led design guidance for smart motorways.

The guidelines include the following:

- Frameworks (Sections 2 to 5)
 - An outline of different types of transport operations that affect motorways in the context of responsibilities that may be conducted by TMCs and equivalent motorway operations teams.
 - An introduction to a proposed Smart Motorway Classification Model (SMCM). The SMCM will enable users to understand typical smart motorway operating characteristics, including technology features that may be used and typical operational outcomes to be achieved. These factors will identify current and potential levels of operational and technology capability of the motorway(s) in question. The SMCM is an optional tool that could be flexibly used by transport agencies to guide discussions on business capabilities for a range of different motorways.
- Motorway Operations Functions and Sub-Functions (Sections 6 to 8)
 - An outline of different activities, tasks and responsibilities that transport agencies can apply to achieve best practice guidance across TMC Business Management, Live Motorway Operations, as well as Motorway Operational Planning and Optimisation.
- Projects Integration (Section 9)
 - Best practice guidance on capabilities and interactions required for project and motorway operations teams to enable successful integration (across all phases of a motorway lifecycle from 'concept' to 'operation') through operational processes, systems and technologies.

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1. Introduction

1.1 Purpose

The Austroads *Best Practice in Smart Motorways Operations* report seeks to support the harmonisation of contemporary practice of Austroads' member organisations by capturing and documenting it as best practice through a consistent framework.

1.2 Scope and Content

This report provides best practice guidelines and supporting information for member agencies who are involved in the operations of smart motorways. A key focus of the guidelines is on human resource capabilities for core tasks to support smart motorway operations across the full project lifecycle.

These guidelines pick up where information and guidance on pre-operational phases (such as infrastructure investment, network operations planning and motorway design) finish. The guidelines focus on operational capabilities and complement the *Guide to Smart Motorways* (AGSM, Austroads 2016a), which provides operations-led design guidance for smart motorways.

The guidelines include the following:

- An outline of different types of transport operations that affect motorways in the context of responsibilities that may be conducted by TMCs and equivalent motorway operations teams.
- An introduction to a proposed Smart Motorway Classification Model (SMCM). The SMCM will enable users to understand typical smart motorway operating characteristics, including technology features that may be used and typical operational outcomes to be achieved. These factors will identify current and potential levels of operational and technology capability of the motorway(s) in question. The SMCM is an optional tool that could be flexibly used by transport agencies to guide discussions on business capabilities for a range of different motorways.
- Best practice guidance on capabilities required for motorway operations teams to enable successful integration (across all phases of a motorway lifecycle from 'concept' to 'operation'), with existing operational processes, systems and technologies.

1.3 Capability Context

1.3.1 Background

The focus of these guidelines is on human resource capabilities for smart motorways operations. These guidelines are premised on the principles of a capability framework that can be applied to the elements of Traffic/Transport Management Centre (TMC) roles, responsibilities, resourcing levels, services levels and operational interactions with stakeholders such as emergency services, other agency TMCs, and tow operators.

The capability framework centres around a common foundation and common language to describe the knowledge, skills and abilities needed to perform tasks within work across all levels of organisations. This framework serves as a consistent basis and approach for developing job descriptions, as well as enabling career pathway planning and progression.

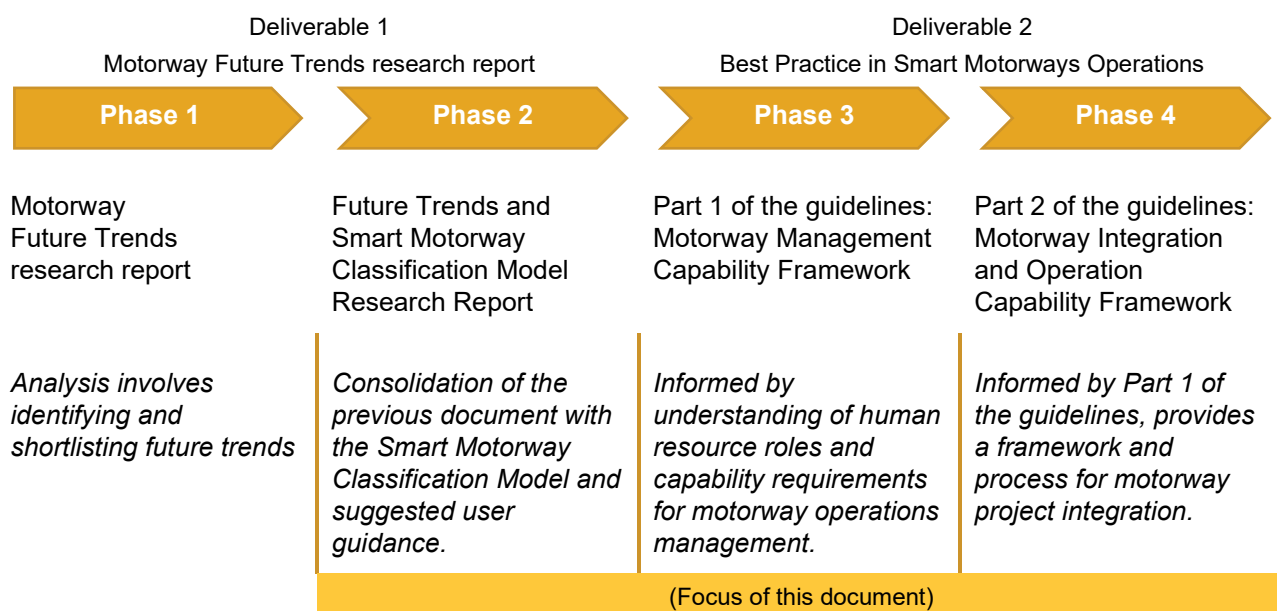
The capability framework also provides links to existing training material currently available, identifies gaps in training requirements, and addresses the approach to continuous improvement, based on role or capability criticality and risk.

- The Integration section of the guidelines is informed by the capability framework. The Integration section defines human resource capability requirements across project lifecycles and business functions.
- These functions include motorway infrastructure planning and design, motorway operations regarding delivering motorway operational outcomes on a daily basis, efficient and effective response to unplanned incidents, and the process of integrating design, planning and ongoing operations in delivering the required motorway performance outcomes.

These guidelines are not intended to enforce mandatory practice and does not provide detailed policies, processes or procedures for the operations of smart motorways. These policies should still be developed by the jurisdictions.

These guidelines form the second deliverable for the *Best Practice in Smart Motorways Operations* project. The key deliverables for the whole project are summarised in Figure 1.1.

Figure 1.1: Key project deliverables



Informed by Deliverable 1, the *Best Practice in Smart Motorways Operations* document has been developed to help agencies address continued pressure to better utilise existing infrastructure assets and resourcing for delivering motorway operations.

This combined document contains both Part 1 and Part 2 of the guidelines and includes:

- Frameworks (Sections 2 to 5)
- Motorway Operations Functions and Sub-Functions (Sections 6 to 8)
- Projects Integration (Section 9).

1.3.2 Scope Exclusions

Where smart motorway operations require best practice for information technology and human resource management within a transport agency, it is expected that these requirements are adequately covered by the organisations' current systems and processes. Therefore, these systems and processes have been excluded from these guidelines.

These guidelines do not include specific guidance around the operation of arterial road networks. However, we recognise that smart motorway operations and projects will either connect to, or be affected by, the existing transport network and so cannot be considered in isolation. We also acknowledge the critical and integrated relationship between managing traffic on motorways and traffic control systems on arterial and local roads.

Section 2.1 provides brief commentary on the capability required around the motorway interface with arterials but does not contain specific guidance around the operation of arterial roads (and associated systems such as signals), which is out of scope for this motorway-focused project.

Section 6.5 and 6.7 provide brief commentary around the associated human resource capabilities required to manage faults, assets and systems. These guidelines do not include detailed coverage on faults and maintenance management (and associated field work or engineering).

Work is currently underway to further evolve the Movement and Place Framework for practitioners throughout Australia and New Zealand. Inclusion of the principles in these guidelines is primarily around relevance to motorway infrastructure planning and project-specific integration delivery. See Section 8 for more information.

Further work is underway toward harmonising training processes (including for areas outside of motorway operations within a TMC) and accreditation through Registered Training Organisations across Australia and New Zealand. Please refer to the Austroads website for the latest guidance.

1.4 Guidelines Use

This document will apply to a wide range of different operational scenarios and situations across jurisdictions. Please refer to Section 2 for the typical types of operational TMC approaches and boundaries.

No one operational approach can be perfectly aligned with these guidelines. We recommend that users apply those sections of these guidelines that best suit their specific operational arrangements, needs and viewpoints. Sections that are not currently relevant for their operations can be used as further inspiration and as a challenge to look at different operational approaches.



These call out boxes are used throughout the guidelines to highlight best practice tips. These tips seek to support the reader in defining the functions and sub-functions of motorway operations but do not necessarily cover specific tasks, activities or responsibilities. These tips may include:

- pointers towards examples
- issues to consider while undertaking an activity or improvement assessment.

Glossary

Table 1.1 outlines the acronyms and terms used within these guidelines.

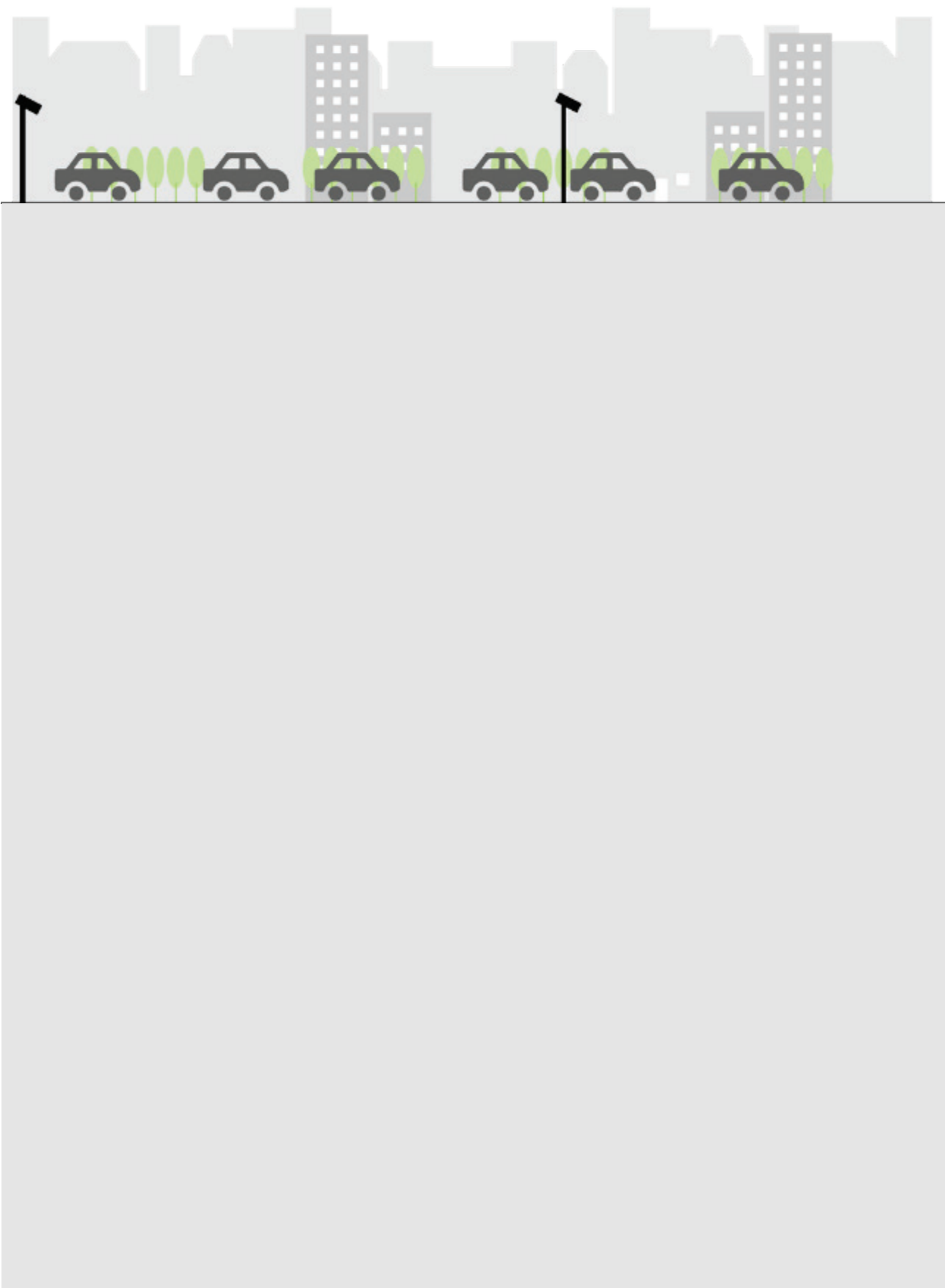
Table 1.1: Glossary of terms

Acronym/Term	Definition/Description
AASHTO	The American Association of State Highway and Transportation Officials
ABMIS	ABMIS Professional is a customisable business management solution
AGSM	Austrroads Guide to Smart Motorways
AID	Automatic Incident Detection
ARRB	Australian Road Research Board
Assessment	The wide variety of methods or tools that educators use to evaluate, measure, and document the academic readiness, learning progress, skill acquisition, or educational needs of students
BAU	Business as Usual
Capability	The ability to do something (definition by Oxford University Press)
CCTV	Closed Circuit Television Camera
Competence	The ability to do something successfully or efficiently (definition by Oxford University Press)
ConOps	Concept of Operations
End-states	Potential motorway aspects and operational situations, which have been outlined for a range of motorway types as part of the Smart Motorways Classification Model
ESA	Emergency Services Agency
FAT	Factory Acceptance Testing
FTE	Full Time Equivalent
GPS	Global Positioning System
HCV	Heavy Commercial Vehicles
HVAC	Heating, Ventilation and Air Conditioning
ICT	Information and Communications Technology
IT	Information Technology
IoT	Internet of Things
IRP	Incident Response Plans
ISP	Information Service Providers
ITS	Intelligent Traffic/Transport Systems
LoS or LOS	Level of Service
Knowledge	Facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject (definition by Oxford University Press) Context of these guidelines: e.g. 'being familiar with the policy information to support the Incident Management sub-function (under Live Motorway Operations)'
KPI	Key Performance Indicator, a measure that enables monitoring of performance in terms of progress towards a specific, defined economic/social/environmental objective (Austrroads 2020e)
MCC	Motorway Control Centre (also see TMC)

Acronym/Term	Definition/Description
McKinsey 7S	A management framework used to evaluate a company's organisational effectiveness and to determine if a set of defined 'hard' and 'soft' elements are in alignment with the overall vision of the company. 'Hard elements' refer to tangible policies or methods that are easily changed whereas 'soft elements' are less tangible, more difficult to determine and are typically changed through shifting company culture (180 Degrees n.d.)
Mid-Block or Midblock	A type of traffic data that captures the number of vehicles crossing an arbitrary line along a corridor, outside of intersections. E.g. automatic tube count on a highway for southbound movements (Austraffic 2021)
OPEX	Operational Expenditure
(Learning) Module	An organised collection of educational or informational content presented together for the purpose of training and development. A Learning Module can support a course goal, a course objective, a subject, a concept, or a theme. The Learning Module is a shell to which other content items such as files, folders and tools are added (University of Southern California n.d.)
LGA	Local Government Authority
LUMS	Lane Use Management Signs
MOU	Memorandum of Understanding
Network Operations Planning	Planning of how the network should operate from a strategic focus through to detailed route management. While this can include identifying some operational gaps or issues, the focus is on better operation of the current network
Network Planning	Planning to determine the correct network to meet the organisational objectives. This has more focus on identifying the network gaps and developing the projects to resolve the gaps
Planned Network Access	A planned activity (whether construction or an event) that has been approved to be undertaken in the road network corridor
PREXY or PRExy	The Port River Expressway links South Australia's major port and rail terminals at the Port of Adelaide with major freight routes to the north and south of Adelaide
PT	Public Transport
PWG	Project Working Group
RACI	Responsible, Accountable, Consulted, Informed
SAT	Site Acceptance Testing
SCATS™	Sydney Coordinated Adaptive Traffic System
Skill	The ability to do something well (definition by Oxford University Press) Context of these guidelines: e.g. 'being able to carry out a certain task e.g. updating VMS appropriately with a message that is easy for drivers to understand (under Live Motorway Operations)'
SLA	Service Level Agreement
SMCM	Smart Motorways Classification Model
SOPs	Standard Operating Procedures
STREAMS™	An integrated ITS and traffic management platform by Transmax
Subject	A branch of knowledge studied or taught
Transport for NSW	Transport for New South Wales

Acronym/Term	Definition/Description
TMC(s)	Traffic/Transport Management Centre is a: • central location for managing the use of the road network in real time • system for delivering road user support services • focal point for technologies used in network monitoring and traffic operations: - telecommunications - surveillance - detection These guidelines use the term TMC(s) when referring to the motorway operations teams of State and Territory transport agencies. This includes the TOC as found in New Zealand at the time of these guidelines
TOC	Transport Operations Centre (also known as a TMC in Australia)
UAT	User Acceptance Testing
US DOT FHWA	United States Department of Transportation: Federal Highway Administration
VMS	Variable Message Sign
VSLs	Variable Speed Limit Signs
Waka Kotahi NZ Transport Agency	Waka Kotahi New Zealand Transport Agency

Part I: Models and Frameworks



2. Scope of Traffic/Transport Management Centre Services

This section provides an overview of transport operations that directly or indirectly affect motorways and involve Traffic Management Centres (TMCs). This section provides insight into how motorway operations can limit or enhance the success of wider transport operations.

The operation of smart motorways is a subset of broader transport operations. These other operations either have a direct impact (e.g. arterial signal operations causing congestion back on to the motorway) or indirect impact (e.g. a well-run public transport operation can reduce the demand for cars using the motorway) on the outcomes of motorway operations.

This section introduces different types of operations that are often included under the banner of ‘motorway operations’.

Understanding the different type of operations will assist the reader when working through these guidelines to establish which sections and guidance are most applicable to their type of operation.

Section 2.2 provides more information on Traffic Management Centres (TMCs) and their divisions.

2.1 Different Types of Operations

Table 2.1 lists different types of operations across transport, with ‘Standard Motorway Operations’ being a core focus of these guidelines.

Table 2.1: Different types of operations

Type of operation	Description
Standard Motorway Operations	Also sometimes known as ‘live operations’, and includes the following activities: • Traffic Flow Operations – active management of traffic control devices to optimise the flow of traffic during normal and peak times, as well as during planned events, such as construction works and public events i.e. parades. • Incident Operations – reactive management of the impacts of unexpected events with a focus on keeping the incident site safe and reducing the resulting congestion. • Faults Management – monitoring and resolution of faults with the networks, ITS systems and field devices to ensure their availability and proper functioning to support live operations.
Tunnel Operations	Operations involving tunnel systems, such as the monitoring and active management of the tunnel lighting, HVAC, fire and life detection and other safety systems to ensure the safe use of the tunnel.
Bridge Operations	While it is rare for bridges to require more than the standard motorway operations, some large bridges (e.g. Tasman Bridge in Hobart, Tasmania) have dedicated incident response vehicles. Opening bridges – where bridges are able to open to allow water traffic pass beneath – may also require specific operational activities.
Traffic Signal Operations	The live management of traffic signal devices at motorway interface with arterials and local roads. The TOC includes control systems that may use real time mid-block data.

Type of operation	Description
Busway Operations	The live management of vehicle movements along the busway 'road' or dedicated lane in both travel directions.
Public Transport Facilities Operations	The live management of public transport facilities such as bus stations, train stations and ferry terminals. These operations include the management of transit stop/berth allocation, public safety, special events and traveller information located at the public transport facilities.
Public Transport Operations	The live management of public transport services (such as bus, light rail, train or ferry) along dedicated routes. These operations include the management of breakdowns, passenger safety, fleet allocation, incidents, timetable scheduling, special events and communications.
Traffic Signal Special Event Operations	The management of a particular type of special event where a vehicle or group of vehicles is provided with a run of green traffic light signals along a specified route, often called a 'Green Wave'. A common example would be to manage a state dignitary moving from the airport to a central city location, in conjunction with the police.
Backup Operations	Where one TMC or control centre takes over from another during 'after hours'. This is when the TMC cannot justify operating 24/7 and (usually) allocates to another centre, low-level operations, such as fault management, basic traffic control and incident management. This response could also apply as a disaster recovery option.

2.2 Traffic Management Centres (TMCs)

2.2.1 Context

Traffic Management Centres (TMCs) are the focus of this section. TMCs are also known as 'Transport Management Centres' or 'Transport Operation Centres' in different jurisdictions across Australia and New Zealand.

A vision for TMCs as described by Transport for NSW is: '[The] TMC exists to lead planning and coordination for the proactive real-time management of the Transport Network enabling seamless, safe and reliable journeys for our customers' (Transport for NSW 2020a).

The 'Transport Operations Room' or 'Control Room' is where the live operations and related activities are carried out in the TMC of some jurisdictions.

Transport for NSW have also produced a useful presentation on the future of their Multi-Modal TMC that looks towards 2056 (Transport for NSW 2019a).

2.2.2 General Description

The role of TMCs or equivalent motorway operations teams (Austroads 2020a) is defined as providing an integrated and focused platform for:

- monitoring the road network
- commanding traffic operations on the network
- coordinating the management of incident responses, planned disruptions and special events
- controlling traffic through control systems at its disposal
- disseminating traffic information to the media and service providers.

The scale and size of TMCs vary across Austroads' member agencies, from large 24/7 purpose-built centres in major cities to small rooms with part-time workstations in smaller cities.

Table 2.2 below provides an example showing the possible hours of operation for different scales of operational needs.

Table 2.2: Example levels of service for varying scales of operations

Scale	Level of Service
Occasional	Special Event and/or Major Incident Response
Peak	Peak period coverage (8 hrs/5 days a week) – for example 6 to 10 am and 3 to 7 pm
Daytime	Short weekday coverage (12 hrs/5 days a week) – for example 7 am till 7 pm
Daytime Plus	Long weekday coverage (16 hrs/5 days a week) – for example 6 am to 10 pm
Continuous Coverage	Continuous coverage (24 hrs/7 days a week)

Source: Adapted from ACT traffic management centre feasibility study (Roads ACT with ARRB 2009)

TMCs can also be established to support one or more than one type of motorway operations. For example, motorway, arterial and local road operations (such as traffic signals) may operate from the same TMC. Larger TMCs have also integrated other activities such as tunnel management, public transport operations and special event management.

TMC teams are usually focussed on motorway operations, but they may also be responsible for other transport operations within the jurisdiction.

For example, the Transport for NSW TMC has different teams to monitor and manage the state road network operations as well as to coordinate aspects of public transport operations (bus, rail, and ferry networks) during peak commuter travel times, special events and unplanned incidents.

Motorway operations can be grouped differently. Some jurisdictions across Australia and New Zealand may have all operations managed from a single TMC (typically in a single organisation e.g. Transport for NSW TMC). Other jurisdictions may manage their operations in separate TMCs (possibly for multiple agencies) requiring a higher level of coordination or integration.

2.2.3 TMC Collaboration

In a number of locations, different jurisdictions have collaborated to either work from the same TMC or to work together to form a single joint operation (possibly within an established shared facility). Joint operations can be effective when motorways, state highways and local roads are run by different jurisdictions or organisations.

For example, experienced police may directly collaborate with incident management planners to share lessons learned across a range of incident types. In comparison, the Auckland Transport Operations Centre (ATOC) is a joint operation that involves Waka Kotahi NZ Transport Agency (motorways and state highways) and Auckland Transport (local roads).

2.2.4 Relationships between Different TMCs

Other specialised traffic control centres can complement TMCs, such as toll road control centres, control rooms for major tunnels and private motorway TMCs. Communications are essential to delivering successful operations and coordination, between any specialised centre and the principal TMC.

In South Queensland, New South Wales and Victoria, privately held motorways are managed by their private asset owner/operators. On these private motorways, the primary role of the transport agency TMC is one of coordination to ensure efficient traffic management across the wider road network throughout the state.

Best practice includes forming formal and working relationships with other operations and associated centres including:

- emergency operation centres typically activated in one-off scenarios, such as national/state/local government civil defence (e.g. mass evacuations due to large bushfires or flood events)
- emergency services centres such as fire, ambulance, police.

In some locations, this positive working relationship has led to the police allocating resources based in TMCs. Having police resources that sit within TMCs facilitates better understanding, effective sharing of information and efficient coordination of actions during planned and unplanned events.

For example, Transport for NSW has established the technical interface requirements between different systems, namely their Operations Management and Control System, Incident Management System, and the TMC systems (Transport for NSW 2020b).

3. The Smart Motorway Classification Model

This section introduces the scope and purpose for developing the proposed Smart Motorways Classification Model (SMCM), which is an optional tool that can be flexibly used by transport agencies to guide discussions. This section explores the dimensions covered in the SMCM, including typical smart motorway operating characteristics and typical operational outcomes to be achieved.

An alternate technology-focused view of the SMCM is also provided to further inform and support a good understanding of the operating characteristics.

3.1 Model Introduction

3.1.1 Overview

The Smart Motorways Classification Model (SMCM) considers:

- both urban and rural motorways
- depth of motorway operational capability – from unmonitored/unmanaged to fully equipped and optimised motorways
- response to and management of recurrent and non-recurrent incidents
- various governance structures of motorways (managed by agencies or by private operators).

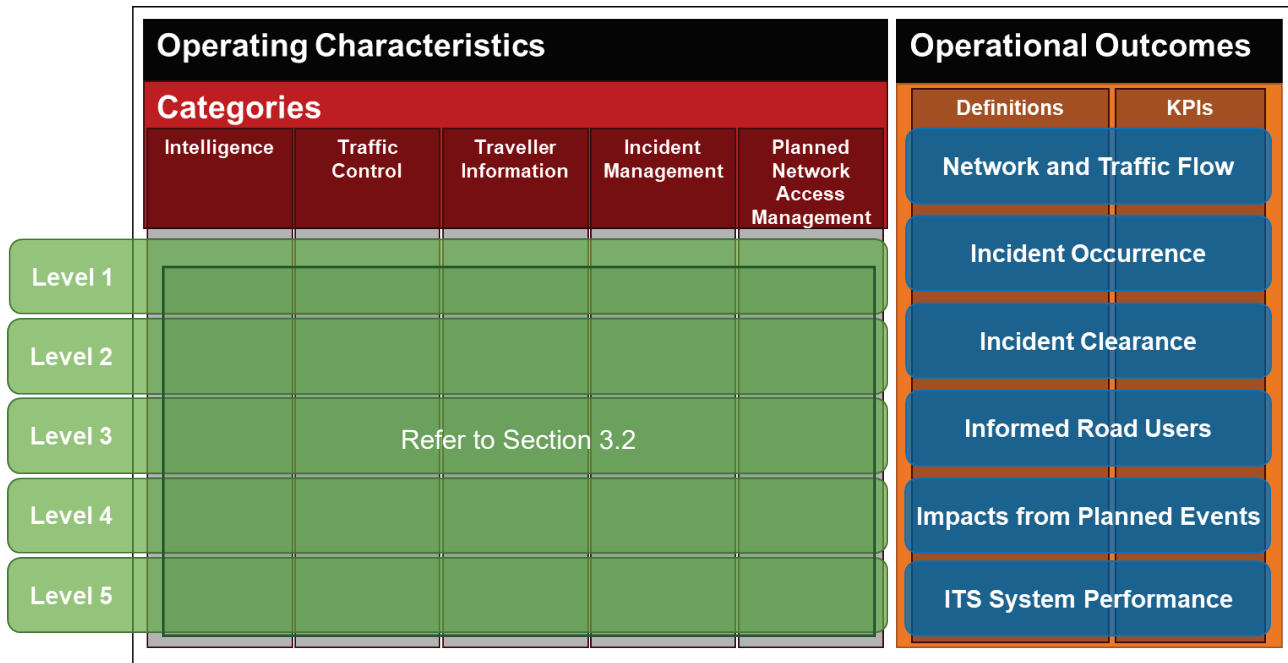
The purpose of the SMCM is:

- to understand the different levels of operating characteristics and how these could be used to achieve the desired operational outcomes for the relevant motorway class
- to define typical characteristics for a range of different motorways, which informs the downstream sections:
 - Capability Framework (Section 4)
 - Intersection between SMCM and Capability Framework (Section 5)
 - Motorway Operations Functions and Sub-Functions (Sections 6 to 8)
 - Integration Framework (Section 9).
- to support planning for future motorways to deliver road managers objectives for operational and customer outcomes.

3.1.2 Dimensions Covered in the SMCM

The SMCM defines the typical operating characteristics and typical operational outcomes that make up the model. Figure 3.1 show an overview of the SMCM.

Figure 3.1: Smart motorways classification model overview



Appendix A provides an enlarged version of the SMCM graphic.

The following sub-sections provide more detail on how to use or interpret the SMCM, as presented in Figure 3.1. For example, Section 3.3 contains further detail for a Technology View, and Section 3.4.1 provides definitions of the operational outcomes dimension.

3.2 Typical Operating Characteristics

This section describes typical characteristics for a smart motorway across different operating levels in a five by five matrix.

3.2.1 Operating Characteristics Levels

The SMCM incorporates five levels of operating characteristics with descriptors in Table 3.1 that provides a description of the relative maturity of each operating characteristic level.

Table 3.1: Operating characteristics levels

Level	Definition of operating characteristics
Level 1	Reactive with no incoming data
Level 2	Reactive with some incoming data
Level 3	Some Proactive Management
Level 4	Substantial Proactive Management
Level 5	Full Proactive Management

While the operating characteristics reflect a logical progression from Level 1 to 5, some motorways will be a mix of aspects across different levels. For example, a motorway could have some aspects of the Level 3 and also have some aspects within Level 2 and Level 1.

3.2.2 Operating Characteristics Categories

Table 3.2 shows the operating characteristics grouped into the following five categories. This grouping allows for a motorway to be positioned at different levels across the different categories.

Table 3.2: Typical operating characteristics categories

Category	Definition
Intelligence	The ability to know what is currently happening on the motorway from congestion levels to stopped vehicles and incidents.
Traffic Control	The ability to provide physical controls or enforceable regulatory direction to motorway users which actively manages traffic flow and limit use of all or part of the motorway.
Traveller Information	The ability to provide and disseminate data and information to inform motorway customers and influence their travel behaviours.
Incident Management	The collection of processes and procedures used to react to an unplanned event.
Planned Network Access Management	The collection of processes and procedures to manage and coordinate access to the motorway corridor for planned events, including road works, utility works and special events.

The SMCM (refer to Figure 3.1) is mainly intended to be used one category at a time by:

- identifying the current level of the motorway Operating Characteristic being assessed
- identifying the desired level for the same motorway Operating Characteristic.

Section 3.5.2 describes an example use of the SMCM.

Alignment with current guidelines:

The categories of Intelligence, Traffic Control and Traveller Information align with:

- three primary functions of smart motorway operation as defined in Section 3.3 of *AGSM* (Austroads 2016a)
- three functional purposes for elements of smart motorways as defined in Section 8.1.2 of *Guide to Traffic Management Part 9: Transport Control Systems – Strategies and Operations* (Austroads 2020a).

Incident Management aligns with the role of active traffic management for motorways as described in Section 2.2 of *AGSM* (Austroads 2016a).

Planned Network Access Management aligns with the planned and special event management as described in Section 5.2 of *Guide to Traffic Management Part 9: Transport Control Systems – Strategies and Operations* (Austroads 2020a).

3.2.3 Operating Characteristics Levels and Categories

Figure 3.2 shows the categories of operating characteristics across five levels.

Figure 3.2: Typical operating characteristics across five levels

		Operating Characteristics				
		Intelligence	Traffic Control	Traveller Information	Incident Management	Planned Network Access Management
Smart Motorway Operations Characteristics Level	Level 1 <i>'Reactive with no incoming data'</i>	No active monitoring of incoming calls and information from the public or emergency services	The use of ad hoc resources and response vehicles to support largely passive traffic control	Static traffic information on temporary signs and limited real-time alerts	Incident response is reactive (usually using road maintenance resources) with no plans, directed by emergency services. No coordination by the road agency	Fully ad hoc with no formal controls in place for addressing traffic impacts and road occupancies
	Level 2 <i>'Reactive with some incoming data'</i>	Some manual visual monitoring and traffic data from limited detection locations	The use of pre-organised field resources and response vehicles to support traffic control with centralised coordination	Information mostly manually created and available via radio and the internet	Part-time TMC with response using standard procedures with local coordination	Application and approval process
	Level 3 <i>'Some proactive management'</i>	Comprehensive visual and traffic detection intelligence available including some local road connections	Using field devices and/or equipment to manage and control traffic - mostly manual	Traveller advice and incident information proactively pushed out through multiple channels e.g. subscription-based alerts	Full-time TMC utilising pre-prepared response and/or detour plans	Centralised management system to manage applications and access
	Level 4 <i>'Substantial proactive management'</i>	Some automated incident and stopped vehicle detection available and congestion alarms to support increased network coverage	Using field devices and/or equipment to manage and control multi-modal traffic - mostly automated	Traveller information able to be tailored to locations or routes	Responding in accordance with established multi-agency response plans	Strong auditing and work completion process as well as coordination with internal works and projects
	Level 5 <i>'Full proactive management'</i>	Fully automated incident and traffic monitoring without using manual resources	Coordinated and automated ITS responses in real time for multi-modal and multi-network, often using multiple systems	Information and data made openly available for optimised decision making, mostly automated	Dynamic multi-modal and multi-network response plans that are adaptive using real time traffic information	Sophisticated event and access coordination to reduce impacts on road users

3.2.4 Planning for Enhanced Operations

When considering a shift to a higher operating characteristic level, use the decision-making process outlined in Table 3.3 to confirm if such a shift is, in fact, required.

Table 3.3: Shifting to higher operating characteristic levels

Step	Question	Action
1	Are you considering progressing to a higher level because you need to improve the operational outcomes?	Yes – proceed to step 2 No – end process
2	Do the current resources need more training or support to allow the team to successfully perform at the current operating characteristic level?	Yes – consider additional training support or providing additional guided experience (see Section 6.3) No – proceed to step 3
3	Do you need more resources to allow the team to successfully perform at the current operating characteristic level?	Yes – consider requesting further resources to allow the operation to achieve the expected operational outcomes that are possible with the current operating characteristic level (see Section 6.6.4) No – proceed to step 4
4	If steps 2 or 3 above do not resolve the performance/outcomes gap then look to progressing to a higher operating characteristic level. Note: more resources or training support may be required with this option	

Progressing to a higher operating characteristic level, especially from ‘mostly manual’ to ‘semi-automated’ and then ‘automated’, could involve the introduction of new applications such as semi or fully automated VSL algorithms.

In these situations, moving up a characteristic level cannot be solved by simply increasing training and resources. Progression will require the support of specialist Smart Motorway/ITS resources, which may be external to the TMC. They will be needed to support the design, implementation, handover, implementation and management of any new Smart Motorway/ITS system.

The TMC will then be trained on how they monitor/integrate with these tools as they are rolled out by the Smart Motorway/ITS team.

3.3 Technology View

The inclusion of a technology view for the SMCM will inform and support a deeper understanding of the operating characteristics across the different smart motorway classification levels.

Although the identified technologies are current at the time of this report, technology is rapidly evolving. Technology evolution is a dimension of the SMCM that considers potential information systems and platforms used across different smart motorway classification classes.

Figure 3.3 provides a technology view.

Figure 3.3: A technology view of the Smart Motorways Classification Model

		Technology View				
		Intelligence	Traffic Control	Traveller Information	Incident Management	Planned Network Access Management
Smart Motorway Operations Characteristics Level	Level 1 <i>'Reactive with no incoming data'</i>	Phones, texts and email	No system	External systems only (e.g. Google Maps)	Incident log (manual or spreadsheet)	Access register (manual or spreadsheet)
	Level 2 <i>'Reactive with some incoming data'</i>	CCTV	VMS	+VMS	Dispatch Management	Access Management database/system
	Level 3 <i>'Some proactive management'</i>	+Traffic Detectors + Weather and Environmental Monitoring + GPS tracking	+Lane Control Systems +Variable Speed Limits + Ramp Signals	+ Dedicated traveller website	Incident Management System for incident logging and supporting resource dispatching	Event and access clash detection
	Level 4 <i>'Substantial proactive management'</i>	+Travel Time Systems +Congestion Alarms	+Wide Area Coordinated VMS Plans +Coordinated Ramp Signals	+Open data available for live events/incidents	Incident Management System including standard response plans and implementation of plans	Event and access coordination management
	Level 5 <i>'Full proactive management'</i>	+AID +Vehicle to Infrastructure Comms	+Dynamic Lane reconfiguration +Higher level of automation of the previous Systems	+Push information to vehicles +Multi-modal traveller advice	Integrated Incident Management System able to control traffic control devices and deploy traveller information	Multi-jurisdiction event and access management

This technology view would also support the use and adoption of the SMCM, since it aligns the user with the language found in the AGSM (Austroads 2016a).

3.4 Typical Operational Outcomes

This section describes typical operational outcomes expected from smart motorways, spread across six different outcomes, and provides example Key Performance Indicators.

3.4.1 Typical Operational Outcomes

The overall focus of smart motorways is to obtain the best performance out of our road infrastructure, to facilitate a more productive and sustainable transport network, and to meet road user and community needs (Austroads 2016a). This area of focus includes objectives to minimise negative impacts caused by recurring congestion or non-recurring incidents, and to respond quickly, then to return traffic flows back to normal as soon as possible (Austroads 2020a).

Other factors relating to the overall operational outcome include: the importance of improving safety, efficiency, reliability, accessibility, resilience, environmental factors and customer experience.

Table 3.4 defines six typical operational outcomes from smart motorways identified through this project.

Table 3.4: Typical operational outcomes from smart motorways

Operational Outcome	Definition
Network and Traffic Flow	Staff can optimising Network Level of Service (LoS) by managing travel speed, capacity and local road connections.
Incident Occurrence	The number and severity of incidents, including secondary incidents is minimised.
Incident Clearance	Incident verification, response, clearance and recovery times are appropriate for the type and scale of incident and time of day .
Informed Road Users	Road users have higher awareness by receiving timely accurate information to help them make their own travel decisions supporting safe and efficient journeys.
Impacts from Planned Events	Planned events, including road works, projects, utility activities, and special events, are approved, coordinated and managed to minimise road network disruption to and users.
ITS System Performance	ITS and Traveller Information Systems provide the expected functionality and reliability to deliver operational benefits to road users.

Section 3.5 contains a suggested series of steps for transport agencies in describing example tasks involved and actions needed to achieve the desired operational outcomes mentioned above.

Key performance indicators (KPIs) can help to further define and measure these outcomes. Section 3.4.2 contains some examples of KPIs that transport agencies can use to measure and track these outcomes.

The Road Manager should determine the desired operating characteristics of each motoring link. These characteristics will depend on:

- demand for use of the motorway
- physical constraints, geometry and motorway configuration (e.g. number of lanes)
- asset properties and condition
- crash history
- level of smart motorway operating characteristics (as described in the first part of the Smart Motorway Classification Model; see Section 3.2).

Road managers will benefit from demonstrating how varying the level of operating characteristics impacts operational outcomes. Use of the SMCM will support investment discussions and decision-making by motorway operations teams of jurisdiction transport agencies. Achieving the six operational outcomes recommended under the SMCM can also underpin benefits realisation for investment business cases.

Table 3.5 illustrates how the smart motorway operational outcomes contribute to the broader motorway outcomes consistent with those referenced in motorway planning and management documents across Australia and New Zealand. These documents include: the *AGSM* (Austroads 2016a), *PIARC Strategic Plan 2020-2023* (World Road Association 2020) and *Austroads Strategic Plan 2020-24* (Austroads 2020b).

Table 3.5: How smart motorway operational outcomes contribute to broader motorway outcomes

Operational Outcome	Safety	Efficiency	Reliability	Connectivity and Accessibility	Resilience and Adaptability	Environmental and Sustainability	Customer Experience
Network and Traffic Flow	✓	✓	✓		✓	✓	✓
Incident Occurrence	✓	✓	✓				✓
Incident Clearance	✓	✓	✓		✓		✓
Informed Road Users	✓	✓	✓	✓		✓	✓
Impacts from Planned Events	✓	✓	✓			✓	✓
ITS System Performance	✓	✓	✓	✓	✓	✓	✓

3.4.2 Key Performance Indicators

The SMCM Operating Characteristic contain a series of Key Performance Indicators (KPIs) across several categories including:

- Intelligence
- Traffic Control
- Traveller Information
- Incident Management
- Planned Network Access Management.

Transport agencies can use KPIs as one approach to quantify performance targets and system availability for a certain motorway or network of motorways. These KPIs could also be used for specific purposes, such as assessing the improved effectiveness of an incident management process (Austroads 2020a).

It should be noted that context is key and road managers will need to develop locally appropriate KPIs for each motorway.

Table 3.6 shows some example KPIs for each operational outcome type described in Section 3.4.1. It is noted that the examples below are not an exhaustive list.

Table 3.6: KPI examples per operational outcome type

Operational Outcome Type	KPI Examples
Network and Traffic Flow ¹	• Network Demand The total kilometres travelled on the entire motorway network by all vehicles over a 24-hour period. Provides a measure of the overall load on the system. • Network Capacity The maximum recorded network kilometres travelled in one hour. Essentially peak network throughput. Higher is better. • Network Efficiency Quantifies the overall magnitude of delay around the network and across the day. Higher is better. • Network Delay Distribution Quantifies how concentrated delay is around the network and across the day. Lower is better. • Network Volatility Quantifies how variable the pattern of delay is around the network and across the day. Essentially travel time reliability assessed at network level. Lower is better.
Incident Occurrence	• Time from the initial occurrence to detection by the TMC staff or systems. • Number of crashes by severity (fatal/serious/moderate/minor/non-injury). • Number of crashes by type (overtaking, same lane rear end, etc.). • Number of crashes across all severity and types.
Incident Clearance	• TMC verification times. • Response time to arrive on scene. • Clearance time to clear the incident scene. • Recovery time for the traffic to return to normal after the incident.
Informed Road Users	• Number of media briefings/releases. • Number of channels used to distribute information. • Time to set for an initial response after an incident occurs (e.g. setting a Variable Message Sign).
Impacts from Planned Events	• Percentage of planned events that utilised the TMC capability. • Travel time reliability during a planned event. • Duration of lane closure and distance of lane closed (i.e. amount of driver exposure to a planned event). • Percentage of planned events that required an extended duration.
ITS System Performance	• Number of devices replaced per year. • Number of faults per device per year. • System 'up-time' availability. • Fault response time of critical devices. • Percent of tasks that are automated rather than manual.

1. Note that Network Demand provides an indicator of the load on the network and the other four measures indicate the performance of the network in handling the load.

3.4.3 Target Setting

The use of KPIs by transport agencies would support the understanding and measuring of the smart motorway operational outcomes. As such, agencies will need to:

- establish clear KPI definitions
- confirm that the KPI can be measured
- establish targets for each motorway or network of motorways.

Targets will need to fit the purpose of the specific motorway and its local context and operating environment. As explained above in Section 3.4.2, road managers will need to develop locally appropriate KPIs for their motorways. On that basis, this report provides suggested targets for smart motorways, however these may be investigated for a future update of the SMCM. Targets are likely to be time-of-day dependent and differ depending on the motorway class.

Motorway Class

Table 3.7 details three overarching motorway classes.

Table 3.7: Motorway classes

Motorway Class	Definition
Rural Motorway	A motorway that connects rural areas (such as small towns) and is far away from built-up places. For example, Calder Freeway (M79) – Macedon to Ravenswood in Victoria.
Inter-Regional Motorway	A motorway that connects two or more regions and distributes vehicular traffic onto the local road network system, from which towns and metropolitan areas can be accessed. For example, Princes Freeway West (M1) – Little River to Waurn Ponds in Victoria.
Urban Motorway	A motorway that runs within or has very close proximity to a metropolitan area. For example: • M2 Motorway between Winston Hills and North Ryde in New South Wales • Monash Freeway (M1) between Toorak Road and Pakenham in Victoria • Kwinana Freeway in Western Australia • Southwestern Motorway in New Zealand.

These definitions align with traditional transport planning classifications focusing on the road's function/purpose within the broader transport system.

Note that Table 3.7 provides only a high-level distinction between urban and rural motorway due to the specific aspects (e.g. size and volumes) of urban and rural motorways differ across Austroads member jurisdictions.

Time of Day

For some of the operational outcomes, setting different targets depending on the time of day may be appropriate. Smart motorway operations often use the following three time periods, and these timeframes can be amended depending on need:

- peak periods (defined locally and usually covers both morning and afternoon peaks)
- inter-peak period (defined as the day time between the morning and afternoon peaks)
- off peak period (defined as the overnight time between the afternoon and morning peaks).

Combining these time periods, Table 3.8 shows an example of how the average travel time reliability by time of day could be applied as a KPI for the operational outcome of network and traffic flow.

Table 3.8: Example target setting matrix for motorway classes by time of day

Motorway Class	Time of day		
	Peak Periods	Inter-Peak Period	Off Peak Period
Rural Motorway	insert target	insert target	insert target
Inter-Regional Motorway	insert target	insert target	insert target
Urban Motorway	insert target	insert target	insert target

3.5 How to Use the SMCM

The SMCM is intended to provide a tool for road managers to achieve their desired operational outcomes through implementing different operational approaches. The SMCM is not mandatory and may be applied, in full or in part, depending on context and jurisdiction needs.

Importantly, the SMCM does not seek to determine a single level of smart motorway operational classification and is not intended to be read from left to right across the whole model.

The SMCM can be used in a number of scenarios, including:

1. undertaking a gap analysis between the current smart motorway operations and the required future levels to deliver the required motorway operational outcomes
2. undertaking an assessment to better understand the current state of the motorway and prioritisation
3. identifying possible combination of future smart motorway operating characteristic levels that the agency can achieve for future motorway(s).

The following step-by-step instructions, together with a worked example and a supporting diagram (Figure 3.4) provide a guide for transport agencies in applying the SMCM. The use of the SMCM would help agencies to understand their current operational outcomes state and then utilise the operating characteristics to move towards a desired future operational outcome state (Scenario 1 above).

3.5.1 General Instructions

The general instructions below provide a guide for using the SMCM for a certain highway or network of highways.

0

Step 0: Choose the Motorway or Network of Motorways to be assessed.

1

Step 1: Identify the current level of operating characteristics for each of the categories. The 'Technology View' (Section 3.3) of the operating characteristics may be utilised to help determine this current state.

2

Step 2: Identify the current operational outcomes of the motorway using KPIs to support this process (current outcomes) where they add value.

3

Step 3: Identify the operational outcomes desired for the motorway. (This is often done through stakeholder engagement and workshops) (desired outcomes).

4

Step 4: Determine if a gap exists in the current versus desired operational outcomes, review how different operating characteristic level(s) could close the gap in the desired operational outcomes.

Figure 3.4 indicates an example use for a hypothetical highway called 'Hwy1'.

Figure 3.4: Example use of the Smart Motorway Classification Model for 'Hwy1'

Step 1: Identify the current level of operating characteristics for each of the categories

	Operating Characteristics					Operational Outcomes	
	Categories					Definitions	KPIs
	Intelligence	Traffic Control	Traveller Information	Incident Management	Planned Network Access Management		
Level 1					1	Network and Traffic Flow	Incident Occurrence
Level 2		1				Incident Clearance	
Level 3	1		1			Informed Road Users	
Level 4				1		Impacts from Planned Events	
Level 5						ITS System Performance	

Step 2: Identify the current operational outcomes using KPIs when they add value

	Operating Characteristics					Operational Outcomes	
	Categories					Definitions	KPIs
	Intelligence	Traffic Control	Traveller Information	Incident Management	Planned Network Access Management		
Level 1					1	Network and Traffic Flow	Incident Occurrence
Level 2		1				Incident Clearance	2
Level 3	1		1			Informed Road Users	
Level 4				1		Impacts from Planned Events	
Level 5						ITS System Performance	

Step 3: Identify the operational outcomes desired for the motorway

	Operating Characteristics					Operational Outcomes	
	Categories					Definitions	KPIs
	Intelligence	Traffic Control	Traveller Information	Incident Management	Planned Network Access Management		
Level 1					1	Network and Traffic Flow	
Level 2		1			1	Incident Occurrence	
Level 3	1		1			Incident Clearance	2
Level 4				1		Informed Road Users	3
Level 5						Impacts from Planned Events	
						ITS System Performance	

Step 4: Review how different operating characteristic level(s) could close the gap in the desired operational outcomes

	Operating Characteristics					Operational Outcomes	
	Categories					Definitions	KPIs
	Intelligence	Traffic Control	Traveller Information	Incident Management	Planned Network Access Management		
Level 1					1	Network and Traffic Flow	
Level 2		1			1	Incident Occurrence	
Level 3	1 4	4	1 4		4	Incident Clearance	2
Level 4				1 4		Informed Road Users	3
Level 5						Impacts from Planned Events	
						ITS System Performance	

3.5.2 Example use of the SMCM

Step 0: Choose the motorway or network of motorways to be assessed

Consider a 300-kilometre hypothetical highway, called 'Hwy1', that links the urbanised outskirts of an Australian city to a large regional area west of the city.

Step 1: Identify the current level of operating characteristics for each of the categories

The transport agency's full-time TMC manages 'Hwy1' and has the following operating characteristics:

- Intelligence – ‘Hwy1’ is being progressively upgraded. CCTV coverage is fairly comprehensive at each end of the highway but is patchy in the middle stretch of the highway. Only major entry and exit points have established traffic detection locations. The TMC monitors specific ‘hot spots’ of congestion for this highway.
 - i.e. current Intelligence Level 2.5.
- Traffic Control – The TMC coordinates a minimal level of field resources and response vehicles to respond to traffic control for ‘Hwy1’, as required.
 - i.e. current Traffic Control Level 1.5.
- Traveller Information – As part of the TMC public communications strategy, this highway is included in traveller advice and incident information that is proactively communicated to the public via radio and the internet.
 - i.e. current Traveller Information Level 2.5.
- Incident Management – The full-time TMC has prepared and established a set of multi-agency plans that outline processes and procedures used to respond to unplanned events on ‘Hwy1’.
 - i.e. current Incident Management Level 3.5.
- Planned Network Access Management – This stretch of road is ‘fairly simple’ and does not have complicated arterial connections (although urban sprawl is now encroaching into the regional areas west of the city and state plans call for ‘Hwy1’ to be progressively upgraded to accommodate the impacts of urbanisation). The government has formalised current business process in place to track and coordinate roadworks or external activities on this highway.
 - i.e. Current Planned Network Access Management Level 1.

Figure 3.4 shows the current level of ‘Hwy1’ under the five categories.

Step 2: Identify the current operational outcomes using KPIs when they add value

Table 3.9 sets out some commentary on the current operational outcomes being experienced on ‘Hwy1’.

Table 3.9: Example current operational outcomes

Operational Outcome Type	Motorway Current State Commentary
Network and Traffic Flow	• Travel times are fairly predictable, but congestion is growing as urbanisation expands, leading to further significant drops in network level of service. • Concern exists that the capacity of ‘Hwy1’ is increasingly being reached in the more urbanised areas.
Incident Occurrence	• The highway is well designed and the number of crashes are limited. • However, the higher travel speeds on ‘Hwy1’ correlates with some historical incidents involving serious injury or fatality.
Incident Clearance	• Response times are currently set at 30 minutes with a target of full incident clearance within 60 minutes for 90% of incidents. • Congestion levels are increasing where urban development is occurring, and more minor and secondary incidents are on the rise.
Informed Road Users	• Road users have limited information available to them. • The information that is available is usually repeated through local radio stations.
Impacts from Planned Events	• Planned events are uncoordinated, but the events have minimal impact due to the relatively low traffic volumes across the majority of the highway. • However, planned events are starting to cause issues closer to developed areas, with some road works not being clear of the highway by the time of peak traffic in the mornings and afternoon.
ITS System Performance	• TMC currently reports no significant issues.

Step 3: Identify the operational outcomes desired for the motorway

The main challenge for 'Hwy1,' is that while the operational outcomes are currently at a reasonable level, the level is gradually declining, particularly where urban growth is increasing demand.

Planned activities and incidents with inadequate traffic control on 'Hwy1' have recently caused congestion that takes longer than expected to clear.

The desired operational outcome for 'Hwy1' is to maintain the current outcome levels as urban growth occurs. Initially, the TMC will need to arrest the current declining outcomes levels to today's levels and then to maintain the desired levels.

However, in the absence of any smart motorway improvements it is expected that the level of operating outcomes will continue to decline.

Therefore, before the gap widens further between current versus desired operational outcomes, action is required.

This example assessment highlights how the gap between current and operational outcomes could be supported by specific *quantitative* KPIs relevant to the particular jurisdiction.

Step 4: Review how different operating characteristic level(s) could close the gap in the desired operational outcomes

The assessment of the current and future needs for operational outcomes has identified that both planned and unplanned events have contributed to the increased congestion. These events have led to longer travel times, less travel time reliability and difficulty in getting incident scenes re-instated for normal operation.

As per the operating characteristics' levels assessment in Figure 3.4 above, both traffic control and planned network access management are currently at lower levels than the desired state.

By referring to the matrix of operating characteristics, the following changes will aim to raise the Traffic Control operating characteristic category to Level 3:

- Installing variable speed limit signs (VSLs) across the first 100 kilometres of 'Hwy1' to reduce the injury severity of incidents happening when greater traffic volumes are still travelling at high speed.
- Installing variable message signs (VMS) between main intersections across the first 20 kilometres of 'Hwy1' and where higher levels of urbanisation are occurring.

By referring to the matrix of operating characteristics, the following additional changes have been recommended to raise the Planned Network Access Management category to Level 3:

- Introduce a formal permitting system for granting access to the network with appropriate conditions set as part of the permits. This system should also include the road and ITS maintenance activities as part of this process.
- Use available data with improved data quality from weekly analysis to identify opportunities in coordinating different planned events to reduce the amount of overall road closures required.

Refer to Section 5 for how this SMCM also intersects with the capability framework.

4. The Capability Framework

This section sets out the foundational principles of the capability framework and describes the different elements of the framework to support its application within the context of smart motorways operations.

4.1 Framework Introduction

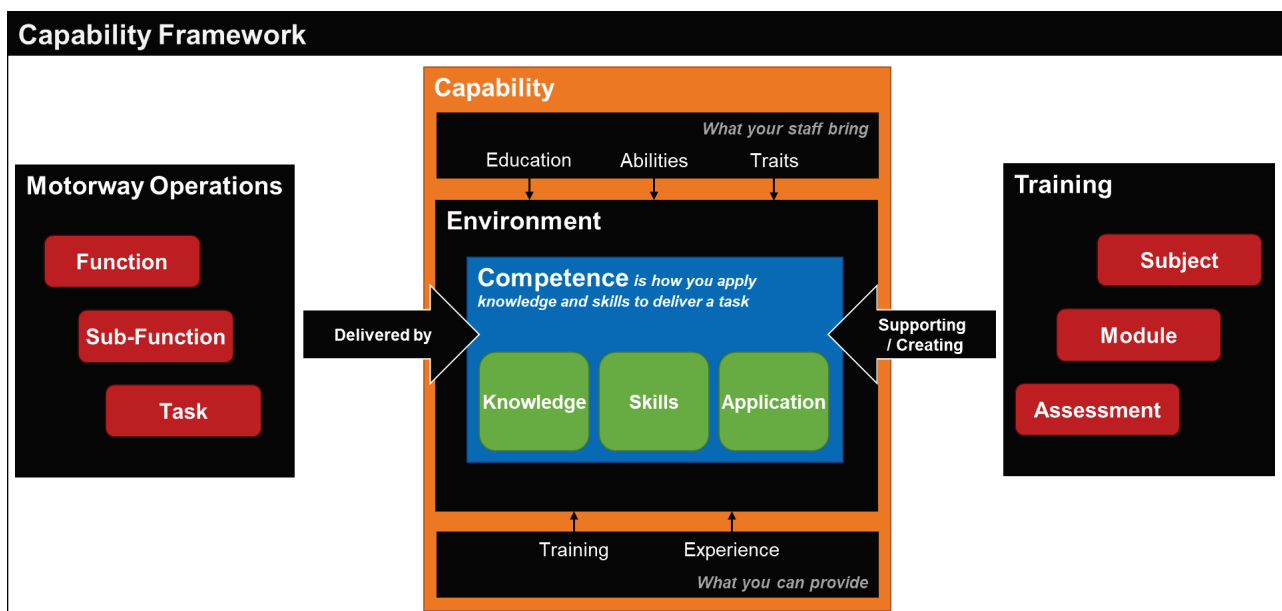
4.1.1 Overview

Two alternative (sometimes complementary) approaches exist to provide capability frameworks. The first approach, outlined in Section 4.1.2, focuses on human resource (staff and suppliers) capability. The second approach focuses on the capability of an organisation as a whole. These guidelines provide brief commentary on this second approach.

A capability framework for an organisation typically defines the core skills and capabilities required for the organisation to deliver to its purpose and meet its business objectives. Such frameworks also refer to processes, policies, procedures, systems and tools.

A capability framework, linked specifically to motorway operations, comprises the elements shown in Figure 4.1. Note that 'Tasks' is interchangeable with 'Activities' and 'Responsibilities' in the capability framework.

Figure 4.1: Elements of a capability framework



The above capability framework shown in Figure 4.1 was developed from a literature review of available frameworks and combining concepts across multiple sources, including:

- *Capability Framework* (University of Otago 2018)
- *Career and Capability Framework Interim User Guide* (Queensland Family and Child Commission 2018)

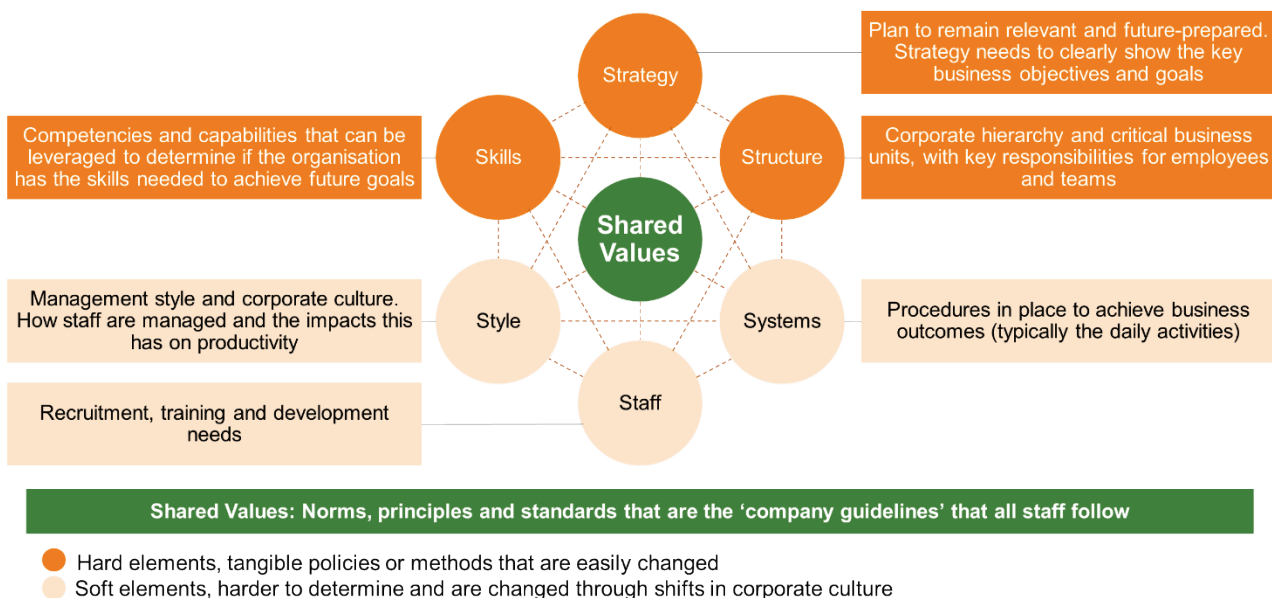
- *TLI – Transport and Logistics Training Package* (Australian Department of Education, Skills and Employment 2021)
- *TLI40519 Certificate IV in Traffic Control Room Operations* (Australian Department of Education, Skills and Employment 2020)
- *DPTI Capability Framework* (South Australia Department of Planning, Transport and Infrastructure 2015)
- *Draft Support Systems and Network Operations Master Capability Framework* (Victorian Department of Transport 2020).

Within the context of motorway operations, the human resource capability needs can be directly correlated with the core tasks typically undertaken at each SMCM operating characteristics level (Section 3).

4.1.2 Organisational Capability and Human Resource Requirements

Organisational capability refers to the collective competencies and experience of the whole organisation and best practice dictates traceability to the organisational purpose and strategy. The McKinsey 7S, shown in Figure 4.2, is often used as a tool to analyse the linkage between strategy and capability.

Figure 4.2: McKinsey '7S' framework



Source: Adapted from Consulting Frameworks: McKinsey 7S Framework (180 Degrees n.d.)

An organisational capability framework typically provides a common suite of tools to support the attraction, recruitment, development and retention of competent personnel. The framework would also provide a consistent approach toward an ongoing review of issues, prioritising such issues and continual improvement needs for the organisation. This ongoing review may include strategic considerations of resilience, disaster recovery, crisis management and specific information technology support.

Good examples of organisational capability frameworks that demonstrate such an approach include:

- *Business Process Frameworks for Transportation Operations: Capability Maturity Frameworks Overview* (US Department of Transportation Federal Highway Administration [US DOT FHWA] 2021)
- *The NSW Public Sector Capability Framework* (New South Wales Public Service Commission 2020)
- *Victorian Public Service Capability Framework* (Victorian Public Sector Commission 2020).

Note that individual human resource capabilities to deliver tasks may be nuanced but form a key part of the collective organisational capability. As individual personnel gain experience and become increasingly skilled, organisational capability may also shift from largely informal ad hoc processes towards having improved governance through established standardised procedures, continuous improvement process and proper engagement with relevant stakeholders.

4.2 Motorway Operations

This section describes the purpose and activities required to operate motorways with the focus on achieving the targeted motorway outcomes (as outlined in Section 3.4). The purpose and activities are described by taking the structured approach of categorising the operations into functions, sub-functions and then either tasks, inputs or responsibilities.

While these tasks and responsibilities might be undertaken by different motorway operations teams within a transport agency, they are all collectively important for the overall delivery and success of motorway operations.

Sections 6 to 9 of this document describe the typical functions that form part of the operations of motorways and against which human resource capability requirements are mapped.

Table 4.1 below provides a summary of the four main functions and sub-functions covered by these guidelines.

Table 4.1: Overview of motorway operations functions and their sub-functions

Function Name	TMC Business Management	Live Motorway Operations	Motorway Operational Planning and Optimisation	Motorway Projects Integration
Sub-Functions	Quality Management	Intelligence	Concept of Operations	Preparation for Project Integration
	Operator Capability and Training	Traffic Control	Incident Management Planning	Project Development (Planning and Design)
	Stakeholder Relationships	Traveller Information	Planned Network Access Management	Project Delivery Technology
	Facility and Fault Management	Incident Management	Optimising TMC Operations	Project Delivery Temporary Traffic Management
	People Management		Network Traffic Optimisation	Project Handover
	Systems Management			

These functions and sub-functions align with AASHTO Guidance (US DOT FHWA 2021) and cover:

- **Business processes** including formal scoping, planning, programming and budgeting
- **Culture** including technical understanding, leadership and outreach
- **Organisation and workforce** including task management, organisational structure, staff development, and recruitment and retention
- **Collaboration** including relationships with public safety agencies, local governments, other governmental planning agencies and the private sector

- **Systems and technology** including use of systems engineering, systems architecture standards, interoperability, and standardisation
- **Performance measurement** including measures definition, data acquisition, and data utilisation.

4.3 Capability

Capability is simply defined by the Oxford University Press as '*the ability to do something*'. Distilling capability into the factors that influence or directly contribute to a person's capability is more complex.

In the context of the capability framework (refer Figure 4.1), a person's capability consists of skills, knowledge and experience. Capability also encompasses having the right training to enable a person to deliver the necessary tasks, activities, or responsibilities as defined throughout these guidelines.

4.3.1 Initial Capability

Initially, when staff assume their business or organisational role, they bring with them their **education**, **abilities** and **traits** (character). These traits play a key part in their initial competence but do not limit the ability to improve competence over time.

The organisations can then provide **experience** and **training** which would be able to directly contribute to the improvement of the competence of that individual.

Section 6.3.5 contains more detail on capability progression.

4.3.2 Environment

As TMCs often have shifts up to 12 hours at a time and the opportunity to take work breaks during a major incident can be limited, it is essential that the operators (and other staff within the motorway operations teams) are provided with the right working environment.

Under the capability framework of these guidelines (refer Figure 4.1), 'Environment' covers the following:

- physical working environment (e.g. chairs, lighting, air conditioning and equipment)
- systems environment (e.g. systems functionality, interfaces and system performance)
- culture environment (including levels of empowerment and support).

For example, an operator working a 12-hour shift is unlikely to be working optimally if they were provided a basic office chair and working under fluorescent lighting. Many TMCs provide chairs and workstations that are specifically designed and built for extended periods of use to minimise eye strain and ensure sound ergonomics.

Section 6.5 provides more detail on the physical and systems working environment as part of general facility and operations management. Section 6.6 provides more detail on the culture environment such as fatigue management as part of People Management.

4.3.3 Competence

Competence, also called 'proficiency', is how a person applies their knowledge and skills to a task, including making decisions and use of available tools.

Competency in this framework is the key component that links the three parts of the model together. A competent operator should undertake tasks, and the operator becomes competent through training. Section 6.3.3 provides more detail on competency management, with capability progression covered in Section 6.3.5.

4.4 Training

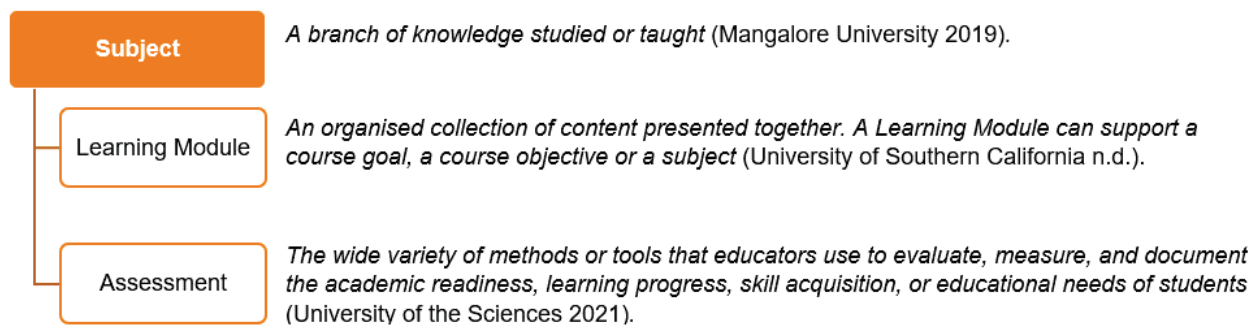
TMCs and motorway operations can present new concepts, tools and systems to staff through training, especially with rapidly evolving technologies for smart motorways. As such, Learning and Development programs are essential to successful motorway outcomes.

Staff can develop the necessary competency through the training programs to carry out motorway operations tasks and activities.

4.4.1 Subjects, Modules and Assessments

Learning and development programs often follow the structure of Subjects > Modules > Assessments. This is further detailed in Figure 4.3.

Figure 4.3: Learning and development programs



Sections 6.3.6 and 6.3.7 provide more detail on training.

5. Intersection between SMCM and Capability Framework

This section describes the intersection between the three models (frameworks) described in the guidelines and seeks to demonstrate where and how they are related.

5.1 The Intersection

The guidelines identify three key themes in the first part of the document:

1. The scope of TMC services, including service types and levels of service (operating hours), as described in Section 2.
2. Typical operating characteristics for each of the operating categories in the SMCM as described in Section 0.
3. The capability needs of the operations teams as supported by the capability framework described in Section 4.

This section provides guidance on how these three themes intersect and interact to enable a useful application of the SMCM and the capability framework.

Figure 5.1 provides a diagram that shows the capability needs as an intersection of the scope of services (y-axis) and the operating characteristic level (x-axis).

Note that the 'scope of services' axis is an arbitrary scale of how complex a TMC operation is, combining:

- the number and type of services being operated from the TMC
- the level of service being delivered by 'hours of operation'
- the network length and complexity being actively monitored and managed.

Also note that as the operating characteristic levels are determined per the five operating characteristic categories, the diagram could effectively be repeated in five different types, one for each category.

Figure 5.1: Capability needs at the intersection of the SMCM and scope of services

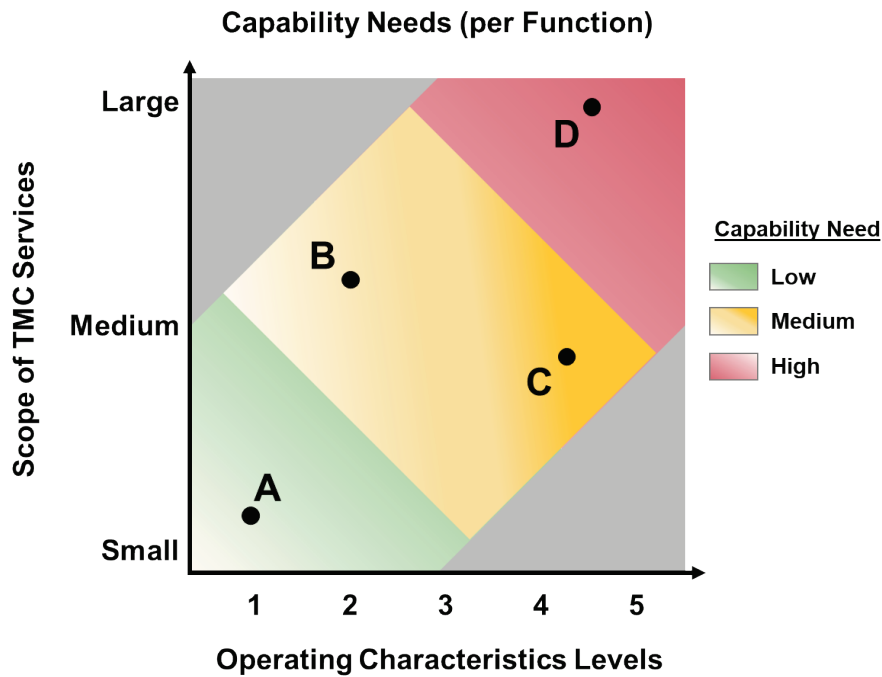


Figure 5.1 includes 'Grey Zones' located at the top left corner and bottom right corners. These zones indicate the unlikelihood of:

- an extensive scope of services being undertaken at an operating characteristic level of 1 or
- a minor scope of services being delivered at an operating characteristic level of 5.

The diagrams marked as A, B, C and D contain four scenarios to demonstrate the application of Figure 5.1. The following four tables provide example descriptions of the three models for the four scenarios. The worked example provided in Table 5.1 to Table 5.4 is for the operating characteristic category of live motorway operations.

Table 5.1: Scenario A: Low operating characteristic level and small scope of TMC services

Scope of Services	Operating Characteristic Levels	Capability Needs
Network Being Managed • Inner city motorways only Operation Types • Standard Motorway Operations TMC Operations Duration • Active monitoring during peak period coverage (8 hrs/5 days a week) – for example 6 to 10 am and 3 to 7 pm Available Resources • Limited staff also perform other duties outside live operations • Limited incident response resources to draw upon	Intelligence • Limited CCTV coverage to support monitoring and event management • Dedicated call hotline for police to advise of incidents and requests for support Traffic Control • Limited VMS • Access to limited call out resources Traveller Information • Arrangement with local radio stations to pass on traveller information for incidents • Local radio station proactively reporting congestion levels during AM and PM peaks only Incident Management • Incident Management Strategy exists • A reasonable working relationship with police (not formalised) • A few response plans prepared for critical section of network Planned Network Access Management • Simple application and approval process for external parties to access and work in the motorway corridor • Records requested and approved activities in a register	'Low' Capability Needs • Operators need to be skilled in using the few ITS systems available to them • Operators need to be confident in taking prompt action as due to the small nature of the team, they are likely to be alone or have limited access to others with more experience • Operators need an understanding of emergency management processes and how police work • Staff involved with Planned Network Access Management will need to know how to maintain the register of activities in train • Staff involved with Planned Network Access Management need to be qualified in temporary traffic management • Staff involved with Planned Network Access Management need an understanding of the impacts that different types of activities would have on the network at different times of the day

Table 5.2: Scenario B: Low operating characteristic level and medium or large scope of TMC services

Scope of Services	Operating Characteristic Levels	Capability Needs
Network Being Managed • 2 large bridges • 4 km road tunnel • total 300 km length of motorways Operation Types • Standard Motorway Operations • After-hours back-up service for a small TMC TMC Operations Duration • Active monitoring during long weekday coverage (16 hrs/5 days a week) – for example 6 am to 10 pm Available Resources • Limited staff perform a wide range of duties relating to live operations, while also responsible for other duties	Intelligence • Some CCTV coverage to support detection of non-recurrent congestion • Dedicated call hotline each for police and ambulance to advise of incidents and requests for support Traffic Control • Centralised coordination with a few pre-organised resources • Some field devices and equipment used e.g. VMS at key decision points Traveller Information • Local radio stations, social media pages, website pass on traveller information for incidents and congestion levels weekday coverage only Incident Management • Incident Management Strategy exists, and is reviewed every 5 years • A good working relationship with police (formalised) • Standard response plans prepared for critical sections of network (including a few detour plans) and the two large bridges Planned Network Access Management • Centralised simple application and approval process for external parties to access and work in the motorway corridor • Records requested and approved activities in a simple database	'Medium' Capability Needs • Operators need to be skilled in using the ITS systems available to them • Operators need to be confident when coordinating pre-organised resources • Operators need an understanding of emergency management processes per the formalised agreements with police (e.g. MOU) • Operators involved with Planned Network Access Management will need to be skilled in using the specific database systems • Staff involved with Planned Network Access Management need to be qualified and experienced in temporary traffic management

Table 5.3: Scenario C: Higher operating characteristic level and small or medium scope of TMC services

Scope of Services	Operating Characteristic Levels	Capability Needs
Network Being Managed • 50 km of motorways • 1 large critical bridge Operation Types • Standard Motorway Operations TMC Operations Duration • Active monitoring during short weekday coverage (12 hrs/5 days a week) – for example 7 am till 7 pm Available Resources • Some staff perform a small range of specific duties relating to live operations, with shared responsibility amongst the team for other duties	Intelligence • Ample CCTV coverage to support automated detection of congestion • Dedicated call hotline each for all emergency services to advise of incidents and requests for support Traffic Control • Many field devices and equipment used e.g. VMS at key decision points • Centralised coordination with some pre-organised specialist resources Traveller Information • Same as above • Ability for people to subscribe for alerts Incident Management • Incident Management Strategy exists and is reviewed every 2-3 years • A good working relationship with police (formalised) • Detailed and comprehensive response plans prepared for critical sections of network (including several detour plans) and the one large bridge Planned Network Access Management • Centralised application and approval process for external parties to access and work in the motorway corridor • Records requested and approved activities in a detailed database	'Medium' Capability Needs • same as above

Table 5.4: Scenario D: High operating characteristic level and large scope of TMC services

Scope of Services	Operating Characteristic Levels	Capability Needs
Network Being Managed • 3 x main critical bridges • All motorways and tunnels • total length 250 km Operation Types • Standard motorway operations • Tunnel • Bridge • Busway • Public transport TMC Operations Duration • Continuous active monitoring (24 hrs/7 days a week) Available Resources • Large pool of staff who perform specific duties within live operations • Multiple incident response resources to draw upon	Intelligence • Full CCTV coverage to support automated monitoring, detection and event management • Dedicated call channels for each emergency service and for external tow service providers to advise of incidents and requests for support Traffic Control • Coordinated and automated equipment and devices for multiple travel modes • Access to a big pool of pre-organised call out resources Traveller Information • Local radio stations, social media pages, website pass on traveller information for incidents and congestion levels at all hours • Subscription alerts are tailored for the person's approximate location Incident Management • Incident Management Strategy exists and is updated annually • A formalised working relationship with police • Multi-agency response plans prepared for all critical sections of network, tunnels and bridge Planned Network Access Management • Sophisticated application and approval process for internal and external parties to access and work in the motorway corridor • Records requested and approved activities in a comprehensive database	'High' Capability Needs • Operators need to be skilled in interpreting output of ITS systems available to them • Operators need to be confident in taking rapid action due to the large network scale being managed and need for proper mitigation of additional flow-on impacts • Operators need an understanding of emergency management processes and how multiple agencies work together • Staff involved with Planned Network Access Management will need to know how to maintain the database of activities • Staff involved with Planned Network Access Management need to be qualified and experienced in temporary traffic management • Staff involved with Planned Network Access Management need an understanding of how to mitigate impacts of different activities on the network at different times of the day

5.2 Capability Framework Tasks by SMCM Operating Characteristic Levels

The tasks shown in the capability framework (Figure 4.1) relate to the operating characteristic levels in the SMCM.

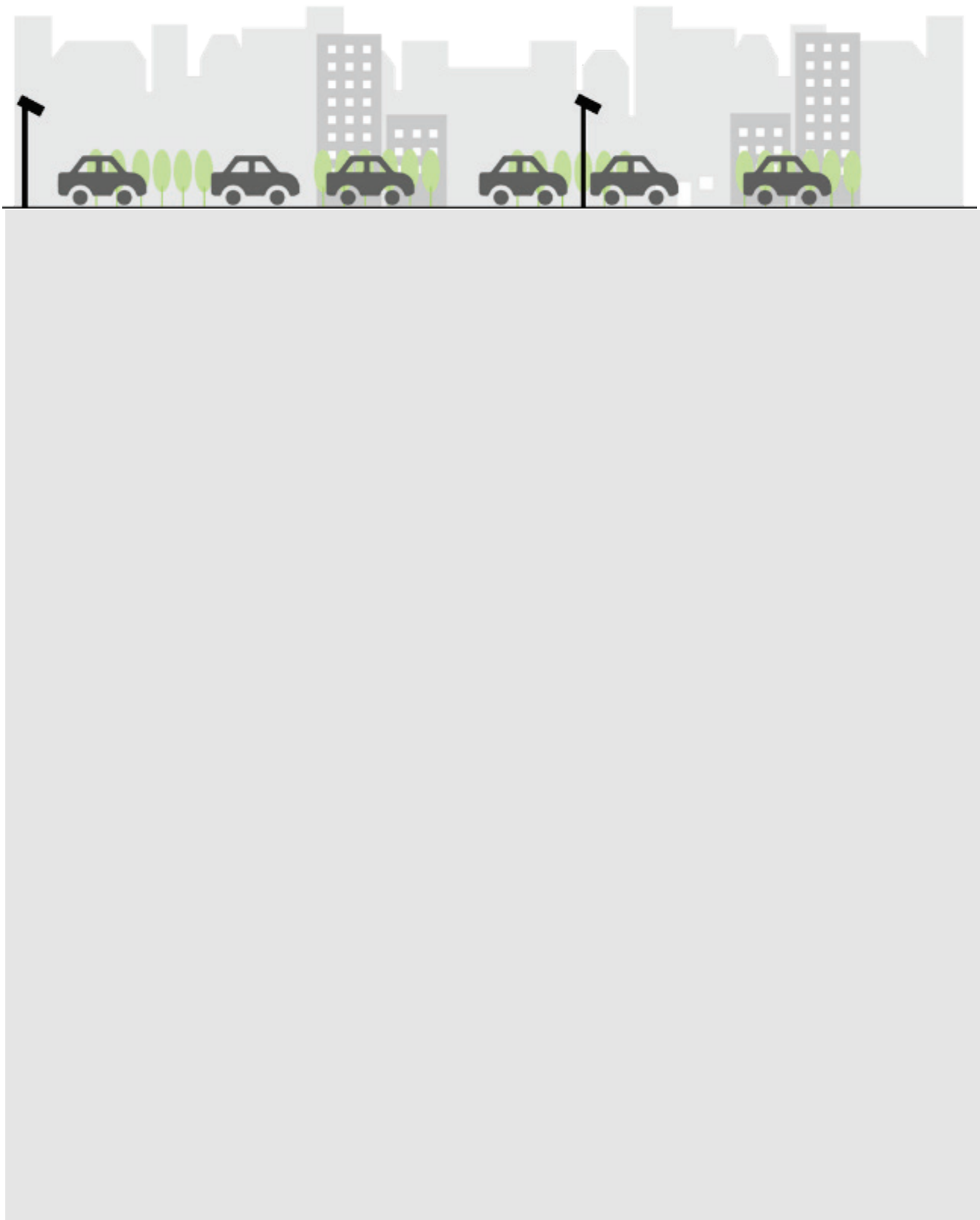
The capability framework functions and sub-functions that directly relate to the operating characteristic categories are shown in Table 5.5.

Table 5.5: SMCM Operating characteristic category versus SMCM functions and sub functions

SMCM Operating Characteristic Category	Capability Framework Function Sub-Function
Intelligence	Live Motorway Operations Intelligence (Section 7.2)
Traffic Control	Live Motorway Operations Traffic Control (Section 7.3)
Traveller Information	Live Motorway Operations Traveller Information (Section 7.4)
Incident Management	Live Motorway Operations Incident Management (Section 7.5) Motorway Operational Planning and Optimisation Incident Management Planning (Section 8.4)
Planned Network Access Management	Motorway Operational Planning and Optimisation Planned Network Access Management (Section 8.5)

Through relating the tasks and/or responsibilities for these sub-functions against the operating characteristic levels, the operations team should gain a thorough understanding of the types of tasks and responsibilities that represent a maturity journey from Level 1 through to Level 5.

Part II: Motorway Operations Functions and Sub-Functions



6. TMC Business Management

This section describes the sub-functions of TMC business management and provides guidance on the activities, tasks and responsibilities that transport agencies can apply to achieve best practice.

6.1 Introduction

The TMC business management function covers the **behind-the-scenes** support areas that play a vital role in enabling live motorway operations. TMC Business Management activities also serve to create the right environment and relationships to support motorway planning, project integration, and operations for planned events and incidents.

This section outlines a number of activities and tasks common to many organisations (e.g. people management sub-function). The intent of this section is to provide the context of the 'why' and the 'how' of such activities as relevant to TMCs (and motorway operations teams), so as to enable the right support (i.e. resourcing and funding) for these activities.

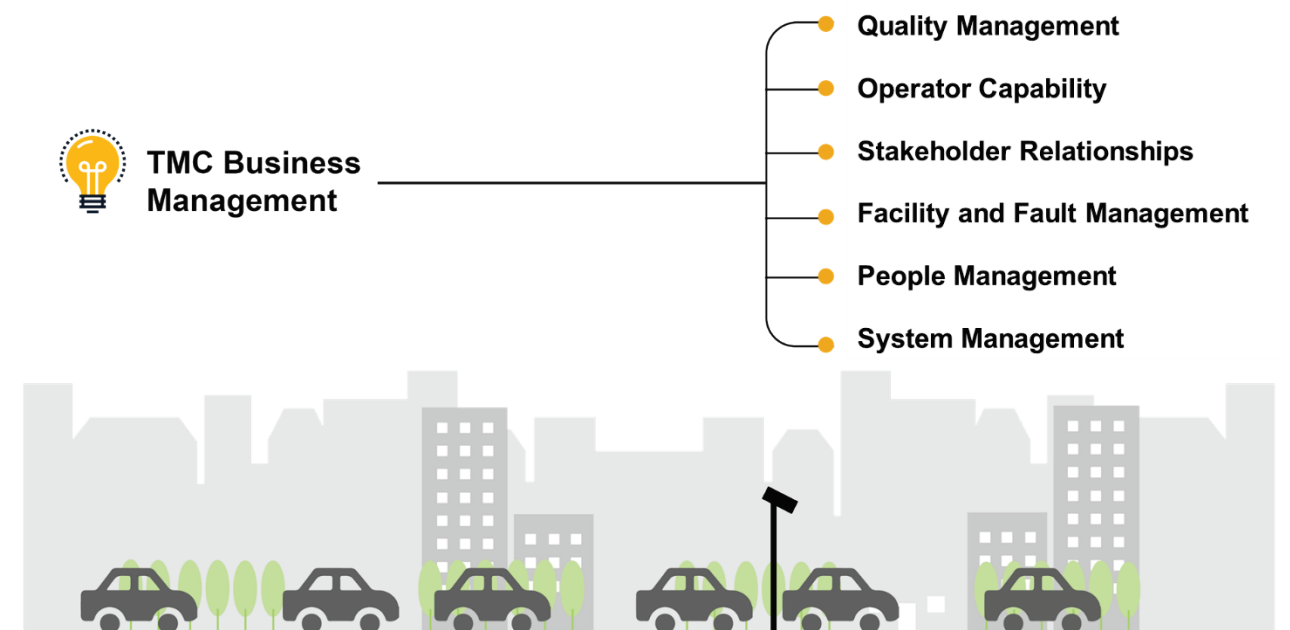


Each TMC should prepare and maintain a business plan at least every three years. As well as other standard information, such as budgets, the plan should cover the seven sub-functions listed in these guidelines and address how the TMC is addressing these needs and what improvements will be made over the duration of the plan.

As discussed in Section 2.2, TMCs are often involved in areas outside of motorway operations. These guidelines focus on the motorway operations aspects of the TMC.

TMC business management is broken into sub-functions as listed in Figure 6.1 and described in more detail in Sections 6.2 to 6.7.

Figure 6.1: TMC Business management sub-functions



6.2 Quality Management

6.2.1 Purpose and Background

Purpose: To create and provide the appropriate level of quality management necessary to support the operations and management of TMCs.

Note: as part of the TMC Business Management function this section focuses on the *behind-the-scenes* activities, including the business support and documentation requirements to enable operations. As such, this section does not address the quality of the actual operations delivery which is addressed in Sections 7 to 9.

A documented quality management approach provides a strong foundation for the operation of the business, ensuring alignment between business operations and with continuity of operations through the staff changes that will occur over time.

The establishment of the TMC business operations quality management also sits within a wider organisational context. TMC business operations needs to fit in with the wider business but can also leverage existing quality management processes that are already set up (e.g. a policy and procedure for undertaking quality audits).

6.2.2 Quality Management Responsibilities

The following provides a list of standard responsibilities for this sub-function that would normally be appropriate for the delivery of smart motorway operations:

- Setup and maintain a quality management system, including policy, process, procedures and work instructions, including:
 - policy for management of new technology
 - policy for appropriate use of communication systems
 - policy for risk management
 - procedure for incident management
 - policy for document management
 - procedure for all the tools/systems provided have been quality assessed and deemed fit for purpose
 - work instruction for manual set up of ITS devices (e.g. Variable Message Sign)
 - manual for the CCTV control system.



Start simple – the best place to start establishing a quality management system is to prepare a quality management system manual that defines the business approach. Staff should begin with simple concepts such as standardising document naming and identifying types of documents that will make up the quality management system.

6.2.3 Continuous Improvement

Motorway operations and TMCs can be challenging work environments, where staff are continuously working with changing situations, while also embracing new technologies. These challenges often result in a need for staff to be continually learning, adapting and coping, so as to improve the operation of motorways.

The first step to continuous improvement is to set up an improvement process as part of the quality management system. Embedding this process will foster a culture of innovation for the business of TMC, which will need to encourage staff and facilitate learning on leveraging the benefits from constantly evolving ITS technologies and their impact on motorway operations.

The following provides some examples of different ways to achieve continuous improvement:

- conduct ongoing reviews of standard operating procedures to ensure optimal outcomes
- hold debriefs after major incidents (see Section 8.4.5)
- identify gaps in capability through use of specific metrics
- undertake quality auditing and assessments
- conduct regular audits and reviews of the TMC operation (within the facility and in the field) and assess compliance with government policies and procedures, undertaken by a formally appointed committee
- apply metrics (e.g. system interventions, call logs, detection time) in these quality audits and reviews of motorway operations that are bespoke and specific to the local TMC conditions
- promote involvement and participation in working groups and industry forums on digital transformation and emerging technologies.



The success of the business operations will equally rely on people, process and systems. All of these three areas will need support for the operation to continually improve. For a culture of continuous improvement and embedding innovative thought, understanding the constant interaction between all these three elements is important.

6.3 Operator Capability and Training

6.3.1 Purpose and Background

Purpose: To provide the necessary experience and training for operators to achieve the appropriate competency for undertaking the functions of the TMC.

A recent Austroads project recognised a lack of traffic management knowledge and skills in young practitioners (Austroads 2020c). This gap led to the development of a series of online learning modules in traffic management, including one on transport operations control strategies and systems.

The full list of training modules, access to the recorded webinars and associated PowerPoint slides can be found on the Austroads Traffic Management Training web page (Austroads 2022).

Further information on operator training and capability is available in the *Human Factors Guidelines for Transportation Management Centers* (US Department of Transportation Federal Highway Administration 2018).

6.3.2 Operator Capability and Training Responsibilities

In addition to the information below, also refer to Section 5 for further information and discussion on the capability needs for different levels of operations.



It is difficult to manage any part of the network in isolation. Operators who are supported in completing relevant training courses would have a broader understanding of how the wider network works will contribute more and make a greater impact

- Always leverage and integrate with existing HR processes, such as performance appraisal and development systems, where possible.
- Use a Framework only as a high-level guide and keep your approach simple and straightforward.
- Training is only one means of achieving learning and development outcomes.

The following provides a list of standard responsibilities for this sub-function typical for the delivery of smart motorway operations:

- develop and maintain a training and competency program across:
 - use of operational tools and systems
 - operational policies, processes and procedures
 - situational decision making.
- develop and maintain documentation that defines the structure for training and competency management. This documentation could include:
 - training and competency policy
 - a Learning and Development Framework that identifies the skills needed and aligns these with appropriate training modules. This document could also support or include a competency framework.
- training plans for different motorway operations roles (see Appendix G for an example training timeline of new TMC operators)
- deliver training modules and mentoring (e.g. through a 3-month 'buddy' program) especially as the TMC/motorway operations become more complex and the need to understand technology applications increases
- evaluate training module useability
- undertake competency assessments for operators
- prepare and run operational scenario workshops
 - providing trials with emergency services and other major third parties
 - increased use of emulated environments for training purposes.
- provide training and competency pathways (Training Organisations/inter-road authority/in-house).



Just because a TMC is large does not mean that the operators necessarily need to have a higher level of capability. Sometimes a TMC operator at a smaller TMC has to be skilled and capable across many different systems and functions whereas in a larger TMC an Operator can be specialised in fewer systems and functions.

6.3.3 Competency Management

In *ISO 55001:2014 Asset Management*, Section 7.2 requires the organisation to undertake the following for competence management:

- determine the necessary competence of person(s) doing work under its control that affects its asset performance, asset management performance and asset management system performance
- ensure that these persons are competent on the basis of appropriate education, training, or experience
- take actions to acquire the necessary competence, and evaluate the effectiveness of the actions taken
- retain appropriate documented information as evidence of competence
- review current and future competency needs and requirements regularly.

While these requirements might be targeted at asset management activities, the same requirements exist generically for how organisations need to support competency for motorway operations.

A formal framework or equivalent plan should be produced and implemented across motorway operations. This competency management framework would include aspects designed to help manage underperformance or poor staff performance.

Competency management activities may be undertaken through a variety of methods and tools, such as:

- performance plans
- formalised theory assessments
- formalised practical testing including use of training simulators
- peer review (e.g. providing critique of incident management activities undertaken by a colleague)
- training to obtain or maintain a certification or licence.

All competency management activities listed above may be undertaken once-off or on a regular basis (e.g. annually). Competency management could be delivered in-house or by external parties and may be undertaken to target specific skills or knowledge areas of TMC staff.

For example, new staff may undertake an entry-level competency check on autonomous TMC operation before they may work unsupervised. Similarly, a senior operator may undertake annual tunnels and LUMS training to maintain and increase their level of competency.



Several providers have off-the-shelf Competency Frameworks that can be used and adapted for most clients' purposes.

6.3.4 Example of Learning and Development Steps for New Staff

The following list outlines the common steps when a new staffer commences in motorway operations:

1. They join the organisation with some initial knowledge which is then supplemented with new knowledge through a start-up training program.
2. They then begin their role using that knowledge to develop new skills through on-the-job or supervised work.
3. These new skills can be enhanced through scenario training and exercises.
4. As they demonstrate their ability to apply their knowledge as skills then they progress on to un-supervised live operations.

6.3.5 Example of Competency Progression

Table 6.1 below defines five operator competency levels. This example includes the expected minimum experience at each level and the corresponding timeframe.

Table 6.1: Example of length of time (experience) required at different operator levels

Level	Operator Levels	Expected Minimum time at this level	Expected maximum time at this level
1	Trainee	4 weeks training	7 weeks training
2	Graduate	9 months	12 months
3	Operator	3 years	5 years
4	Senior	5 years	No maximum
5	Chief	By invitation only	

Note that 'experience' duration starts from when the operator graduates from the initial training and commences as a live operator permanently on the roster.

Once an operator has graduated from the initial training and attained the minimum level of experience required for the next grade, they can apply for the next level of competency.

The fourth column in Table 6.1 above sets out the expectations that the operators will continue to progress through the competency levels.

This example shows clearly that experience is a key part of being competent and that an operator cannot progress up the levels on just training and passing tests alone.

6.3.6 Training Types

Different types of training are required to support knowledge growth for motorway operations.

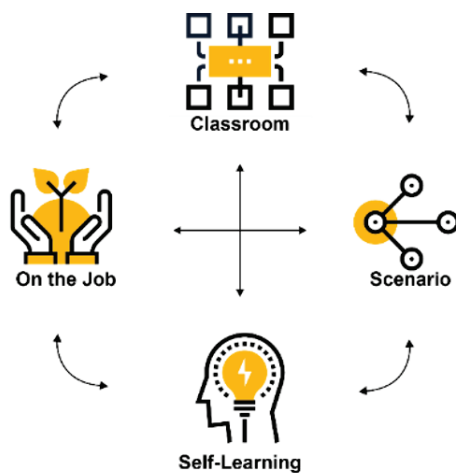
As with the principles behind competency management in Section 6.3.3, training should be tailored and should target specific skills, abilities, or knowledge areas to facilitate staff development and professional growth. The knowledge area of technology and intelligent transport systems is particularly important in contemporary TMC businesses.

Training may be one-off to refine certain advanced capability or undertaken on a regular basis to gradually improve capability. Training content usually covers a specific type or multiple types of TMC operations (see Section 2.1).

Training courses may be delivered in-house or by external parties. Note that external parties can be certified individuals, specialist training officers or external staff sourced from a registered training organisation.

This section and Figure 6.2 outline four types of training and provides some examples.

Figure 6.2: Types of training



‘Classroom’ Training

Formalised lessons with structured content and often associated assessments to measure level of knowledge and competency attained. Some examples include:

- career progression training through an accredited supplier in traffic operations
- first aid training
- training on how to use specific systems (e.g. traffic signal system, job logging system)
- training on a specific business process that could utilise multiple systems (e.g. incident management process)
- tier 1 (junior) versus tier 2 (senior) operator training
- introduction to emergency management

- 2-day course for Level 1 Coordinated Incident Management System (CIMS)
- refresher training on planned event procedures
- relevant courses conducted through the appropriate Industry Training Organisation (ITO).

‘Self-Learning’ Training

Learning in the staff member’s own time is becoming more common and usually utilises e-learning and videos. This approach can range from formal training where assessments are built into the e-learning module through to more informal training that is aimed at being informational, such as a video on the latest updates to software. Some examples include:

- e-learning module on introduction to civil defence and emergency management
- Waka Kotahi NZ Transport Agency provides LinkedIn™ Learning access for all staff
- video distributed to staff to communicate new user functionality for the VMS control system
- viewing a system update video
- reading memos relating to required operational changes based on a new Standard Operating Procedure
- familiarisation with operational manuals e.g. *Variable Message Signs Operational Manual* (Roads ACT 2011)
- video training library of work instructions, which can be system specific e.g. STREAMS™ workflow in QLD.

‘On the Job’ Training

Staff work under supervision in the live environment and with the support of experienced staff to guide the trainee. Some examples include:

- ‘buddy’ system for new staff for a nominal period, say 4-6 months
- updates on system changes
- emerging and new technologies including applications of machine learning
- short briefings on system updates during periods of low operational activity.

‘Scenario’ Training

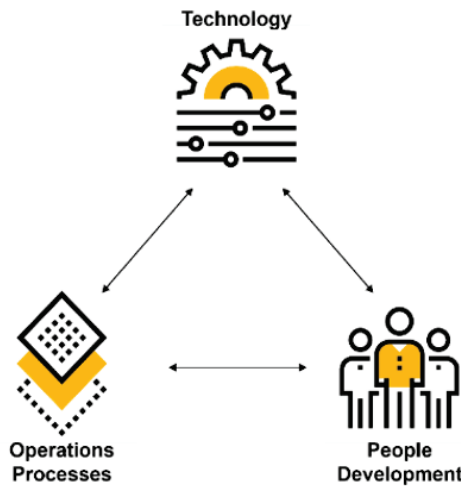
Scenario training involves the use of simulations and/or simulators to demonstrate to trainees, operational situations that they may not often encounter, from which to learn and work through. This training provides a safe environment where there are no consequences for failing but rather, facilitates and encourages learning. Some examples include:

- operational scenario workshops prior to launch of new system or infrastructure
- emergency management practice (often called exercises)
- use of a traffic simulation to practise the control of traffic signals for different scenarios
- software testing on an IT test platform (can double as training experience)
- desktop worked scenario with questions on how the individual would respond to different situations.

6.3.7 Training Focus

While a training program includes different types of training, the training plan will need to include the three focus areas such as Technology Systems, Operations Processes, People Development (Figure 6.3).

Figure 6.3: Training plan focus areas



Technology Systems

Training in specific systems focused on what inputs are required and how to achieve specific tasks. Some examples include:

- how to operate the CCTV control system
- how to access different weather monitoring stations and download the appropriate data
- how to look up approved road closures from the organisations work permitting system.

Operations Processes

Training in the operations processes and procedures focused on achieving outcomes. Some examples include:

- training on the processes and procedures from the quality management system
- induction training to introduce and provide an overview of motorway operations and facilities
- introductory training on regulations, traffic engineering and other ITS aspects
- training on installation, use, maintenance requirements of specific asset and systems
- training on emergency procedures and liaison with the media.

People Development

Training that focuses more on the 'soft' skills, broader capability and resilience of the operators. Some examples include:

- cultural awareness training
- an external course on operational management
- team leadership training for the senior operators
- courses that introduce principles and ideas for problem solving such as human-centred design thinking.

6.4 Stakeholder Relationships

6.4.1 Purpose and Background

Purpose: To create and manage relationships with external stakeholders that allow the outcomes from motorway operations to be maximised.

This section excludes the operations relationship with the road users, which is covered in Section 7.4 on Traveller Information.

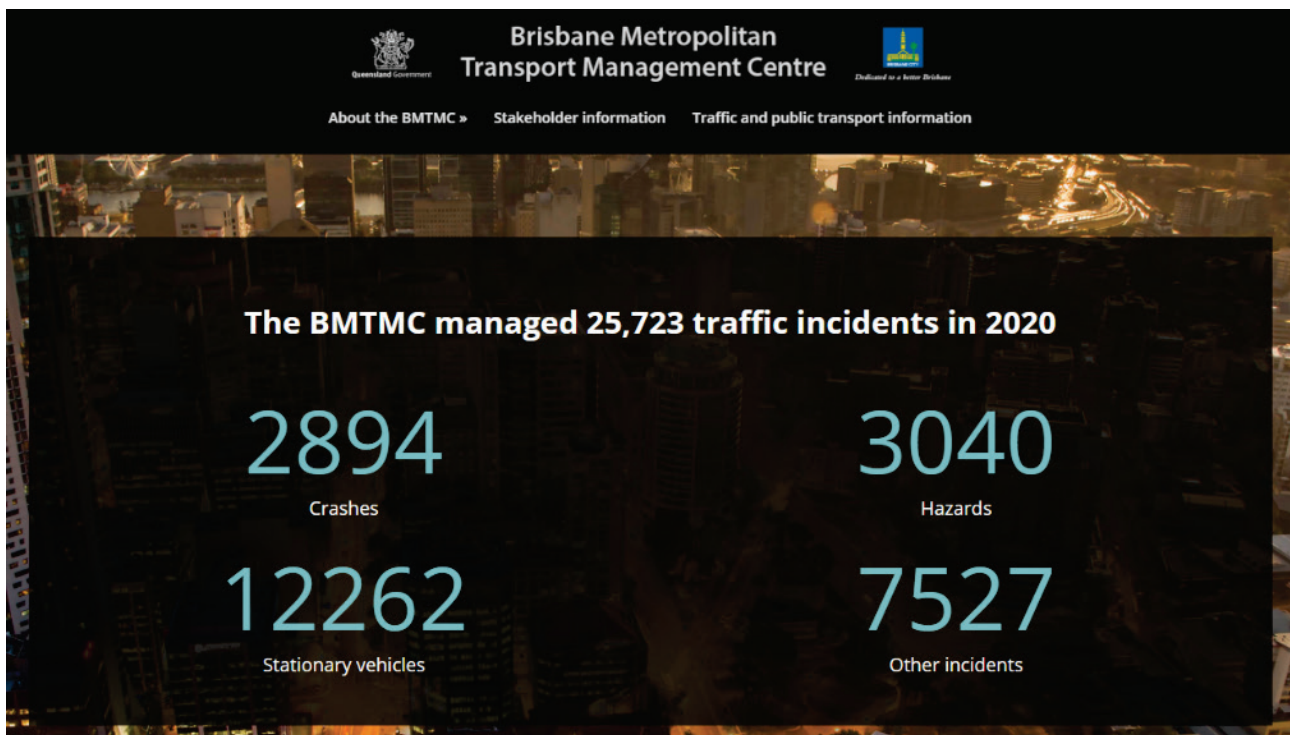
Types of relationships will range from highly formal, involving agreements such as a Memorandum of Understanding (MOU), through to informal relationships such as educating the public.

6.4.2 Stakeholder Relationships Responsibilities

Below is a list of standard responsibilities for this sub-function typical for the delivery of Smart Motorway operations. Stakeholders may be internal or external to the TMC or operational team.

- Create and maintain a close working relationship with neighbouring road agency operations and TMCs (ideally formally via a MOU) for the management of incidents, common outcomes and network connection points. This working relationship could include:
 - understand the boundaries of operations including during joint operations
 - rules based operating agreements
 - system to system interface between operating systems including asset maintenance liability
 - periodic meetings on good practices
 - liaison with other teams such as TMCs on an ongoing basis to discuss new technologies.
- Create and maintain a close active working relationship with media outlets and/or the in-house media team for effective dissemination and reporting of information to the public and to collaborate for the management of major incidents and events.
- Create and maintain a good working relationship with public transport (PT) providers who are based at the same facility or via a MOU around PT operations and the effects on the network.
- Provide educational opportunities to stakeholders and the public to help improve the understanding of motorway operations, the challenges and the successes. These opportunities could include:
 - a web-presence about the TMC and operations, for example, the Brisbane Metropolitan Transport Management Centre website (Brisbane Metropolitan Transport Management Centre n.d.)
 - organised visits and tours of the TMC.
- Establish standards and requirements for industry when interacting with TMCs, including at the boundaries of two adjacent TMCs.
- Actively engage with other authorities and agencies (e.g. police, ambulance, civil defence, motorists' associations).

Figure 6.4: Example stakeholder information on traffic management displayed on the Brisbane Metropolitan Transport Management Centre web page



Source: Brisbane Metropolitan Transport Management Centre (n.d.)

Note that the relationship with police and emergency services for incident management is covered under Section 8.4.2 as part of Section 8.4 Incident Management Planning.

Note also that some further relationships for the supply of field resources to support during incidents and events, is covered under Section 8.4.3 as part of Section 8.4 Incident Management Planning.

6.4.3 Case Study

Who | The Tasmania Department of State Growth (DSG)

Problem | The Tasman Bridge provides a critical link between eastern and western Hobart, as well as to the Hobart International Airport and regional areas. Incidents that occurred on the Tasman Bridge have resulted in heavy congestion along the Tasman Highway. This congestion commonly extended towards Hobart CBD and caused gridlock within the city.

Solution | An improvement project, led by DSG in close collaboration with Tasmania Police (with inputs from Hobart City Council), in 2017 enabled more effective communications for rapid incident management response and recovery. The project covered the Tasman Bridge as well as the broader network, including nearby traffic signals and state roads.

Benefits | The project resulted in a communications agreement between DSG and Tasmania Police. They also developed collaborative incident management plans, leading to DSG's improved working relationship with the police and vice versa.

6.5 Asset Management

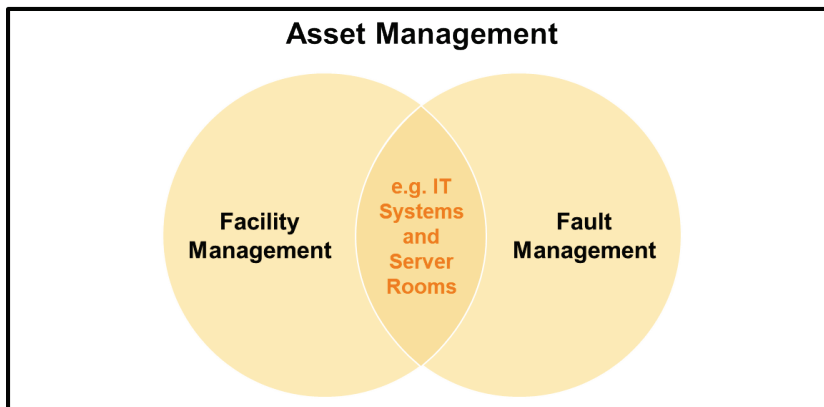
6.5.1 Purpose and Background

Purpose: To provide the necessary asset, facility and fault management activities that support the TMC and enable it to operate for its intended purpose.

This section covers asset management, encompassing both facility management and fault management activities. Fault management in these guidelines specifically refers to the ITS and roadside equipment whereas facility management refers to the office environment (i.e. building, desks, chairs).

Figure 6.5 shows the relationship between these three areas. Asset management is the broader term that includes facility and faults management as well as more strategic and management activities. Note that facility management and fault management are interrelated and have overlaps in responsibilities and, as per the diagram, converge in the IT systems usually housed in the TMC IT server room.

Figure 6.5: Relationship between asset, facility and fault management



Further information on TMC environments and design can be found in Chapter 4 The TMC Environment and Chapter 5 Displays and Controls in the *Human Factor Guidelines for Transportation Management Centres* (US Department of Transportation Federal Highway Administration 2018).

Figure 6.6: Example NSW TMC operator facility



Source: *Intelligent Congestion Management Program case study (Transport for NSW 2018a)*

6.5.2 Asset Management Responsibilities

Fault management is a key part of asset management to ensure assets are functioning to the required level of service throughout their lifecycle. The following provides a list of standard responsibilities for asset management appropriate for the management of the facilities and systems used for the delivery of smart motorway operations:

- If the organisation has established asset management at an organisation level, then ensure that all of the responsibilities and activities highlighted in this section conform and fit in with the organisational approach (for asset management).
- Asset management processes that have been established are required to be followed to ensure that the 'practice' meets the organisational needs, such as safety and legislative compliance for the operation of Smart Motorways.
- Prepare and maintain an Asset Management Plan, which may include content outlined in the AGAM Part 2 (Managing Asset Management) and Part 10 (Implementation and Improvement) such as:
 - levels of service
 - future demand
 - risk management
 - asset life-cycle management (maintenance activities, renewal forecasts, new capital programs, etc.)
 - financial information and funding scenarios
 - asset management practices and improvement plans.

- Undertake asset management for the facilities and the equipment in accordance with the underlying asset management strategy and direction for improved facility and fault management performance, including the identification of:
 - maintenance and renewal needs (Austroads 2016b)
 - improvement programs
 - annual budgets.
- Arrange any contracts or agreements to undertake maintenance, renewal and improvement works.
- Carry out appropriate change management for when changes need to be made to the operations facilities and systems.
- Prepare a disaster recovery plan, with particular attention to continuity of power, communications (voice and data), identified critical assets and resources that form part of the Smart Motorways.

If the organisation does not have an established or formal asset management approach then there are a number of standards, manuals and organisations that can provide guidance, including:

- Guide to Asset Management (Austroads 2020f; AGAM)
- ISO 55000 series
- International Infrastructure Management Manual (IIMM) by NAMS a division of the Infrastructure Public Works Engineers of Australasia (IPWEA)
- Asset Management Council
- Global Forum on Maintenance and Asset Management (GFMAM).

6.5.3 Facility Management Responsibilities

The following provides a list of standard responsibilities specific to facilities management to support the delivery of smart motorway operations:

- Prepare and maintain a Facilities Management Plan (FMP) that describes how the responsibilities covered by this section will be addressed. This FMP should either include or be linked with a separate Asset Management Plan.
- Provide the facilities that create the right environment from which to successfully deliver operations. This can include:
 - The required spacing and placement of equipment, such as the correct sight lines to comfortably view any common display panels for CCTV and other operational information.
 - A fit-for-purpose lighting and air conditioning environment that reflects that the operators are often working for long periods, including up to 12-hour shifts and also working overnight.
 - The appropriate desk and seating ergonomics that support operators working up to 12-hour shifts in an emergency like environment.
- Maintain any emergency back-up power and communication needs.

Figure 6.7: Example Queensland TMC operator facility



Source: Brisbane Metropolitan Transport Management Centre (n.d.)

6.5.4 Fault Management Responsibilities

The following provides a list of standard responsibilities specific for fault management to support the delivery of smart motorway operations:

- Provide the necessary fault and asset management activities that allow the motorway operations systems, field equipment and devices to meet their expected service times, asset life, functionality, and operational purpose.
- Provide a range of tools and systems to monitor, manage and predict faults (including automatic and remote fault testing).
- Conduct routine checks involving physical inspection of assets on the network and field devices.
- Undertake frequent maintenance of computer systems (including hardware), the server room and communications assets.
- Provide feedback and 'lessons learned' to technicians, service providers and other relevant stakeholders regarding the operating conditions and limitations of assets (e.g. traffic control signs).
- Undertake a risk analysis on how different types of faults affect the ability to carry out operations.
- Liaise with the Asset Managers for ITS assets to ensure the alignment with fault reporting and full lifecycle management is considered.
- As the operation grows, the organisation will need to provide dedicated fault/contract managements. For example, the Auckland Transport Operations Centre (ATOC) employs dedicated contract managers to oversee the maintenance, renewal and upgrade works for traffic signals and CCTV maintenance as well as ensuring that the right data is maintained and updated in the asset management information system.

If the organisation does not have an established or formal fault management approach then there are a number of standards, manuals and organisations available that can provide guidance, as previously listed in Section 6.5.2.

6.6 People Management

6.6.1 Purpose

Purpose: To provide the necessary people management and human resource (HR) activities that enable and support the recruitment, wellbeing, and retention of motorway operations staff.

6.6.2 People Management Responsibilities

The following provides a list of the general HR responsibilities that would be expected to be delivered or supported by HR staff in the organisation:

- maintain work health, safety and environment obligations including mental health support after a major incident event
- define roles and responsibilities within teams and for teams within the broader business
- facilitate career progression and professional growth including stretching the staffer's development into specialist operational areas
- provide staff continuity planning (e.g. working from home arrangements) as part of pandemic response and other emergency scenarios
- ensure adherence to suitable fatigue management
- ensure compliance with national employment laws and union agreements.



Tasks should be allocated in a way that operators' mental workload remains in a mid-level range. In this range, operators are able to engage in their current tasks while reserving additional mental resources that are needed to react to sudden events (Federal Highways Administration 2018).

More specific responsibilities have been included in the following sections.

6.6.3 Recruitment

The main challenge with the recruitment of TMC operators and staff is the difficulty in sourcing candidates with prior relevant experience for this niche area. Recruitment needs to focus more on the correct aptitude and attributes to cope with working in fast-paced environments that deal with the public and public emergencies, using a significant number of systems and technologies.

The *Human Factors Guidelines for Transportation Management Centres* (Federal Highways Administration 2018) provides further information on operator knowledge, skills and abilities as well as selection of candidates.

Note that specific competency-based tests and/or minimum years of experience may still form part of the requirements prior to the attainment of certain roles (e.g. TMC Senior Operator).

6.6.4 TMC Roles

Table 6.2 provides a list of possible roles that could be required to staff a TMC. These roles will depend on the size of the operation, and may require more than one person. In some smaller operations, more than one role may be carried out by a single person.

Dedicated versus Multi-Function Roles

When designing the right roles for motorway operation, managers should consider whether some or all of the operators should be dedicated to one area of operations (e.g. just motorway incident response) or cover a number of operations (depending on the broader organisation structure).

For example, at Victoria DoT, managers integrate day to day operation of managed motorways with the existing day to day traffic management and incident response functions.

Table 6.2: Example TMC roles

Name of Role	Role Description
TMC and Operations Room	
TMC Manager	Oversee all aspects of the Traffic Management Centre to ensure that the facility is fit-for-purpose, the operations staff are well supported and that the operations undertaken from the centre are conducted efficiently and effectively.
Operations Supervisor	Responsible for maintaining day to day operational activities undertaken from the TMC Operations Room
Operator Trainer	Responsible for all training and skills development needs for the operators, including the establishment and maintenance of the training and competency programs.
Trainee Operator	Undertake a subset of the Operator duties and support the operations team in the live environment including systems monitoring services using a collection of traffic control and reporting systems.
Operator	Undertake a broad set of duties using a collection of systems covering intelligence, traffic control, dispatching and traveller information to manage planned and unplanned events in the live operations environment.
Senior Operator	If operations are large enough to allow the allocation of senior operators onto each shift then they would provide leadership and have increased responsibilities, over and above the role of an operator in the live operations environment, including the following: • act as an incident coordinator for major unplanned events • act as operations coordinator for major planned events • deliver some of the training for new operators or new services • liaise and negotiate with internal stakeholders to address concerns associated with (and to progress and provide input for) programs, projects, systems and/or services.
Traveller Information Coordinator	Responsible for effective and efficient information dissemination through available communication channels and roadside devices. May address the processing of data and video for traveller information purposes, and the dissemination of information to media, customers, other partnering agencies and other traveller information systems. These functions are typically contracted to Information Service Providers (ISP).
ITS Maintenance and Faults Leader	Responsible for managing the faults and maintenance process for the ITS and smart motorway systems as well as establishing and managing the supply chain to support fault resolution and maintenance and renewal works.
ITS Technology Leader/Technician	Responsible for providing information technology (IT) skills to the running and maintenance of the ITS systems that usually connect to the TMC. Will usually get heavily involved in the handover phase of smart motorway projects (see Section 9.7).
Network Operations Planning and Optimisation	
Network Operations Planner	Responsible for determining architectures, long range plans, systems planning process, modelling/analysis, concepts of operations, and driving performance measurements/evaluations matching the local context.

Name of Role	Role Description
Incident Management Planner	Addresses the preparation of incident response plans to be used during possible incidents, including; incident categorisation, incident severity levels, traffic detours, congestion mitigation measures, traveller information strategies, and stakeholder relationship with incident response resources and emergency services.
Network Performance Analyst	Responsible for analysing available data using locally driven metrics and providing input to developing solutions for complex problems in the motorway network. May also impart knowledge to key stakeholders on motorway operations issues e.g. locations prone to recurrent congestion, incident occurrence patterns, pinch points at an interface between motorway and arterial
Network Optimisation Engineer	Systematic focus on how to setup and configure ITS systems (e.g. ramp signalling, traffic signals along routes, variable speed management) to optimise the network performance against the defined objectives and outcomes.
Network Access Manager or Coordinator	Responsible for conducting advanced planning and coordination related to various events (e.g. major construction, special events, multifaceted roadworks that span the full carriageway), assessing applications for network access and make determinations under the relevant legislation, investigating compliance issues and formulating acceptable solutions to minimise impact on traffic operations. May also train people in using the agency internet/intranet portal, develop and deliver new systems to align with legislative changes and recommend amendments to current practices.
Transport Planning and Projects Integration	
Motorway Project Liaison (see Section 9.1.5)	Responsible for championing operational and project integration needs (focussed on achieving desired outcomes) as the key point of contact between the project team and wider operations team. Also facilitates access to appropriate operational expertise as well as negotiates or influences other business units, organisations and agencies throughout the project.
Handover and Implementation Liaison (see Section 9.7)	Responsible for successful interactions between the project team and motorway operations team during the handover and implementation phase, focussing on meeting the 'go-live' operational needs and integration of new systems (if any).

Career Development

Several approaches and models exist for career development. Some may be more formal within an established organisational structure with clearly defined senior, intermediate and junior roles, while others could be focused on capability or proficiency development as opposed to formal positions/roles.

Some potential steps for career progression could include:

- move or rotate operators to other areas of the business outside of the operations room or TMC. These rotations could include roles such as:
 - network optimisation
 - network operations planning
 - road planning coordination
 - maintenance contract manager
 - planned road interventions (signs/lines).
- conduct 'development days' for operators to help them experience other areas of the business
- provide staff with funding for further study outside of their current role.



Career progression can be difficult for operations staff as often a flat structure is required to staff the control room operations. Consider other duties outside of the control room to support people development as well as recognising seniority. This could include developing training material, liaison with projects, guiding tours of the facility and managing shift rosters.

Table 6.3 provides an example of a framework for operators and other operations staff to progress from proficiency levels of 'Awareness' through to 'Expert'.

Table 6.3: Example Operations Staff Proficiency Levels

Proficiency Levels			
Awareness	Working	Practitioner	Expert
- Entry level awareness for individuals newly in role - Has a common knowledge and understanding of the basic skills, knowledge and behaviours associated with a capability - Applies basic techniques and concepts to complete processes from start to finish - Individuals knowledge is deepened by time and experiences within the role including provision of basic training	- Individual has gained experience over 6 to 18 months within the role. - Applies knowledge and skill successfully to increased level of complexity associated with a capability - Assistance may be required on occasion, but in general an individual works independently - Identifies barriers impeding capability demonstration and seeks and implements a relevant course of action to remedy - Individuals enhance their skills through completion of work and directing others	- Individual has gained experience in this capability in similar roles and environment over 2 to 3 years - Consistently applies knowledge and skill to complexity associated with a capability - Is recognised as a credible source of advice and information - Can direct others in tasks related to this capability to deliver successful outcomes - Can navigate complexities associated with the demonstration of this capability across multiple stakeholders - Assists, consults and leads others to apply a capability - Coaches and mentors others to enable development of the capability	- Individual has gained experience, skills and knowledge in this capability over several years. - Excels in demonstrating this capability and has a strategic focus to develop this capability at organisational level - Is recognised organisational wide for expertise and influence across a number of teams/projects - Maximises capability uplift across the organisation, and seeks to resolve issues restricting the development of the capability

Source: *Draft Support Systems and Network Operations Master Capability Framework* (Victorian Department of Transport 2020)

Also refer to Section 6.3 for more information on operator capability and training.

6.6.5 Staffing Levels

When setting staffing levels, managers should consider the following factors relating to the motorway operating environment:

- number of systems and roadside technologies
- level of systems sophistication (e.g. types of equipment or technology)
- length of corridor being covered (through monitoring and/or controls)
- level of automation
- extent of active monitoring (e.g. part-time or full-time TMC)
- volume of planned works (including maintenance) within the managed area
- Impact (number and timing) of major infrastructure projects involving motorways and operations input (see Section 9).

The SMCM covered in Section 3 indicates that motorways with increasing sophistication and greater level of operating characteristics will have growing operational demands to match. Subsequently, the staffing, equipment resourcing and environment of TMCs will need to evolve when a transport agency looks to move towards a desired future state of motorway operations.

A greater number of systems and roadside technologies paired with higher systems sophistication may lead to increased maintenance needs and additional specialist smart motorways staff (e.g. to undertake proactive fault management).

Also, a lower level of automation may lead to a higher need for additional TMC and network optimisation staff. A higher level of automation may lead to a reduced need for TMC and network optimisation staff but the staff may need to be better-trained to interface with more sophisticated systems.

The *Traffic Control System Operations: Installation, Management and Maintenance Manual* (Institute of Transportation Engineers 2001) includes Table 6.4 below that shows example full time equivalent (FTE) staffing levels for different scales of operation.

Table 6.4: Example staffing levels (ITE 2001)

Agency Category	Hours of Operation (Level of Service)	Program/Centre Manager	Shift Manager/ Supervisor	System Operator	Computer/Network Support
Small	Special Event, Incident Response	-	-	0.5	-
Medium	Peak Period Coverage (8 hrs/5 days)	0.5	1	1	0.5
Large	Short Weekday (12 hrs/5 days)	1	1	2	1
Extended Large	Long Weekday (16 hrs/5 days)	1	2	3	1
Regional	Continuous (24 hrs/7 days)	1	2	5	2

Source: ACT traffic management centre feasibility study (Roads ACT with ARRB 2009)

TMCs are unlikely to achieve their desired motorway operational outcomes if the operational area increases (i.e. as new smart motorways infrastructure projects are built and delivered) without a corresponding increase in smart motorways specialist staffing levels and/or level of automation.

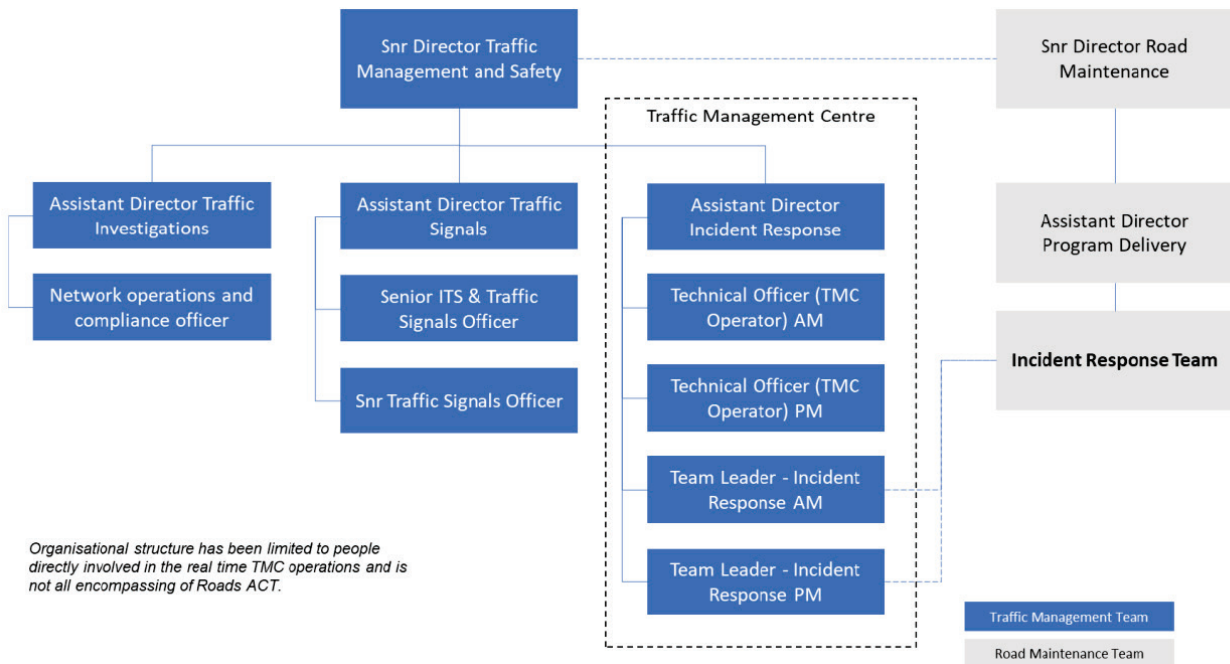
6.6.6 Example Organisation Structure

Organisation structures for motorways operational teams vary across the Austroads member jurisdictions. Many have a dedicated motorways operations team (separate to other traffic teams) that sits within a broader area while some have specialist operations staff embedded across multiple areas without a dedicated motorways team.

For example, the South Australia DIT (Department for Infrastructure and Transport) Traffic Management Centre team sits in Network Management Services and the Smart Motorway and Corridors Team sits in Customer Strategy and Technology within Transport for NSW. On the other hand, the South East Queensland TMC cluster have operators with many activity types that cover motorways and other parts of their transport network.

Figure 6.8 provides an example of an organisation structure covering motorway operations, where the TMC sits within Traffic Management and Safety alongside Traffic Signals and Traffic Investigations but separate to the Road Maintenance team.

Figure 6.8: Example of motorway operations organisation structure



Source: Draft Traffic Management Centre Operational Framework (Roads ACT with AECOM 2020)

6.7 Systems Management

6.7.1 Purpose and Background

Purpose: To provide the necessary systems (and software) management activities that support the acquisition, operation, maintenance and availability of motorway operations systems

Motorway operations systems in a TMC that require management activities cover:

- **Network monitoring systems** including traffic and road use monitoring, data handling
- **Traffic control/management systems** including lane control, ramp metering, traffic flow/speed management, automated operation systems
- **Traveller information systems** including travel time systems, variable message signage, in-vehicle devices, radio, website, social media, as well as database systems that hold transport, infrastructure and event information
- **Event detection and monitoring systems** including video access and control, over height detection, automated incident detection systems
- **Field resources management systems** including dispatch management, vehicle location systems
- **Corridor access permitting systems** including temporary traffic management approval, events approval, road use coordination/activity scheduling systems as well as GIS applications
- **Fault management systems** including ITS, communications and other field devices
- **Display management systems** including human/machine interface.

6.7.2 Systems Management Responsibilities

Below is a list of standard responsibilities for this sub-function considered appropriate for the delivery of smart motorway operations:

- system acquisition and licencing
- system training and support
- system maintenance (e.g. security patches)
- system configuration
- back up facilities (including back up power source for emergencies)
- alarm management, a key part of which involves determining acceptable false alarm rates or level of confidence (e.g. outputs from automatic incident detection)
- provision of configuration and operational support for newly deployed devices on the existing system and associated communication networks
- cyber security management
- change management that is fit-for-purpose for the scale of technology, project and implementation being delivered.

6.7.3 Case Study

Who | Transport for NSW

Purpose | In 2014, Transport for NSW were proactively seeking a streamlined platform for incidents and case management of faults. The platform needed to incorporate existing roadside devices and systems, while supporting collaborative incident management, in alignment with the Transport for NSW business goals:

- better prioritise and manage device fault response
- reduce time to respond and improve engineering resource efficiency
- track and report on device faults.

Solution | *Streamlining State Transport Management: Improving Fault Management With An Agile Platform* (Pegasystems 2014) outlines the agile new incident and case management system for planned and unplanned events. The system has a fault management service (FMS) which automates prioritisation and escalation to manage the process flow to specialised technicians. See Appendix I for more detail on this agile project.

Benefits and Learnings | The FMS enables a dynamic approach to remotely route and expeditiously resolve reported device faults. However, reliance on the manual management of fault incidents by operational staff if and when the system does not properly communicate device descriptions still remains.

7. Live Motorway Operations

This section describes the sub-functions of live motorway operations and provides guidance on the activities, tasks and responsibilities that transport agencies can apply to achieve best practice.

7.1 Introduction

Live motorway operations is the primary and *front-facing* function for managing the day-to-day operational aspects of motorways in recurrent and non-recurrent conditions. Activities range from the monitoring of systems and setting up for an event through to reacting to incidents and recurrent conditions, with the key commonality being that they are all occurring in real-time ('live').

Section 3.2 introduced different levels of operation maturity that exist due to different needs and complexity. These guidelines can be used to support all levels from low level operations that are mostly reactive through to full smart motorways.

Live operations continue to evolve with recent developments including a growing focus on managing and promoting different modal shares. These guidelines provide the foundations for any type of operation and the principles to cope with a changing future.

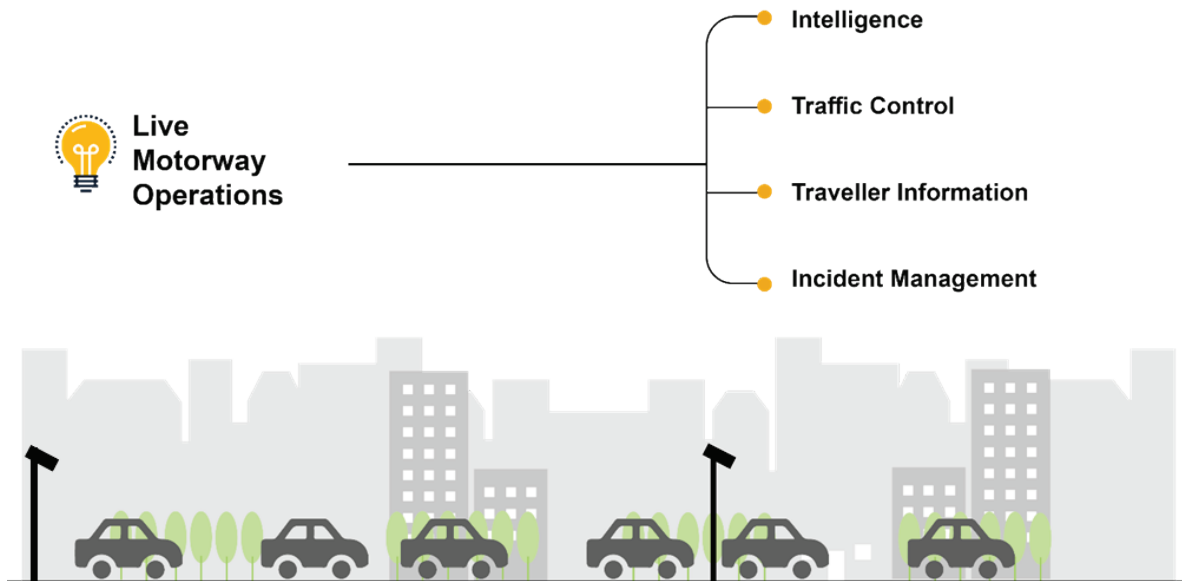
As discussed in Section 2.2, TMCs are often involved in more than one type of motorway operation as well as other operations distinct from motorways. However, these guidelines focus on the motorway operations including:

- Incident Management
- Planned Event Management
- Flow Management
- Tidal Flow and Special Lane Management.

Sections 7.2 to 7.5 set out the four sub-functions of live motorway operations used to manage the above-listed operations. They act as the operational 'building blocks' that can be used to manage any situation or need.

Also note that these four sub-functions, as listed in Figure 7.1, align with the SMCM defined in Section 3 and should work in concert with each other, not as siloed activities.

Figure 7.1: Live motorway operations sub-functions



7.1.1 Live Operations Purpose

The purpose of a smart motorway is to reduce network volatility and delay to improve efficiency and ensure optimum capacity is maintained. Smart motorway infrastructure and operational procedures can be used to:

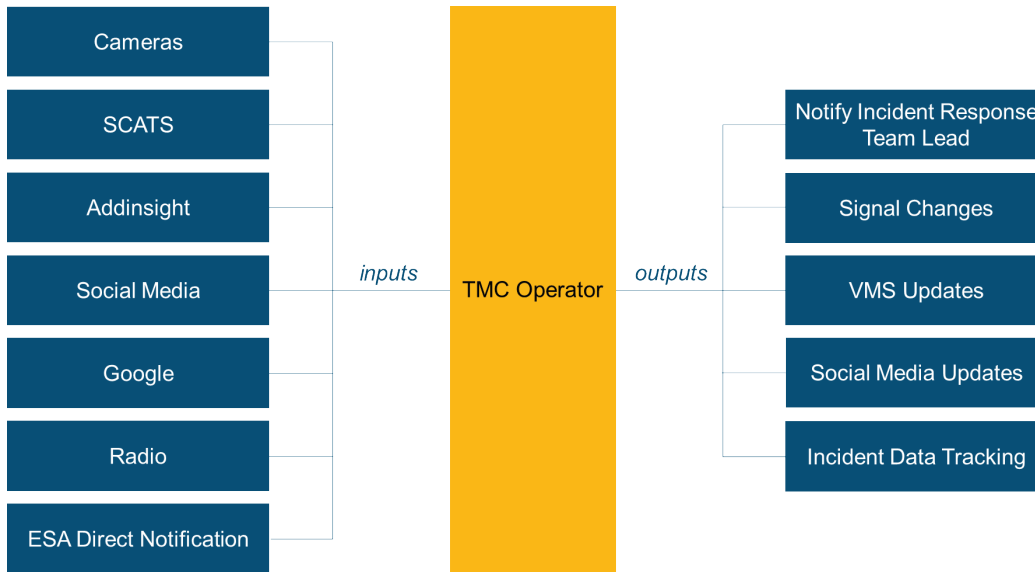
- influence demand
- influence customer behaviour
- improve incident management
- improve event management including maintenance
- optimise the network in real time
- proactively respond to planned and unplanned events and network conditions.

The monitoring of performance operation is essential to support continuous improvement as described in Section 6.2.3.

Example KPIs for monitoring motorway performance can be found under the Smart Motorway Classification Model (SMCM) motorway outcomes in Section 3.4.2.

Figure 7.2 provides an example of the variety of inputs and outputs that a TMC must handle during live operations.

Figure 7.2: Example ACT TMC inputs and outputs for a role in live operations



Source: Adapted from Draft Traffic Management Centre Operational Framework (Roads ACT with AECOM 2020)

7.1.2 Motorway Operations ‘Tools’

The motorway operations team have numerous ‘tools’ at their disposal to use to influence the customer experience during planned and unplanned events.

Table 7.1: Overview of tools for motorway operations

Tools	Description
Closed Circuit Television (CCTV)	On-road cameras to allow operators to visually monitor the roadway as well as a key data input for systems such as automated incident detection.
Vehicle Detection System	A variety of technologies that allow vehicle speed and traffic volume to be monitored real-time.
Variable Message Signs (VMS)	Electronic message boards that allow operators to display instructions or information directly to the road users. Often these are used to advise road conditions or closures ahead, support wider network incidents and support safety campaigns.
Lane Control Signals/Lane Use Management Systems (LUMS)	Electronic signs that are for the sole purpose of advising road users whether a lane is open or closed or advising road users to drive to a specified speed (for a given lane). Display lane closures or diversions, with capability to display variable speed limits.
Variable Speed Limits	Electronic signs that are for the sole purpose of advising road users what the current speed limit is for a section of motorway.
Traveller information	A variety of, and growing, range of communication channels that allow operators to provide real time traveller information/advice (e.g. traveller websites, radio, google, Twitter™, Facebook™).
Traffic signals	Prioritise and optimise movements at intersections with motorway ramps e.g. through the use of SCATS™, STREAMS™.
Field Resources	People, vehicles and equipment available for the operators to dispatch to incident and breakdown locations. Their role is to support the incident controller (if applicable) and then help with any clean-up and road reopening as efficiently and safely as possible.
Emergency services	Usually the first responder to incidents (and in some jurisdictions breakdowns). Their initial role is to ensure safety at the incident scene and to act as the incident controller when required.

Figure 7.3: Brisbane Metropolitan Transport Management Centre web page on their role in managing incidents

Here's how we manage traffic incidents



- 1. Detect**

Our operators detect traffic incidents through police and emergency services, bus operators, vehicle detectors, CCTV cameras, and information from the public, our traffic response units, or social media.
- 2. Verify**

The first step in managing an incident is verifying its existence, either through our traffic response units, police on scene, camera or multiple calls to 131940.
- 3. Respond**

Our initial response focuses on making the incident scene and approaches safe, warning motorists and dispatching incident responders.
- 4. Manage**

We aim to minimise congestion by helping motorists plan ahead, and clearing incidents from traffic lanes as quickly as possible.
- 5. Clear**

Once an incident is clear, we continue to monitor and manage roads throughout the area, and provide travel updates until traffic has returned to normal.
- 6. Review**

We always review our response to major traffic incidents to look for ways we can improve our incident management processes and provide motorists a safer and more predictable commute.

7.2 Intelligence

7.2.1 Purpose

Purpose: To monitor and collect live data and information to either detect, verify or predict disturbances from normal traffic conditions, whether caused by incidents or arising from unusual congestion, as quickly as possible, in order to take prompt remedial action.

Note that 'Intelligence' does not cover information disseminated outside of the TMC (see Section 7.4 on Traveller Information).

7.2.2 Intelligence Tasks

The following provides a list of standard tasks for this sub-function that would normally be appropriate for the delivery of smart motorway operations.

Tasks have been aligned with the operating characteristic 'maturity' levels of the SMCM (Section 3.2.1) to demonstrate how capability needs increase when progressing up through the levels. Tasks at the different maturity levels are intended to be cumulative, starting at the baseline Level 1 through to Level 5:

Level 1 – 'Reactive with no incoming data'

- use the available information to verify and validate **called in** incidents are real and correct and confirm the location. This information should also include any intelligence on the severity of incidents
- raise general awareness towards reporting incidents (e.g. if a staff member drives past an incident that is outside of the TMC systems coverage)

Level 2 – 'Reactive with some incoming data'

- monitor the live motorway network (e.g. using incoming traffic volume data and video feeds) to **manually** detect breakdowns, incidents or unusual congestion
- use the available data and information to verify and validate **detected** incidents are real and correct and confirm the location. This information should also include any intelligence on the type and severity of incidents
- monitor changes in weather and environment to aid operational decision making.

Level 3 – 'Some proactive management'

- monitor the live motorway network and **the local road connections** (e.g. using incoming traffic volume data and video feeds) to **manually** detect breakdowns, incidents or unusual congestion
- prioritise surveillance of high-risk locations (e.g. wind on bridges, queued traffic in tunnels)
- establish strategy for data management and intelligence gathering, ensuring a wholistic network intelligence
- maintain working relationships with other agencies involved in incident mitigation/response to share intelligence
- maintain a high level of situational awareness across the motorway network.

Level 4 – 'Substantial proactive management'

- monitor the live motorway network (e.g. using incoming traffic volume data and video feeds) to **automatically** detect breakdowns, incidents or unusual congestion
- use the available data and information to verify and validate **automated detection** of incidents are real and correct and confirm the location. This information should also include any intelligence on the type and severity of incidents.

Level 5 – 'Full proactive management'

Use data collection and analytics to predict potential incidents and alert agencies.



If motorway video footage is to be shared as webcams, best practice is to use separate cameras to those used by the operators. This method supports privacy as operators can tilt and zooms around an incident scene and this footage would be inappropriate for a live webcam.

Use pre-sets on the CCTV so that operators can quickly orientate themselves to know which direction they are looking.

Consider using a diverse range of information sources to support identifying and verifying breakdowns, incidents and unusual congestion, including:

- cameras
- real-time data on vehicle travel speeds
- social media platform feeds
- information through call centres for public to report problems and incidents to TMC
- dedicated TMC phone line used by police and emergency services
- maintenance teams who became aware of incident through duties.

7.2.3 Case Study

Who | Transport for NSW

Problem | The previous traffic management system was built for the Sydney Olympics in 2000 and needed updating to better inform current day operations and reduce reliance on manual processes. The Transport for NSW TMC also wanted a single view across multiple modes for monitoring live road network conditions.

Solution | Transport for NSW developed and implemented an Intelligent Congestion Management Program (ICMP). The ICMP is an integrated and collaboratively built multi-modal transport platform with real-time monitoring, notification and data science elements. The ICMP involves service providers managing major events and delivering network operations planning, publication of information to the public, Power Business Intelligence and predictive modelling (both offline and in real time).

The new system was in place by end of 2020 and also autogenerates congestion alerts that identify unusual conditions on the road network. Additionally the predictive analytics assist operators to predict 30 minutes into the future and act within five minutes of an unplanned event or incident.

Refer to the Transport for NSW Intelligent Congestion Management Program case study for more detail (Transport for NSW 2018a).

Benefits | The new system enabled Transport for NSW TMC to have:

- improved visibility and situational awareness across all modes of transport to support decision making
- improved detection analysis, incident response and clearance times
- proactive management and prevention of congestion
- improved customer journey times, reliability and satisfaction.

7.3 Traffic Control

7.3.1 Purpose

Purpose: To use the available data and information to carry out the active management of traffic using varying types of traffic control devices.

Active traffic management on motorways supports and enables:

- end of queue protection
- optimising and smoothing traffic flow
- safety for road users
- the use of different space e.g. reversible lanes, dynamic shoulders
- traffic diversion when needed e.g. road closure or lane closure during incident.

7.3.2 Traffic Control Tasks

The following list contains standard tasks for this sub-function that would normally be appropriate for the delivery of smart motorway operations. The tasks have been aligned with the operating characteristic 'maturity' levels of the SMCM (Section 3.2.1) to demonstrate how capability needs increase when progressing up through the levels. The tasks at the different maturity levels are intended to be a stepped process, starting at the baseline Level 1 and progressing through to Level 5:

Level 1 – 'Reactive with no incoming data'

- use ad hoc resources and response vehicles to support largely passive traffic control
- traffic control done by field resources.

Level 2 – 'Reactive with some incoming data'

- use pre-organised field resources and response vehicles to support traffic control with centralised coordination
- provide some coordination of field resources including between emergency services and the road authorities' resources.

Level 3 – 'Some proactive management'

- use, control, adjust, monitor field devices and ITS technologies **manually** to manage traffic impacts from incidents, planned events and recurrent congestion
- **manually** manage traffic impacts, on the wider network, resulting from detour routes
- apply speed controls across the managed motorway, in accordance with operational rules, with **manual use** of standard response plans
- apply lane controls across the managed motorway, in accordance with operational rules, with **manual use** of standard response plans
- apply shoulder controls across the managed motorway, in accordance with operational rules, with **manual use** of standard response plans
- manage strategic routes by giving them priority during incidents and managing unusual congestion.

Level 4 – 'Substantial proactive management'

- use, control, adjust, monitor field devices and ITS technologies with **some automation** to manage traffic impacts from incidents, planned events and recurrent congestion
- use **some automation** to manage traffic impacts, on the wider network, resulting from detour routes
- apply speed controls across the managed motorway, in accordance with operational rules, with **some automation** of standard or dynamic response plans
- apply lane controls across the managed motorway, in accordance with operational rules, with **some automation** of standard or dynamic response plans
- apply shoulder controls across the managed motorway, in accordance with operational rules, with **some automation** of standard or dynamic response plans
- clear and manage multi-modal traffic congestion with some automation in a coordinated manner
- actively manage queues at on and off ramps using ramp signals and arterial traffic signals.

Level 5 – 'Full proactive management'

- use, control, adjust, monitor field devices and ITS technologies with **full automation** to manage traffic impacts from incidents, planned events and recurrent congestion
- use **full automation** to manage traffic impacts, on the wider network, resulting from detour routes

- apply speed controls across the managed motorway, in accordance with operational rules, with **full automation** of standard or dynamic response plans
- apply lane controls across the managed motorway, in accordance with operational rules, with **full automation** of standard or dynamic response plans
- apply shoulder controls across the managed motorway, in accordance with operational rules, with **full automation** of standard or dynamic response plans
- select and apply operational rules using automated dynamic plans that involve several device types and systems
- actively manage motorway inflows and lane capacity to maximise network productivity (speed x flow).



With growing complexity of smart motorway systems, and available devices, more systems now apply a standard or dynamic plan to sections of the motorway. Operators need to understand when these plans are working or have created an unexpected consequence, to ensure continual improvement and in the future, support 'machine-learning' in the automation of these plans.

7.4 Traveller Information

7.4.1 Purpose and Background

Purpose: To disseminate available and correct data/information to the public to:

- positively influence or affect driver and commuter behaviour
- manage public expectations.

This task includes the transfer of information between stakeholders, agencies, contractors, consultant organisations, transport operators, PT operators and road users to influence the best use of the available motorway network.

Table 7.2: Types of traveller information technology

Technology	Target User Category
Variable Message Signs (VMS)	On-road Users
Trip planning apps (e.g. Google™ Maps, TomTom™)	All Users
Websites	All users
Social Media	All users
SMS service	All users
Commercial radio broadcasts	All users
Traffic hotline	All users

7.4.2 Traveller Information Tasks

The following lists contains standard tasks for this sub-function that would normally be appropriate for the delivery of smart motorway operations.

The tasks aligned with the operating characteristic 'maturity' levels of the SMCM (Section 3.2.1) to demonstrate how capability needs increase when progressing up through the levels.

The tasks at the different maturity levels are intended to be a stepped process, starting at the baseline Level 1 and progressing through to Level 5:

Level 1 – ‘Reactive with no incoming data’

- call out field resources to put up static temporary information signs.

Level 2 – ‘Reactive with some incoming data’

- create traveller information message content manually
- provide real-time travel information and messaging to radio stations for them to broadcast and support drivers being informed to make their own route choices
- update a simple traveller information website to enable drivers to make their own informed route choices.

Level 3 – ‘Some proactive management’

- foster a culture of 'the customer at the heart' and facilitate understanding of customers
- create traveller information message content with some automation
- distribute accurate, timely live traveller advice and incident information to road users through multiple channels with some automation e.g. subscription-based alerts in a proactive manner
- coordinate incident notification and responses to ensure consistent messaging
- update and manage the traffic website for incident information, with some of the congestion levels now automated
- undertake 'holiday weekend' media campaigns to mitigate the worst of the congestion often experienced on the major routes to and from the major urban centres on holiday weekends
- communicate externally about upcoming planned events (e.g. roadworks) and alternative routes to use prior to key decision points on the network
- provide for media-trained or media staff in the TMC
- establish communications strategy for traveller information e.g. Campaigns around new technology and road management, social media policy and updates for radio stations.

Level 4 – ‘Substantial proactive management’

- provide tailored traveller information, for road users, to certain locations or routes
- using all of the available traveller information technologies and communication channels, inform customers of incidents or unexpected congestion resulting from planned events or other situations on a mostly automated basis.

Level 5 – ‘Full proactive management’

- provide accurate, timely traffic information to road users and to potential future road users across multiple modes fully automatically
- provide open information and open data for optimised decision making, mostly automated.



Confirm communication channels are secure with limited access permissions by TMC staff.
Allow only legitimate and verified information to be broadcast to the general public.

7.4.3 Case Study

Who | Victoria Department of Transport

Purpose | The Victorian Department of Transport sought to improve their efficiency for incident response activities. Currently, the incident management process involves separate job creation and start of response.

Solution | The Victorian Department of Transport is integrate the existing electronic incident logging system with situational awareness tools. This integration will enable the job creation and start of response to occur simultaneously.

Benefits | The new situational awareness tools will enable TMC staff to obtain better knowledge of the incident with faster sharing of this knowledge amongst operational staff.

7.5 Incident Management

7.5.1 Purpose and Background

Purpose: To detect, verify, dispatch incident resources, apply response plans and then manage the resulting traffic congestion to minimise the impacts on the road users, all while optimising safety for the incident scene, incident responders and the road users.

Incident management under live motorway operations covers the activities undertaken when any incident occurs on the motorway. The overarching goal for motorway operations is to provide an integrated and proactive outcome to minimise incident duration (see Figure 7.4) and 'get traffic moving again as quickly as possible' (VicRoads 2021). Using the elements of Intelligence, Traffic Control and Traveller Information will provide optimal outcomes.

Incident management ranges from handling a very minor situation through to the process of managing multi-agency, multi-jurisdictional responses.

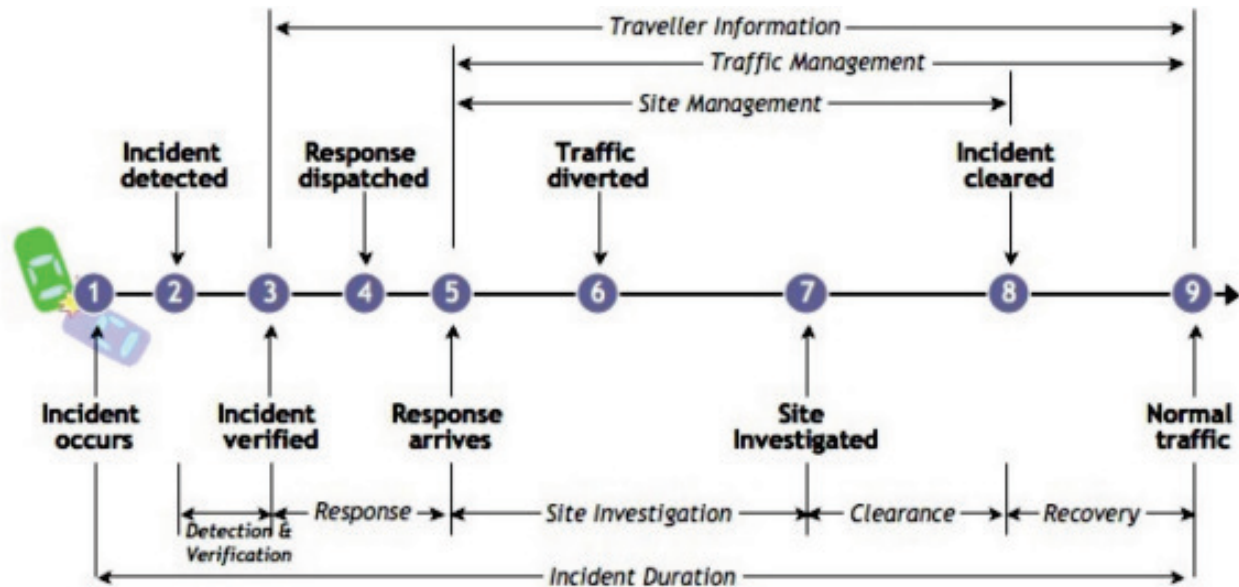
The aims of incident management are to:

- reduce the duration of incident and the resulting incident related delay
- improve safety of road users and responders
- manage environmental impacts and minimise harm to the environment.

Figure 7.4 sets out the timeline of an incident in five phases and highlights the key elements of the response. These five phases are:

1. Detection and Verification
2. Response
3. Site Investigation
4. Clearance
5. Recovery.

Figure 7.4: Traffic incident management components and timeline



Source: Austroads 2017a

Guidance on incident management preparedness is covered in Section 8.4.

In addition to the tasks listed below, further information and detail are available in the research report *Techniques for Incident Management to Support Network Operations Planning* (Austroads 2017a).

7.5.2 Incident Management Tasks

Incident management response is made up of the above sub-functions of intelligence, traffic control and traveller information. This section highlights the tasks that are specific to incident management.

The following list contains standard tasks for this sub-function that would normally be appropriate for the delivery of smart motorway operations.

The tasks have been aligned with the operating characteristic 'maturity' levels of the SMCM (Section 3.2.1) to demonstrate how capability needs increase when progressing up through the levels.

The tasks at the different maturity levels are intended to be a stepped process, starting at the baseline Level 1 and progressing through to Level 5:

Level 1 – 'Reactive with no incoming data'

- call out and use road maintenance resources for incident management response, clearance and recovery.

Level 2 – 'Reactive with some incoming data'

- assess the situation, to determine the level of incident by considering the time of day, type of incident, severity, complexity, sensitivity and possible impacts
- call out, notify and liaise with emergency and repair services
- conduct incident management response using standard procedures with local coordination
- ensure any incoming information used for incident management planning is reliable through cross-checking with multiple sources prior to deploying significant resources.

Level 3 – ‘Some proactive management’

- facilitate swift roadside assistance/towing (see Section 8.4.3)
- coordinate with traffic control on local roads as needed to:
 - install temporary signage
 - implement, develop, operate detour routes
 - monitor traffic operations.
- conduct incident management response using nominated response plans (including detour plans) where appropriate
- monitor and obtain updates from the incident scene
- for longer incidents, provide up-to-date information to customers through the available traveller information technologies and communication channels
- during the incident, determine and operate alternative travel routes for both the inner and outer cordons
- assess, direct, dispatch incident response (field) resources and clearance activities:
 - active management of field resources such as incident management crews, towing, recovery through direct liaison and contact
 - coordinate police and emergency support for response resources getting to the incident site
 - protect the incident site by implementing traffic control strategies (see Section 7.3)
 - identify if any emergency road work and infrastructure repair is required.

Level 4 – ‘Substantial proactive management’

- coordinate with traffic control on local roads and public transport as needed
- follow agreed communication and response protocols between agencies as established through multi-agency response plans
- provide quickest route guidance to the response team and provide signal priority if warranted
- following the initial dispatching and planned implementations for a major incident, it is best to start considering the reopening options early so that options can be discussed and planned for
- use positive ‘road open’ VMS messages after an incident is cleared, e.g. *‘the road is open again but still some congestion’*. This positive approach to messaging helps manage road user expectations by communicating progress and status of the situation.

Level 5 – ‘Full proactive management’

- for major incidents, aim to disperse the impact, rather than concentrate it, balancing the resulting unusual traffic load across the strategic network as far as possible
- follow agreed dynamic multi-modal and multi-network response plans that are adaptive using real time traffic information.

7.5.3 Case Study

Who | The Queensland Department of Transport and Main Roads

Purpose | The Queensland Department of Transport and Main Roads are proactively seeking to improve incident detection and verification times.

Solution | Their solution includes providing an enhanced common operator view (COV) within the existing STREAMS™ Platform. Once completed, TMC staff will have the ability to select and view multiple layers of information for their smart motorways and broader transport network across the state. This platform includes information and data on live traffic, planned events, unplanned incidents, devices, response units, and public transport.

Benefits | Information will be fully consolidated into a single map view and used to quickly alert TMC staff of potential incidents for their verification and if needed, response.

8. Motorway Operational Planning and Optimisation

This section describes the sub-functions of motorway operational planning and optimisation and provides guidance on the activities, tasks and responsibilities that transport agencies can apply to achieve best practice.

8.1 Introduction

Operational planning and optimisation is a key function to enable successful live operations of smart motorway. This function includes the internal TMC (or equivalent motorway operations teams) processes and activities around:

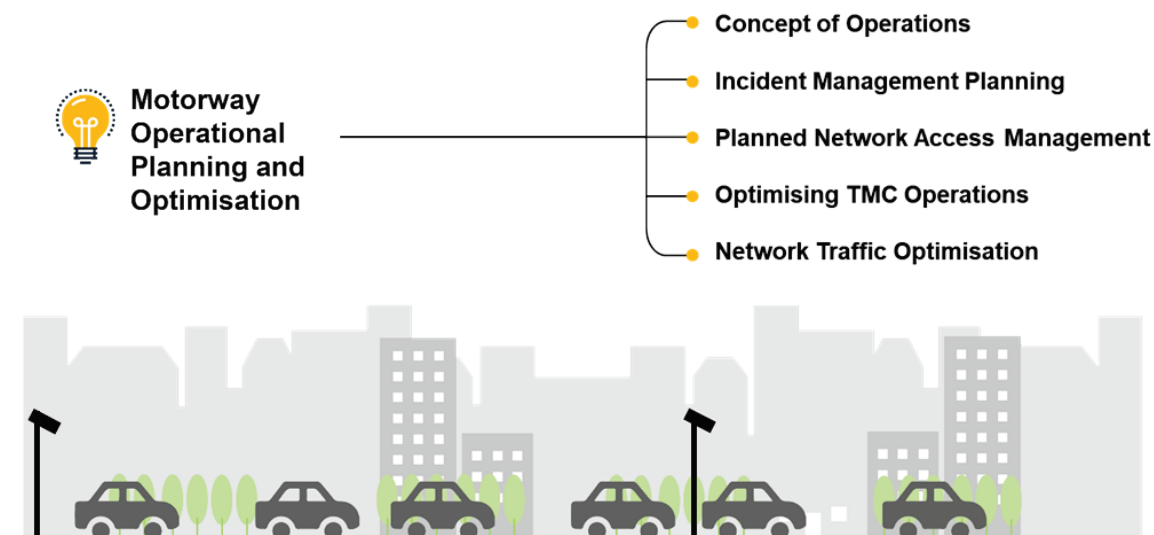
- planning for operations
- planning for events that occur on or beside the motorway
- monitoring and reviewing network performance
- assessing how smart motorways systems can be better used
- optimising the network.

Intentional well-established stakeholder relationships with enhanced coordination with police, other emergency services, incident response resources (including tow-trucks) and other business units play a key contributing role in the successful management of planned and un-planned events.

Applying best practice across these activities should lead to continuous improvement in minimising disruptions to the broader road network and users.

Motorway operational planning and optimisation includes the sub-functions as listed in Figure 8.1 and described in more detail in Sections 8.3 to 8.7.

Figure 8.1: Motorway operational planning and optimisation sub-functions



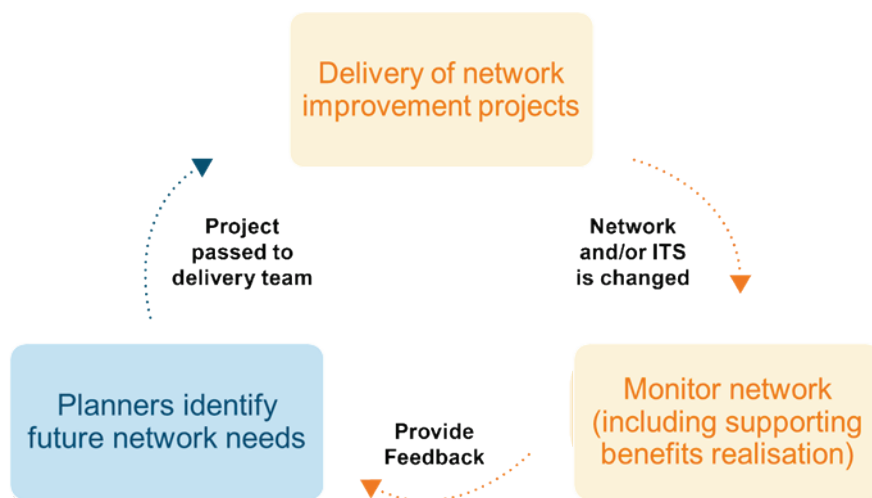
8.2 Network Operations Planning

Network operations planning aims to guide operation from a strategic focus through to detailed route management. It seeks to link policy and planning objectives to guide development of a strategic modal network that manages competing transport and land use priorities (Austroads 2021a).

Figure 8.2 shows how the monitoring of the network's current state by the operations team plays a key role in supporting network planners to identify the problem areas and future needs. Examples of operations feedback information can include:

- network performance data (e.g. congestion pain points during peak periods)
- smart motorway/ITS performance
- operational data (e.g. incident logs, crash analyses).

Figure 8.2: Feedback loop involving the operations, planning and project delivery



Network operations planning also incorporates the development of Network Operating Plans (NOP). NOPs outline the strategic context in the way the network should be operated and how this plays a vital role in achieving the desired network outcomes. It is important for NOPs to include or reference motorway operations.

The *Guide to Traffic Management Part 4: Network Management Strategies* (Austroads 2020d) states that a NOP 'aims to guide the operation and development of the road/transport network towards managing competing priorities under optimal conditions'.

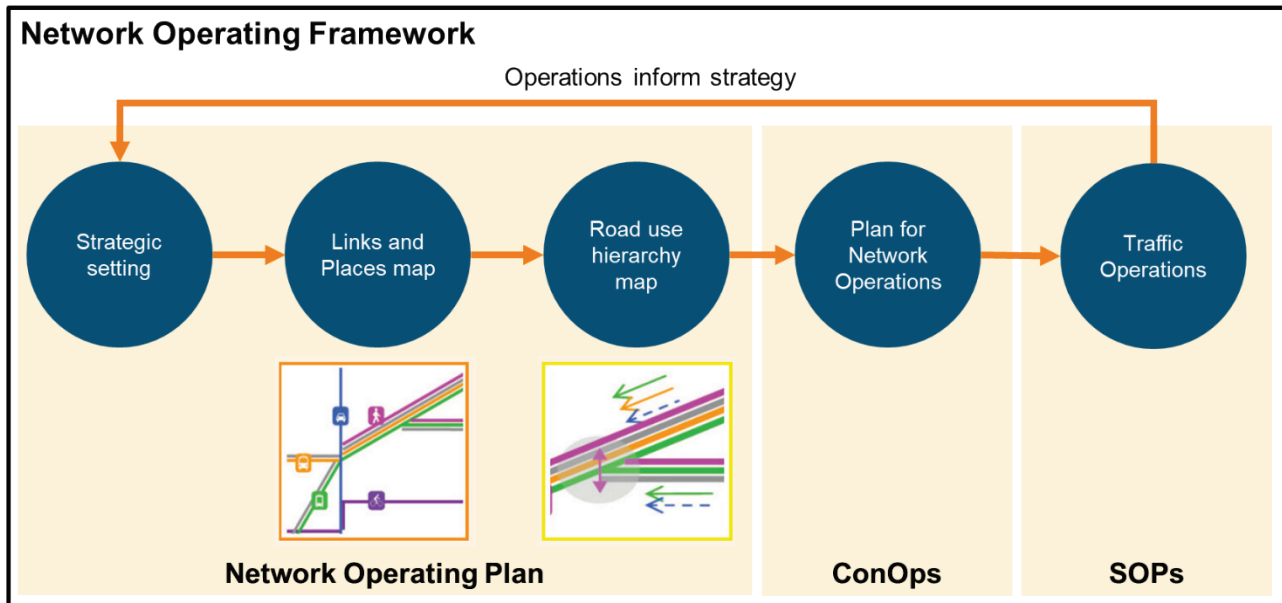
The operational direction and key performance indicators become widely established when there is a clear strategic vision for how the network is intended to operate. As a result, the operational planning can be undertaken with related measures used to determine effectiveness of operational performance.



Establish organisation-level motorway network planning policies or guidelines that require operations to be actively involved to positively contribute to the planning processes, through representation in steering committees, workshops and project discussions. These policies may include the timing for participation and co-endorsement in Concept of Operations development.

The linkage between operational intervention and strategic decisions on motorway planning and design is illustrated in Figure 8.3, based on the Waka Kotahi NZ Transport Agency process. Note that the process diagram is current at the time of preparing this report.

Figure 8.3: Example Network Operating Framework process diagram



Source: Adapted from Network operating framework (Waka Kotahi NZ Transport Agency 2021)

Jurisdictions will also need to consider multi-modal planning and the operating intent of the broader transport network in defining the operating intent for their motorways.

8.3 Concept of Operations (ConOps)

The use of Network Operating Framework (NOF) process is growing across Austroads' member agencies. Key output activities include developing a Network Operating Plan (NOP), Concept of Operations (ConOps) and Standard Operating Procedures (SOPs).

A ConOps usually describes a shared vision and clear plan that an organisation would follow when operating a transport network in the live environment. The ConOps is a common resource used by people working at the strategic end of the operations planning process and 'on-the-ground' practitioners who are involved in tactical or day-to-day motorway operations.

ConOps should also be a document made available to all stakeholders, no matter their background or role (US Department of Transportation Federal Highway Administration 2006). ConOps outline how the network is to be managed to enable key transport policy and guidance and to achieve its operational objectives.

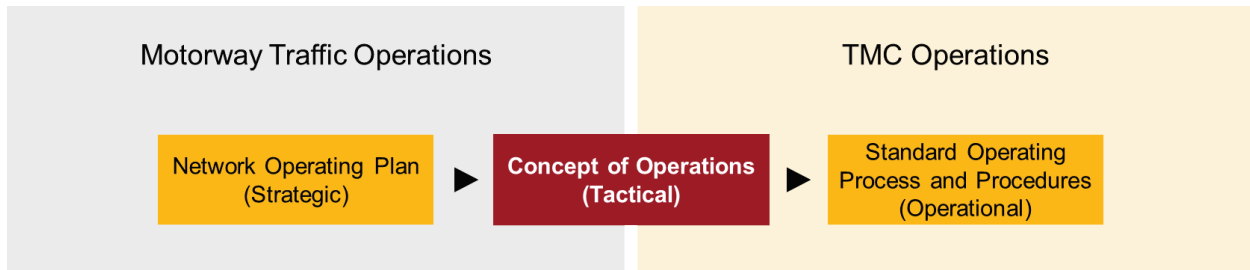
For example, the *Smart Motorways Concept of Operations* (Highways England 2016) is a strategic resource documenting a shared vision for operating the smart motorway live environment (including all lane running or controlled motorway schemes designed to IAN 161/15). It is publicly available and widely used by:

- people responsible for the design or operation of smart motorway schemes
- people performing incident management or maintenance activities on these sections once built
- people involved with customer and stakeholder communications.

ConOps may also describe the technology, systems and operational strategies required to deliver the operational outcomes during typical live conditions and for planned and unplanned scenarios.

Building on *Current Practice and Developments in Concept of Operations Across Road Agencies in Australia and New Zealand* (Austroads 2017b), Figure 8.4 shows where a ConOps fits within motorway operational planning.

Figure 8.4: Where a Concept of Operations fits within motorway operational planning



The NOP is produced as an output from network operations planning and used to inform development of the ConOps where motorway operational teams are a critical stakeholder.

The ConOps then provides key guidance for motorway operational teams to be detailed further into SOPs. ConOps may also feed into development of a 'Functional and Operational Requirements Document' (South Australia Department for Infrastructure and Transport n.d.) or similar as part of major transport infrastructure projects (more detail in Section 9).



Motorway operational teams are a critical stakeholder for the development of ConOps alongside people working at the strategic end of the operations planning process. There is a strong need to conduct consultation activities to involve these operational teams throughout the ConOps development in order to cultivate understanding and good working relationships.

8.3.1 ConOps Responsibilities

Operators need strong direction for certain actions such as what speed limit to select, when to close additional lanes for safety, when to close lanes for incidents in shoulder. The ConOps has the opportunity to provide the necessary policy and guidance that creates clarity for the TMC operators when managing different scenarios.

The following list contains typical activities that should involve operational resources.

- Promote development of comprehensive ConOps at:
 - the system level, to inform network control systems and tools
 - individual transport infrastructure project level, to inform the design stage.
- Regular and ongoing involvement by motorway operations teams in the development of ConOps around motorway live operation requirements and addressing shortcomings (if any).
- Participation in steering committees and working groups (including endorsing briefings) in the network operating planning process.
- Investigate potential change management or training requirements for motorway operations teams as identified in the ConOps.



Prepare and promote use of a template Smart Motorway Concept of Operations (as exemplified by QLD TMR 2020) to provide guidance, structure and consistency in the planning and design of a managed motorways project.

8.3.2 Case Study

Who | South Australia Department for Infrastructure and Transport

Problem | The Department needed a common and consistent vision for the management and operations of the new 'Torrens Road to River Torrens' section (T2T) of the North South Motorway Corridor. The project team needed sufficient detail covering the systems, practices and operational concept needs before starting development of the ITS infrastructure detailed design for T2T.

Solution | The project team, in collaboration with the operations team, developed a specific ConOps focussed on the operational concept. This framework was consistent with and prepared separately to the overall North South Motorway ConOps. The document provides operational detail as outlined in Table 8.1 below.

Table 8.1: Example operational concept detail in a ConOps document

Section name	Description
System Overview	- Describes the current system environment for operating within the section, traffic analysis, operational objectives, proposed ITS System (with priority motorway elements for inclusion) and operating scenarios - Also outlines current operational policies and constraints, modes of operation for current system, current traffic performance and the ITS system support environment.
Normal Operations	Describes normal operations of proposed ITS system in peak and off-peak periods, for ramp metering and LUMS operation.
Planned Activities	Describes operation of planned activities including lane closures for maintenance and special events.
Unplanned Incidents	Describes classification of incidents and response strategies for major and minor incidents in interim and ultimate situations including detours.
Summary of Impacts	- Describes classification of incidents and response strategies for major and minor incidents in interim staging and ultimate situations. - Also outlines operational impacts and organisational impacts (i.e. operator training and system reporting, incident response capability, community education, operator actions such as monitoring and system adjustment, and management of faults).

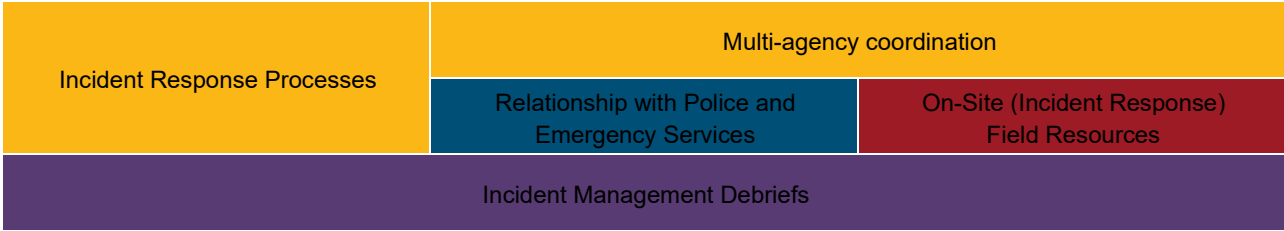
Source: North South Corridor Concept of Operations – Torrens Road to River Torrens section (South Australia Department of Planning, Transport and Infrastructure 2015)

Benefits | This T2T ConOps helped the project team capture and embed operational concepts throughout the project lifecycle. Additionally alignment of the ITS infrastructure detailed design with the ConOps enabled the operations team to maintain network performance for the whole North South Corridor once the T2T was integrated and completed.

8.4 Incident Management Planning

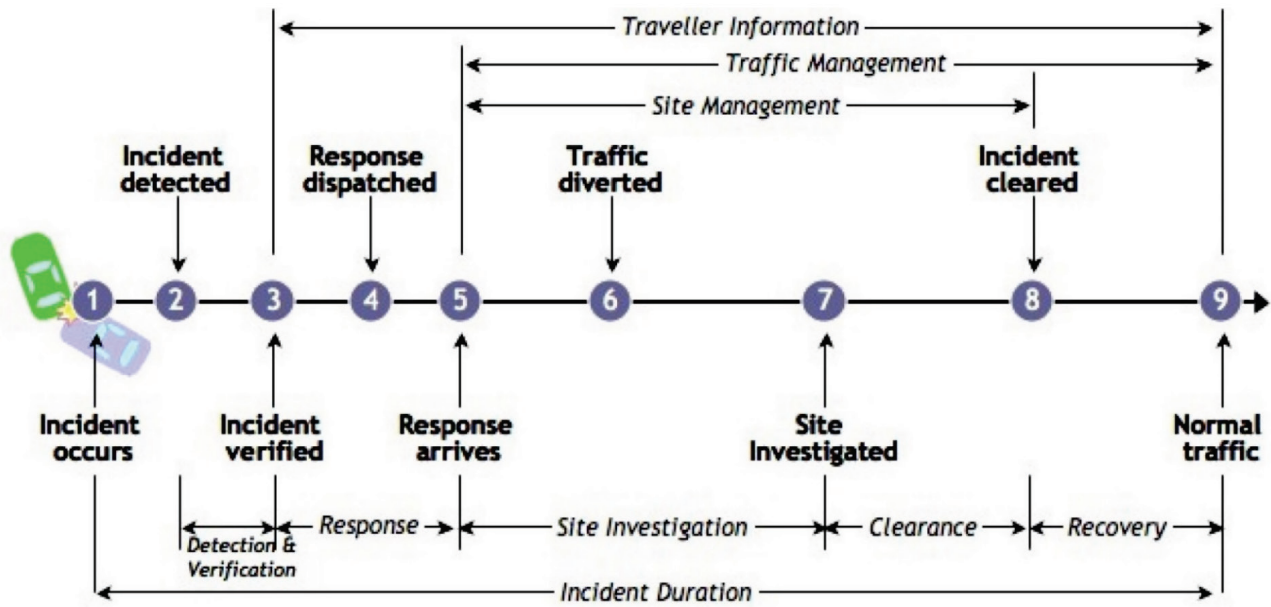
Incident management planning covers the array of preparatory actions for any incidents that may occur on a motorway in the future. The overarching goals for motorway operations teams are to (1) sustain incident response processes and (2) ensure a coordinated multi-agency approach when an incident occurs. Both purposes are underpinned by incident management debriefs as a feedback loop. This is summarised in Figure 8.5 with detail on each component provided in Sections 8.4.1 to 8.4.5.

Figure 8.5: Incident management planning overview



Effective incident management planning ensures swift action and minimised impacts on normal traffic movements in the network across the incident duration. Figure 8.6 (Austroads 2017a) provides an overview of the temporal development of a traffic incident from occurrence to return of normal traffic conditions.

Figure 8.6: Traffic incident management timeline

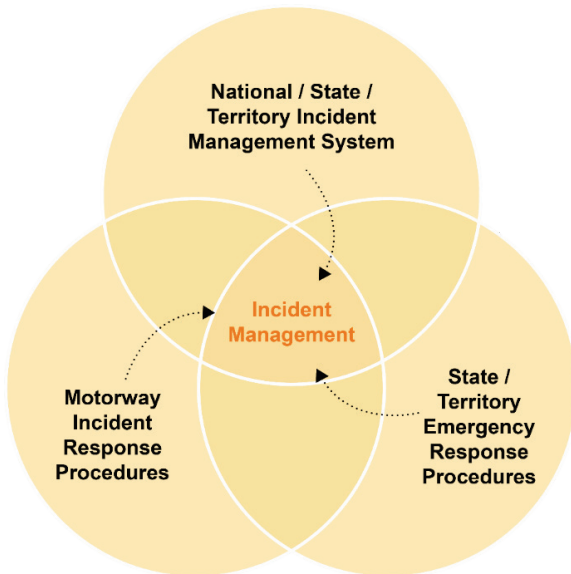


Source: Austroads 2017a

This section focuses on the array of preparatory actions that come before the first step labelled 'incident occurs' in the diagram. Refer to Section 7.5 for the tasks and activities relating to incident management under live operations.

Incident management planning for motorways could also be considered for larger scale events, such as severe flooding and bushfires. Figure 8.7 refers to the coordination required between plans. An example of a territory emergency response procedure is the *Australian Capital Territory Emergency Plan* (ACT Emergency Service Agency 2014).

Figure 8.7: Multiple documents and tools for incident management



More detail on incident management is available in existing Austroads guidance and publications including:

- Section 5.1 and Commentary 1 in Guide to Traffic Management Part 9: Transport Control Systems – Strategies and Operations (Austroads 2020a)
- Techniques for Incident Management to Support Network Operations Planning (Austroads 2017a)
- Section 5.1.2 in Freeway Design Parameters for Fully Managed Operations (Austroads 2009)
- Traffic Incident Management: Best Practice (Austroads 2007).

8.4.1 Incident Management Planning Responsibilities

Incident management planning responsibilities can be defined as undertaking deliberate preparatory actions and intentionally carrying out the standard responsibilities, as described below, for the delivery of smart motorway operations. These responsibilities would enable motorway operations teams to sustain incident response processes for their smart motorways while maximising the safety and efficiency of the broader transport network.

The responsibilities are aligned with the operating characteristic 'maturity' levels of the SMCM (Section 3.2.1) to demonstrate how capability needs increase when progressing up through the levels.

The tasks at the different maturity levels are intended to be a stepped process, starting at the baseline Level 1 and progressing through to Level 5:

Level 1 – 'Reactive with no incoming data'

- none

Level 2 – 'Reactive with some incoming data'

- agree upon a protocol with emergency services on the roles and responsibilities in the control of the site/event under different scenarios
- plan and maintain incident management procedures

Level 3 – 'Some proactive management'

- plan and maintain an incident classification matrix or framework including classification levels (see Appendix D)

- plan and maintain incident response plans including potential detour routes for different incident types (see Section 8.4.4)
- plan and maintain channels for external communication to the public and to incident response stakeholders/resources
- plan and maintain ITS **static** response plans including the use of specific devices or technologies e.g. variable message signs, speed control and lane management systems to help manage motorway incidents and divert traffic flow to arterial roads
- ensure external operating partners are involved in incident management planning for integrated/optimal outcomes
- coordinate closely with local government authorities including agreed diversion planning
- liaise with police and emergency services and establish a formalised communication channel (see Section 8.4.2)
- contract heavy towing/salvage equipment to be on standby during peak periods
- assist with towing regulations proposals
- hold 'hot' and 'cold' major incident debriefings to ensure knowledge gain and learnings (see Section 8.4.5)
- allocate and maintain dedicated staff resources for incident management, incident readiness, incident response activities (see Section 7.5 for incident management during live operations and Section 6.6.5 for staffing levels and roles)
- collect and analyse response time data and information to support continuous improvements
- undertake multi agency training to improve communication
- organise/provide for heavy and light tow trucks to manage the impact of truck incidents.

Level 4 – 'Substantial proactive management'

- plan and maintain ITS **dynamic** response plans including the use of specific devices or technologies e.g. variable message signs, speed control and lane management systems to help manage motorway incidents and divert traffic flow to arterial roads
- establish an agreed approach to incidents at road authority boundaries with clear and defined roles and responsibilities for all people involved and agreement with the local authorities for diversion planning
- directly control all towing on the network (e.g. avoid competition for towing leading to excess tow trucks at the site or trucks turning up)
- develop agreed advanced communication and response protocols between agencies (including who controls the incident site and the transfer of roles at different phases of the incident)
- establish quick clearance targets and establish the necessary coordination to achieve these, e.g. clearing all incidents within 90 minutes
- implement a clear shoulder policy using towing compounds for abandoned or disabled vehicles.

Level 5 – 'Full proactive management'

- continuous improvement: Review actions and plans to maximise the influence over driver behaviours.'



Having tow trucks organised (rostered) and arrive to the incident scene efficiently and safely can often be the critical challenge for improving clearance times.

8.4.2 Police and Emergency Services Relationship

Multi-agency collaboration enables the clear understanding of roles and priorities which facilitates a coordinated approach when an incident occurs. For example, the established working relationship between police and emergency services, with the TMC or motorway operations teams, one or several arrangements may exist such as:

- established Memorandum of Understanding (MOU), Memorandum of Agreement (MOA) or equivalent formal agreements. These documents could include detail on the extent and scope of TMC control of incident
 - For example, representatives from NSW Police are permanently based at the TMC which centralises incident response resources in a multi-agency team (see Section 6.4 for more detail). The NSW Police Superintendent, Inspector, Police Liaison Officers and the Motorcycle Response team are based in the same facility.
- legislative obligations
 - For example, the ACT TMC holds a central coordination role for any incident. However they still acknowledge the overarching responsibility the Emergency Services Agency (ESA)/police has in managing 'risk to life' and 'risk to public safety'. Outside of these, the TMC's role would be key towards achieving a coordinated approach and transition into normal traffic operations.
- resources management
- ongoing governance and oversight model
- shared incident command system
- special routes for emergency vehicles
- create and maintain a close working relationship with Emergency Services (ideally formally via a MOU) for the management of incidents and events.

Appendix E provides an example MOU and Appendix F has an example incident management operator checklist.

8.4.3 Incident Field Resources

Different types of on-site incident response field resources, can include:

- incident response vehicles
- specialist personnel and equipment such as:
 - spill clean-up
 - light vehicle towing
 - heavy truck towing.
- road crews (patrols and maintenance)
- tow truck and roadside assistance operators (when planning for and during breakdowns, e.g. NSW and NRMA).

For the specific relationship between incident field resources and motorway operations teams, one or several arrangements may exist, such as Service Level Agreements (SLA) with a third party that provides roadside assist/towing services.

The owner or provider of incident field resources usually vary across jurisdictions and are tied to the relationship with and involvement of police.

For an example of resourcing levels, Sydney (as at 2017) had the following field resources available for incident response and management:

- 21 transport commanders
- 8 traffic emergency patrol crews
- police motor response team
- light and heavy tow trucks and staff based at key locations including the Sydney Harbour Bridge, Sydney Harbour Tunnel and ANZAC Bridge.

8.4.4 Incident Types

Another aspect of incident management planning is the consideration of different potential incident types, and their associated equipment and resources needs. A standard procedure or process should be established and maintained for each incident type by motorway operations teams. Equipment and resource needs for different incident types should also be considered when determining staffing levels (see Section 6.6.5).

Some incident types that occur on motorways may include (but not limited to):

- hazardous and non-hazardous spills
- police operations
- unauthorised access
- equipment fault or system failure e.g. VMS not operational
- road incidents e.g. a fatal or serious crash (single or multi vehicle), breakdowns, emergency road work
- bridge incidents e.g. over height vehicle strikes, load limit, high winds on exposed bridges
- weather events or natural disasters incidents e.g. bushfire, smoke, flooding, lightning strike.



For jurisdictions with multiple TMCs, a standardised response in classifying incident type and severity in order to have common terminology and shared systems configuration (if relevant) would be a useful approach.

8.4.5 Incident Management Debriefs

Adopting a continuous improvement approach is vital. Key learnings from major incidents offer significant benefits to how incidents can be better managed and what 'behind-the-scenes' incident planning activities could be undertaken in optimising live incident management.

Debriefs should be held after each major incident, with all agencies that were involved. As a minimum, debriefs should be held for every fatal accident:

- identify the timeline chronology (see Figure 8.6), incident type and severity
- assess what went well and what areas can be improved upon (Waka Kotahi NZ Transport Agency 2011)
- involve shared learnings and team discussions on potential improvements (e.g. how the incident site was managed) with all the agencies involved
- ensure incident management debriefs learnings are shared to a wider audience, as appropriate, and are used to:
 - update standard operating procedures
 - create or update any specific response plans or detour plans that were utilised
 - create or update any training materials as needed.

8.4.6 Case Study 1

Who | ACT Transport Canberra and City Services (TCCS)

Problem | TCCS noted a lack of consistent documentation to formally describe an overarching framework for operators responding to any incident affecting the safety or operation of the road network across the ACT. Roles and responsibilities between stakeholders (who are internal and external to TCCS) were not formally agreed or defined.

Solution | TCCS developed a generic checklist and draft *Incident Management Plan* (Roads ACT 2020) to formalise a structure to inform appropriate incident response, in conjunction with individual Incident Response Plans. Together, the checklist and IMP provide key points to be considered and relevant communication protocols for operators and operational staff. These protocols and procedures include defining the incident type, location of incident, key contact persons, transport network impact from incident, temporary traffic management, incident closure and recovery.

Benefits | These documents formalised a structure for the typical activities involved as part of ACT TCCS' incident management planning. The checklist and draft IMP provide a tool to help operators be more consistent, efficient and thorough in their incident response when assessing incidents and guide their understanding of specific roles and responsibilities across incident response stakeholders.

Appendix F provides the generic checklist for use by operators and operational staff.

8.4.7 Case Study 2

Who | Waka Kotahi NZ Transport Agency

Purpose | Given current knowledge of an incident, staff within the TMC or motorway operations teams must prepare to respond or provide support in a structured manner.

Solution | Development of the 'Transport Incident Severity Categorisation' matrix as part of Wellington TOC's *Incident Response Levels SOP* (Waka Kotahi NZ Transport Agency 2021) enables any operations staff to rate incidents with a severity level between one and five (Minor to Catastrophic). Incidents categorised between one and three (coloured dark green, light green, yellow) are directly managed by TOC. Incidents in categories four and five (coloured orange, red) are escalated to Executive level using standard procedures. See Figure 8.8.

Each severity level corresponds with an incident severity category to ensure all parties understand the nature of the incident and an appropriate response.

Benefits | Different operators are able to categorise incidents using a common matrix to enable the appropriate level of response. This matrix also ensures all parties understand at what point they will be required to step in and participate in managing the response, be it at the tactical, operational or strategic level.

Figure 8.8: Example transport incident severity categorisation

Incident Level	People	Reputation	Property	Environmental	Delay to Customer		Service Delivery	Accessibility
(a)	(b)	(c)	(d)	(e)	(f)		(h)	(i)
Severity level of incident	Level of harm to staff at work, agents/contractors on AT/NZTA worksite and/or customers whilst using our transport network/services	Impact to AT and/or NZTA reputation	Damage to assets owned by AT or NZTA - Need to determine whether we want to include assets operated by AT/NZTA or their service providers	Actual or potential damage to land, water or air	Delay in travel time for the customer (user of the transport system). These timings should take into consideration whether the incident occurs during peak or non peak. If not during peak periods then the impact to customer delays is much less significant.		Impact on our ability to deliver BAU services	Ease of access to location of incident. Constraint could be physical (tunnel, water or single access road into location), or time based (2hrs to travel to rural location).
					Urban	Rural		
5 (Catastrophic)	Widespread deaths	Sustained (beyond the incident) negative media coverage Breakdown in relationships with external groups	Multiple assets impacted. Critical assets impacted.	Extensive damage to the environment requiring significant and immediate clean-up effort	> 24 hrs	> 24 hrs	Services not available for > 24 hrs	Inability to access location without major civil defence support
4 (Headline)	Multiple serious injuries or deaths CAVEAT: This people measure must combine with at least one other category (b - i) across this row to be categorised as a Headline (level 4) incident. If this is the only 'box ticked' on this row then it is deemed a level 3 incident.	Significant negative impact on stakeholder confidence High profile community and/or area High profile group or event impacted	Significant damage making the area unusable - instant repairs and diversion required	Contained environmental damage requiring immediate clean up	3 - 24 hrs	5 - 24 hrs	Major disruption to services but likely to be fully operating within 5 - 24 hrs	Ability to access location is restricted and will cause delays of >3 hrs before appropriate response arrives on site
3 (Serious)	Serious harm or death	National media coverage Immediate relationship concerns in resolving the incident	Obvious damage and repair required. Workarounds can be put in place for immediate management.	Clean up and remediation work required in the foreseeable future	1 - 3 hrs	2 - 5 hrs	Significant disruption to services but likely to be fully operating within 2 - 5 hrs	Ability to access location is restricted and will cause delays of between 1 - 2 hrs before appropriate response arrives on site
2 (Significant)	Minor injuries	Some community complaints Isolated stakeholder relationship issues	Minimal damage (e.g. broken barrier)	Contained pollution requires clean up	30 - 60 mins	30 mins - 2 hrs	Minor impact (service still available but reduced i.e. lane reduction, delay in bus/train service, partial reduction in parking availability)	Access is restricted but response is set up to manage i.e. water based or tunnel incident but standard response capability well established
1 (Minor)	No injuries	Short term, localised media attention	No damage	Slight, short term damage to land and/or eco systems	< 30 mins	< 30 mins	Negligible impact	No access issues

Source: Incident Response Levels SOP (Waka Kotahi NZ Transport Agency 2021)

8.5 Planned Network Access Management

Planned Network Access Management is also known by terms such as road occupancy management and corridor access management.

Planned event categories include:

- special events (e.g. parades and sporting events)
- roadwork (maintenance, renewals and development)
- road occupancy (by third parties e.g. public utility installation and maintenance).

Special events refer to any planned activity that is wholly or partly conducted on roads, requires special traffic management arrangements, and may involve large numbers of participants and/or spectators.

Considerations may include:

- scale of the event (that determines the level of planning required)
- execution of management plans which may require coordination among multiple agencies.

The overarching goal for motorway operations teams is to manage the approvals, issue permits and ensure a coordinated approach for planned use of the road corridor. The coordinated approach seeks to uphold public safety and minimise impacts on typical traffic movements. This work may occur in the form of a dedicated team or division within the TMC being responsible for the preparatory work before any planned events.

Preparatory work usually involves scheduling, temporary traffic management and collaboration (or joint operations) to coordinate special events such as road works, filming and smart motorway interventions. Note that permit systems have different names such as:

- Road Occupancy Licence (NSW)
- Corridor Access Permit (NZ)
- Road Corridor Permit (QLD)
- Work Permit (NT and SA)
- Road Event Permit (NT).

A number of jurisdictions will already have created formal codes of conduct for accessing and working in road corridors. These frameworks will often set out legal requirements for the associated processes. For example:

- The *Utilities Access Act* (NZ Government 2010) was enacted and required the formation of a *National Code of Practice* (NZ Government with NZ Utilities Advisory Group 2019). This sets out processes and requirements for any utility wanting to access the road corridor, including motorways and state highways.
- *Guide to Traffic and Transport Management for Special Events* (Transport for NSW 2018b).

8.5.1 Planned Network Access Management Responsibilities

Motorway operations teams are required to manage or be involved with planned events to ensure public safety and minimise impacts to the broader network. The following list contains standard responsibilities for this sub-function that would normally be appropriate for the delivery of smart motorway operations.

The responsibilities align with the operating characteristic 'maturity' levels of the SMCM (Section 3.2.1) to demonstrate how capability needs increase when progressing up through the levels.

The tasks at the different maturity levels are intended to be a stepped process, starting at the baseline Level 1 and progressing through to Level 5:

Level 1 – ‘Reactive with no incoming data’

- respond to ad hoc network access events (if approached) and provide traffic management commentary and /or support

Level 2 – ‘Reactive with some incoming data’

- prepare and maintain Standard Operating Plans for regular activities and events
- assess applications received in accordance with approvals process
- issue road work permit approvals (or similar) for any planned event or road work proposed
- identify detour routes as part of assessing the possible traffic impacts on the local area and surroundings

Level 3 – ‘Some proactive management’

- maintain and use a centralised management system to manage applications and access
- develop and regularly update formalised guides for traffic and transport management at the jurisdiction level relating to planned road works and special events
- involvement with temporary traffic management approvals and intervention measures including:
 - planning and implementing alternative routes
 - updating signs and signals to alert passengers on the network.
- coordinate with internal works and projects
- seek approval/authorisation for partial (lane/road) or full motorway closure/Road Occupancy License (ROL)/permit to access
- conduct auditing and work completion process.

Level 4 – ‘Substantial proactive management’

- coordinate and manage planning and approval of future maintenance, road works, utility works and special events:
 - work closely through a multi-agency approach including contractors, event organisers and venue managers
 - notify the relevant government bodies (e.g. state highway owner, local area command police, local council) of potential impacts
 - facilitate operator access to Traffic Management Plans (e.g. with LUMS plans) for coordinated roadworks outcomes
 - enter planned activities into the TMC facing incident system.
- proactively use signage, devices and technologies (e.g. LUMS, VMS) to support planned maintenance activities and communicate event information to road users
- formalise the roles and responsibilities of all active and passive stakeholders involved, in order to manage:
 - over dimension, over mass vehicles
 - any construction that might conflict with the occupancy
 - any impacts on public transport, local residents and businesses
 - the hours during which the occupancy will be in effect.

Level 5 – ‘Full proactive management’

- sophisticated event and access system with multi-agency coordination to reduce impacts on road users.

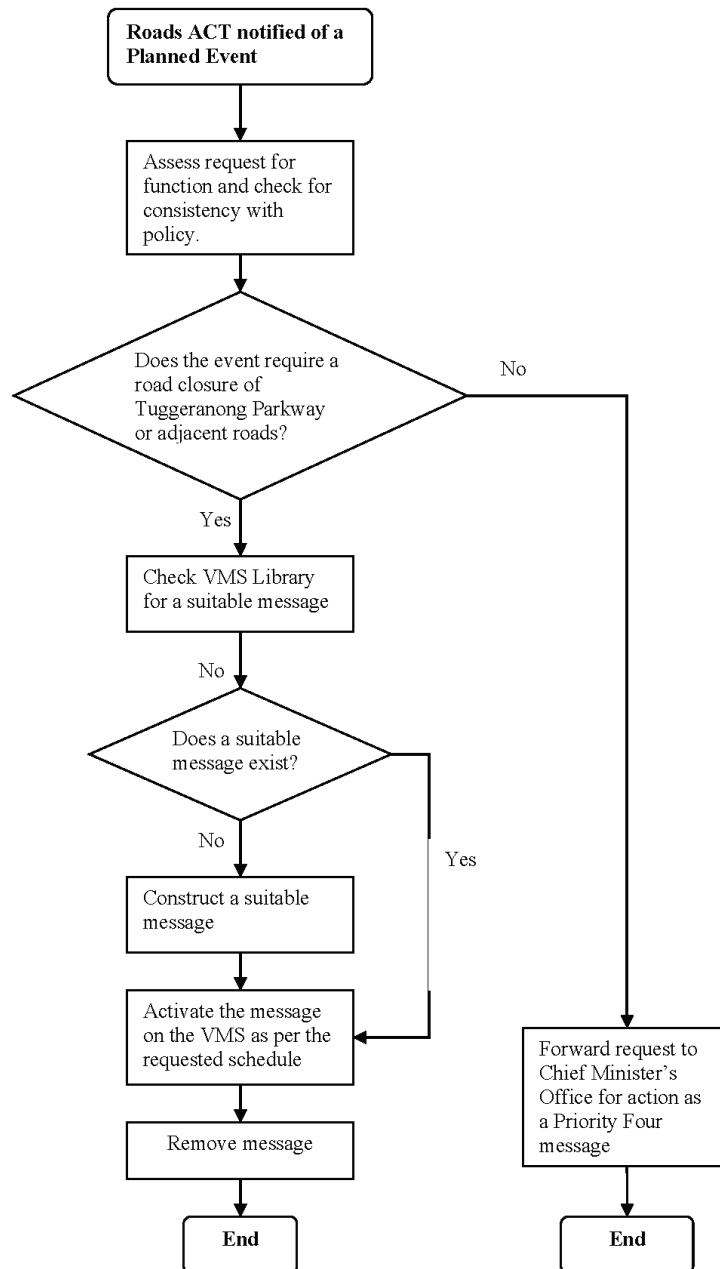
8.5.2 Case Study 1

Who | Roads ACT, a division of Transport Canberra and City Services (TCCS)

Problem | Planned events (including partial and full road closures) were not utilising the available ITS, or used it inconsistently.

Solution | Roads ACT prepared a *Variable Message Sign Operational Protocol for Road Closures* (ACT Government 2010) for any traffic management information displayed on VMS along the Tuggeranong Parkway and adjacent roads. This document covers standard procedures to be followed by TCCS during a full or partial road closure resulting from planned activities as well as road and environmental incidents. Figure 8.9 shows an example procedure to display messages for planned events.

Figure 8.9: Example ACT procedure to display messages for planned events



Source: Variable Message Sign Operational Protocol for Road Closures (ACT Government 2010)

To support improved coordination and liaison, this document also includes a contact directory amongst internal TCCS staff, ACT Policing, emergency services, and their media liaison officer.

Benefits | This protocol helps Roads ACT to consistently ensure consideration of their ITS devices when planning for upcoming events and supports the effective use of these systems alongside additional media communications to inform motorway users.

8.5.3 Case Study 2

Who | Transport for NSW

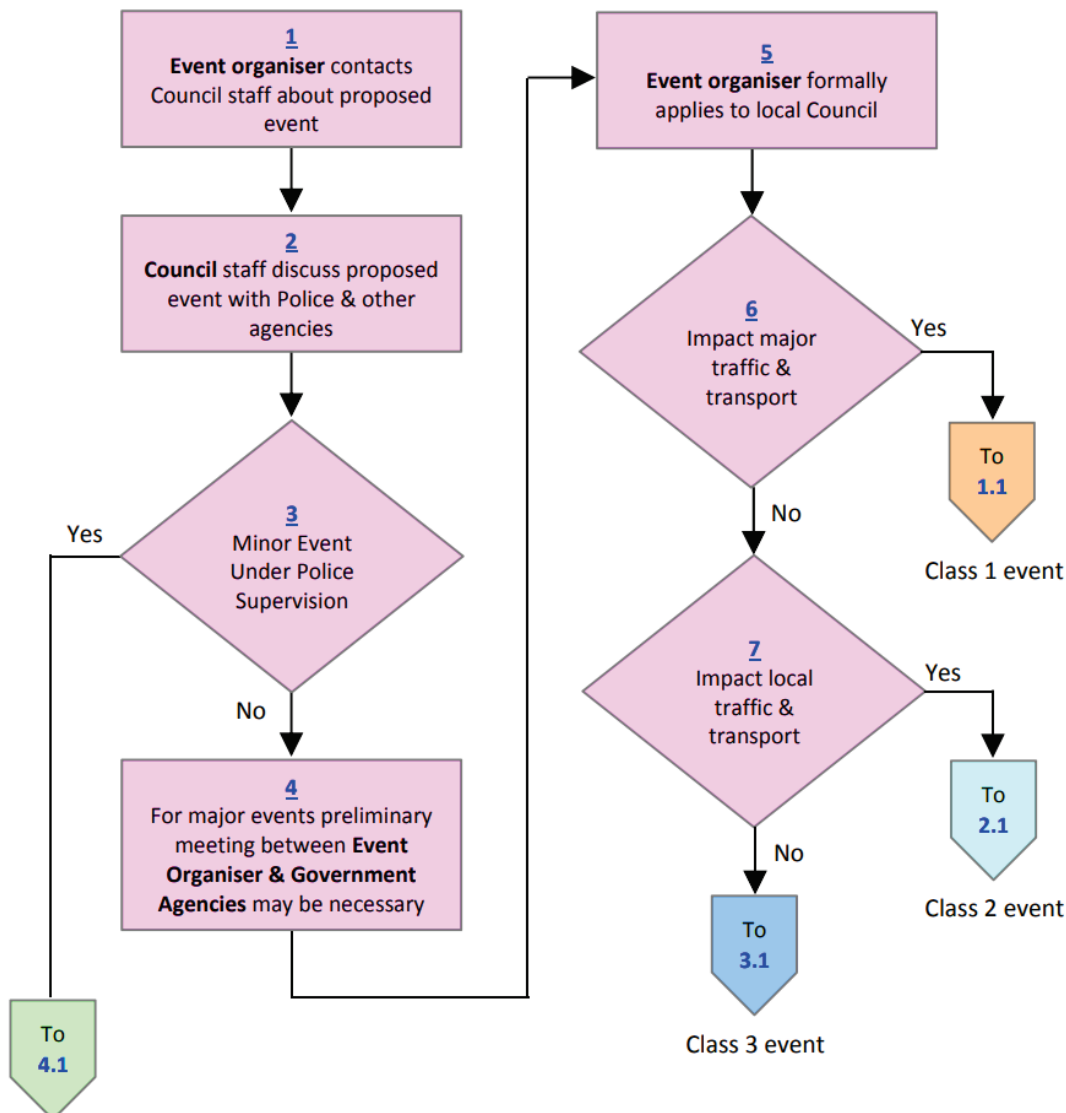
Problem | Transport for NSW noted an increase in frequency and different types of special events across the NSW road network. Higher traffic volumes on the road network also mean an increasing trend of public liability claims. Agencies needed a formalised state-level document that outlines roles and responsibilities for different organisations involved, to drive consistency in the planning of all special events.

Solution | A task force assembled in March 2002 prepared the first edition of the *Guide to Traffic and Transport Management for Special Events* (Transport for NSW 2018b), which provides direction and an improved process that works in all Local Government Areas across NSW. This framework includes four classes of special events, focused on the disruption to:

1. traffic and transport systems
2. the non-event community.

Figure 8.10 shows the process overview starting with the local council as the first point of contact and motorway operational teams being aware and/or involved during each step, as needed.

Figure 8.10: Example special events process overview



Source: *Guide to Traffic and Transport Management for Special Events* (Transport for NSW 2018b)

This document also covers miscellaneous topics to support their improved coordination and liaison amongst people involved across agencies, including (but not limited to):

- filming as a special event
- Vehicle Races on Roads or Road-Related Areas
- Public Transport and the Transport Management Plan
- NSW Premier Department – Event Operations Group.

Benefits | This type of formalised protocol helps NSW TMC to consistently ensure consideration of their operational insights for upcoming special events and supports effective consultation when planning the use of traffic and transport management measures.

8.6 Optimising TMC Operations

Across Australia and New Zealand, we see increased focus on enhancing productivity and the effectiveness of existing systems through operational initiatives within the TMC (or equivalent motorways operations teams).

Motorway operations teams typically conduct regular reviews of staff and systems performance, adjusting certain aspects within the TMC to optimise operations and facilitate continuous improvement internally (see Section 6.2.3).

The following list notes TMC operations optimisation activities that could be used as prompts for how operations are reviewed and optimised:

- review staffing levels to determine any mismatch with the TMC operating needs
- review staff welfare e.g. frequency of double shifts, working environment
- review training and operations to identify gaps in TMC systems, processes and capabilities
- review current use of systems, including:
 - existing systems configuration and their available capabilities to determine if they are being used to their fullest potential
 - whether any system had been recently upgraded in order to include new automation features that could be leveraged.
- review locally driven operational performance metrics e.g. incident response times, call out success rates
- review coordination between systems for both human-to-system and system-to-system interaction, e.g. does the pre-set minimum distance to inform drivers of an incident through nearby VMS need to be changed or tested
- review existing detour plans and potential need for developing new plans to fill any gaps.

The internal review of TMC operations may contribute towards building a business case for an improvement project to adjust ways of working or establish new systems for the smart motorways and TMC operations.

8.6.1 Maturity Self-Assessment

Another method for reviewing performance would be to 'rate' an operations team against these guidelines. The guidelines define many tasks, responsibilities and actions that represent best practice for the operation of smart motorways and against several functions and sub-functions. An assessment of the current operational maturity could be achieved by rating on the basis of what the team is doing, partially doing, and not doing. A similar exercise can be repeated for the future state, that is, what the team should be doing.

Appendix C is a checklist to support a maturity self-assessment – assessing the gap between the current and future state to develop an improvement program that will lead toward the desired operating maturity level.

8.7 Network Traffic Optimisation

Many jurisdictions have a continued investment focus on enhancing productivity and efficiency, alongside support for travel demand management initiatives. This investment focus seeks to address the problem of urban congestion and ensure high quality, well-integrated and reliable services are delivered (Main Roads Western Australia 2021).

Motorway operations teams typically conduct an ongoing review of network performance and adjust the motorway network and associated systems for safer and more efficient travel. Network traffic optimisation can be considered through two perspectives, namely:

- facilitate efficient road user movements and throughputs using existing tools and systems
- redistribute the movement of people and goods across the broader transport network through deliberate planning and resulting shifts in travel behaviour

Network optimisation should respond to strategic network aspirations and the agreed operational approach to managing the network. Network optimisation should seek to:

- provide direction to decision making that supports strategic and wider network outcomes
- implement operational and infrastructure interventions that respond to network outcomes sought
- measure performance of the network (for all road users) against agreed key performance indicators.

While Network Traffic Optimisation does overlap with Route Management, the latter focuses more on different areas.

8.7.1 Network Traffic Optimisation Responsibilities

The following list provides standard responsibilities for Network Traffic Optimisation that would normally be appropriate for the delivery of efficient road user movements on smart motorways:

- conduct ongoing regular reviews of network performance using locally driven metrics (e.g. vehicle throughput, road user safety etc.) in line with defined network objectives (e.g. rural motorway, urban motorway, key crossroads)
- use the SMCM as a reference document to identify operational changes that may support optimisation of the motorway network and associated systems
- establish clear business processes for periodic and ongoing identification of improvement opportunities
- adjust/optimize traffic control configurations and systems on the network (e.g. ITS, SCATS, ramp metering sites, speed controls) to influence traffic flow across the motorway and at interface points (e.g. intersections, on-ramps, mainline)
- allocate and maintain dedicated staff resources for optimisation activities (see Section 6.6.5)
- work with contractors to maintain and enhance network capacity
- undertake simulation/modelling/review of motorway algorithms or signal optimisation programs with confirmed calibration parameters to optimise performance:
 - integrated collaboration with traffic engineering, modellers, analysts, mathematicians, technologists and smart motorways technical teams to determine optimal configurations that will better inform operations

- provide advice on where infrastructure/systems should be implemented. This may include (but not limited to):
 - heavy commercial vehicles (HCV) usage
 - PT priority
 - tidal flow systems
 - lane use management
 - variable speed management
 - ramp signals.
- formalise and champion ongoing route and network optimisation processes across operational resources (e.g. to improve availability of specialised skills such as using STREAMS™) through a network optimisation framework (e.g. *Smarter solutions: network optimisation framework* (QLD TMR 2019))
- consider, explore and make use of emerging technologies or update existing tools to improve network efficiencies and safety e.g. automated systems to adjust ramp signal timing, improve tool usability and reduce barriers to gaining expertise exemplified in the *Draft Smart Motorways Action Plan* (QLD TMR 2019).

Some systems are better utilised through locally-led automation or optimisation activities, informed by specific performance measures and metrics of the motorway operations. For example, the amount of time to detect an incident would differ depending on the level of automation. Manual detection may be measured in minutes whereas semi-automated or automated detection processes may be measured in seconds (if not milliseconds).

8.7.2 Travel Demand Management

The following list provides standard responsibilities for travel demand management that would normally be appropriate for the delivery of redistribution of road user movements across smart motorways and the broader transport network. Operational teams could either be involved to make contributions towards these schemes and programs/initiatives or in some cases lead such schemes and programs.

- leverage the inherent structure of broader road network, which can provide multiple route choices
- close collaboration between the transport agency and smart motorway/private motorway operators in the development of planning proposals and implementation of travel mode shift programs
- develop demand management strategies
- examine temporal changes in road user mode choice in line with expansion to alternate travel offerings e.g. public transport via light rail, uptake of autonomous vehicles
- provide data analytics, insights and other input to advisory strategies and planning proposals
- ongoing review and identification of tools, systems and operator processes to maximise ability to effectively monitor, manage and optimise the network
- feedback into strategic planning and infrastructure planning operational insights
- review corridor/area management to ensure holistic approach and integrated road system control
- review and understand interactions of ITS tools to optimise flow
- undertake/conduct compliance studies on devices e.g. LUMS displays.

Note that this list would be additional to those covered by Section 8.7.1.

8.7.3 Case Study

Who | Department of Transport, Victoria

Problem | No formal guidance on supporting speed homogenisation through network optimisation control (alongside speed limit controls and enforcement) on motorways. Missing guidance on speed homogenisation included the motorway interface, the entry and exit points, arterials and the broader road network.

Solution | *Managed Motorway Design Guide Volume 2, Part 2: Network Optimisation Tools* (VicRoads 2019) was developed and covers the control tools associated with network optimisation control:

1. City Wide Coordinated Ramp Metering (CWCRM)
2. Exit Ramp Management System.

The individual tools available for use in the active management of motorways are shown in Figure 8.11. This includes tools that are currently in operation, as well as tools that are in development or planned for development. Each Managed Motorway tool in VicRoads is part of a total control system (e.g. integrated tool chain) and can split into two categories, namely 'Control Tools' and 'Foundation Tools'.

Figure 8.11: Example VIC network optimisation tool kit

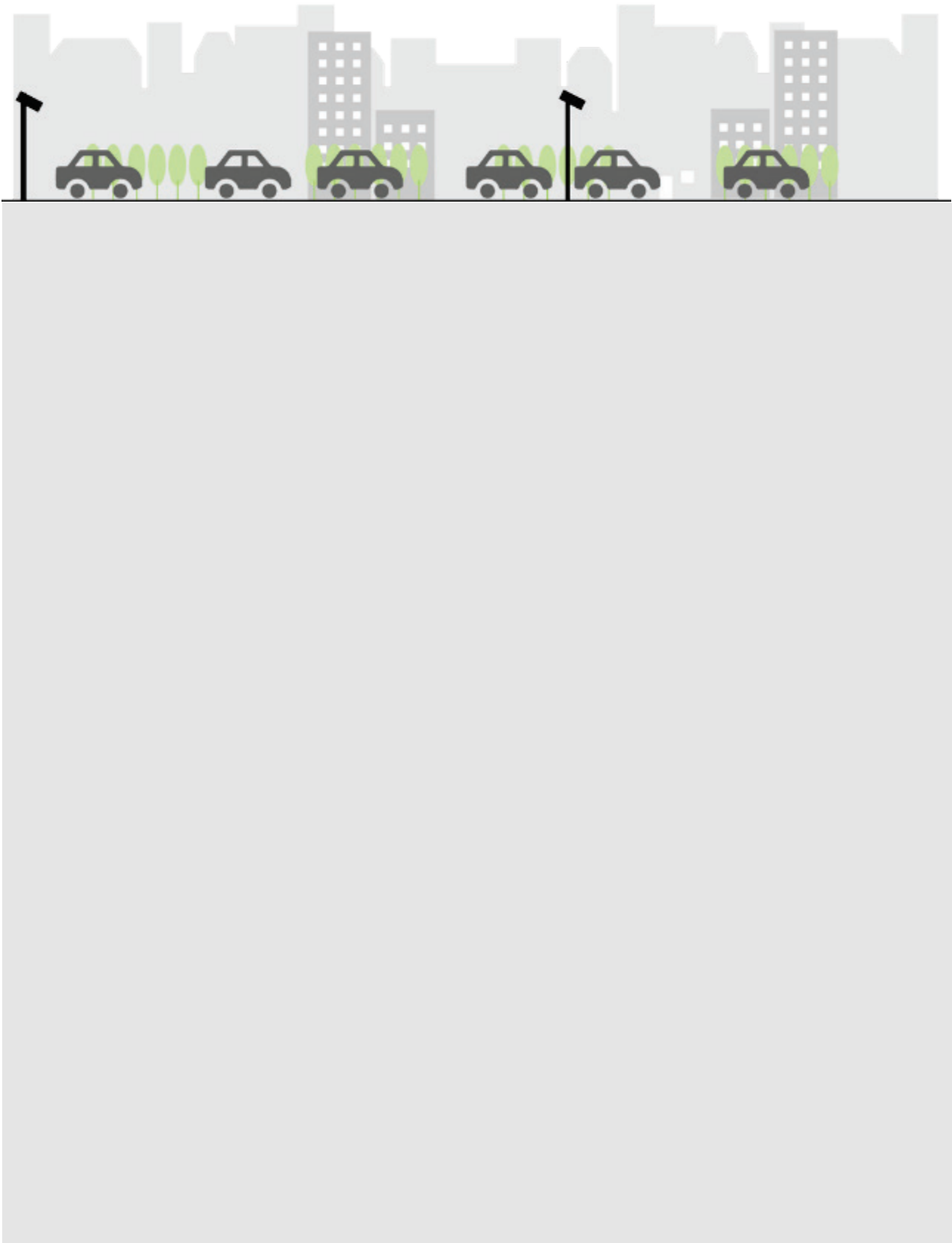
Control Tools		Foundation Tools	
Network Optimisation Control	Intervention Control	Information	Intelligence
City Wide Coordinated ramp Metering (CWVRM) system	Lane use management system (LUMS) including variable speed limits (VSL)	Variable message signs (VMS)	Traffic detectors (primarily speed, volume and occupancy – SVO – data)
Dynamic variable speed limits (DVSL) ¹	Entry ramp management system	External information publication for third party use	CCTV
Arterial road interface system	Wide area network dispersion (WAND) ²		Automatic incident detection (AID) ¹
Arterial road management system ²	Motorway dynamic re-configuration (including entry and exit ramp mgt systems) ²		Congestion alarms ²
Exit ramp management system			Real-time graphical user interface (GUI)
End-of-motorway management system ²			Weather and environmental monitoring system

¹ Tools currently in development to be integrated with CWCRM - ² Tools planned for development

Source: *Managed Motorway Design Guide Volume 2, Part 2: Network Optimisation Tools* (VicRoads 2019)

Benefits | The VicRoads Managed Motorway 'network optimisation' toolkit and related guidance enabled improved integration with the arterial road traffic signal system at interface points of the motorway. These network optimisation control tools would jointly ensure the motorway asset is optimised at all times and under all conditions. 'All conditions' essentially means to bring traffic on, through and off the motorway smoothly and efficiently.

Part III: Projects Integration



9. Motorway Projects Integration

This section provides guidance for integrating operational requirements into the development, delivery and handover of smart motorway projects.

9.1 Introduction

9.1.1 Context

The integration of technology and systems into motorway projects is key to ensure operable, maintainable and a consistent approach so that these projects can fully realise their benefits.

A number of frameworks on transport planning and project delivery that currently guide these activities. These guidelines focus on projects that either create, improve, or modify smart motorways, in particular with regard to:

- the information required for project teams to understand how their project will need to integrate and implement into existing systems, networks and operations
- the interactions that could and should occur between the operations teams and the project teams throughout the lifecycle of the project
- the tasks and activities to which operations teams can collaborate with delivery team in order to improve the operational outcomes and support the delivery of project benefits.

This report is also complemented by the *Austroads Guide to Smart Motorways* (Austroads 2016a), which defines the need to establish up-front the operational context to identify performance gaps. These performance gaps form a key driver for motorway projects.

Operational needs should also:

1. be central to optioneering and evaluation during the project planning phase
2. drive the selection of the intelligent transport systems (ITS), and
3. be referenced during the system testing/validation and the handover (transition) to operations.

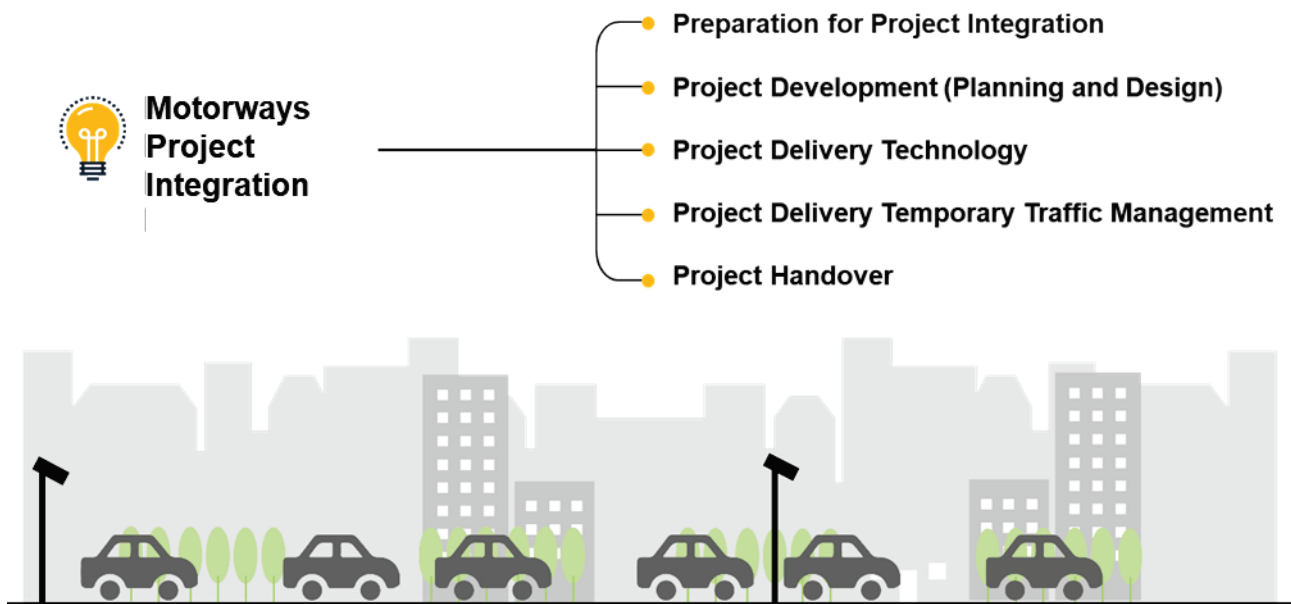
Having operational input into projects is also consistent with a systems engineering framework as contextualised in the *AGSM* (Austroads 2016a). This framework sets out the need for active engagement from operations teams which should be present through the whole lifecycle of motorway infrastructure projects.



While it is relatively easy for project teams to understand the specifications, requirements and costs for the design and installation of the physical smart motorway technology (and supporting infrastructure), operations teams provide the practical understanding of comprehensive operational aspects e.g. system integration, connecting and testing, operational costs and usability.

Motorway projects integration is broken into sub-functions as listed in Figure 9.1 and described in more detail in Sections 9.3 to 9.7.

Figure 9.1: Motorway projects integration sub-functions



9.1.2 Project Scale and Lifecycle

Smart motorway projects may vary in scale and complexity, ranging from the installation of a single new device (e.g. CCTV) through to the construction and integration of a large new smart motorway.

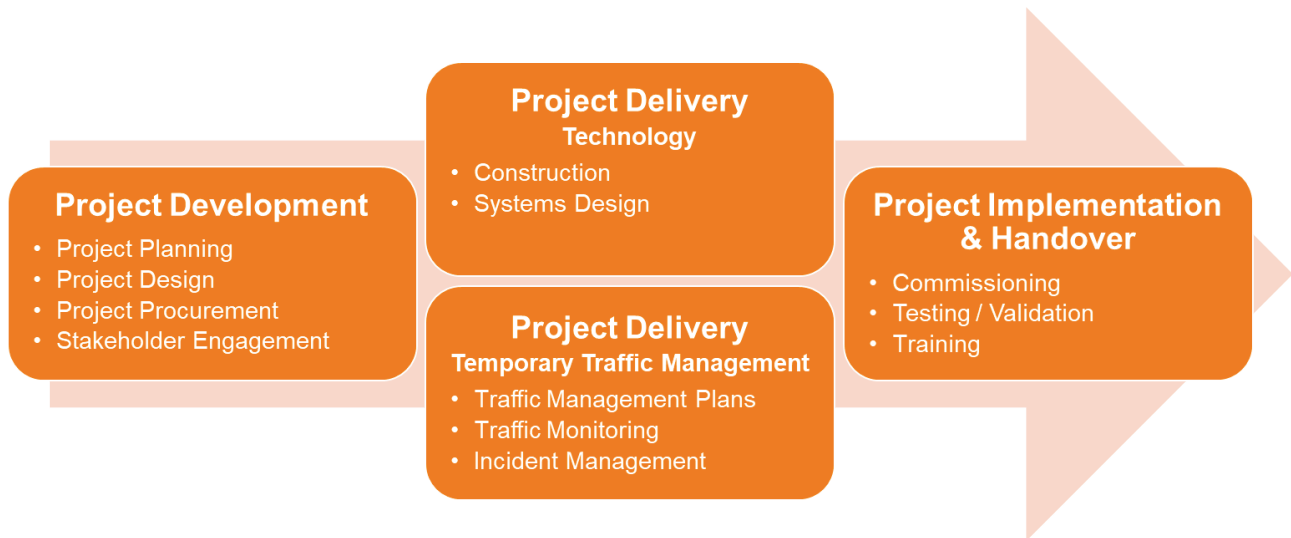
The following list provides several different dimensions by which the complexity of a project can be measured:

- project extent:
 - length of motorway being constructed or benefited
 - extent of monitoring to be implemented (not always the same as the length of motorway)
 - number and scale of tunnels and/or bridges.
- ITS devices and networks:
 - number of networks involved
 - number of field devices
 - whether any of the technology to be used is new to the jurisdiction and TMC
 - power and electrical loads.
- TMC facilities:
 - unaffected
 - new and/or expanded facilities, including:
 - control/operations room
 - office space
 - IT requirements (e.g. server room and IT equipment).
- live operations considerations:
 - operating systems (user interface)
 - operations/service types (see Table 2.1 for a list)

- training and knowledge requirements
- impact on the organisational make-up and culture of the operating team (e.g. the need to have formalised relationships and workflow between internal teams or external agencies, embedding a collaborative culture to share information and knowledge).

Figure 9.2 shows, within the context of these guidelines, the project lifecycle categorised into phases.

Figure 9.2: Typical motorway project lifecycle



9.1.3 Who should use this Section?

Operations teams	To gain an understanding of what activities they should be involved in and/or champion their involvement during smart motorway projects.
Project teams	To gain an understanding on what activities the operations team should be involved in during the project and the value this can provide.

9.1.4 How to use this Section

The sophistication of effort and detail in project integration does not depend on the maturity of the current operation, but instead is based on the scale and complexity of project being delivered.

If the scale of the project produces a 'step-up' in maturity and/or complexity for the current operations, then the operations team may need to contract in the right expertise to represent its operational interests in the project.

This report encourages different jurisdictions (with varying levels of maturity) to pick and choose what aspects that they want to use, as opposed to dictating what they should or should not do. The guidelines are intended to be flexible to accommodate the many different types of projects and scenarios likely to be encountered.

As described in Section 9.1.2, smart motorway projects can vary in scale and complexity. Users of these guidelines will need to adjust the expectations set out in the guidelines to suit the scale and complexity of their particular project.

9.1.5 Project Liaison Role

For larger projects, it is useful and efficient for the operations team to allocate a team member to act as the key liaison with the project team. This role can then champion the activities described in more detail below as well as facilitating the project team to access the most appropriate operational expertise for different project integration needs.

The following points provide some guidance on the capabilities from which the project liaison role will benefit:

- experience with motorway operations
- proficient knowledge of operational concepts for smart motorways, development and application of ConOps
- ability to link strategic direction and objectives to operational outcomes
- ability to apply and synthesise operational experience (including resourcing requirements) to inform strategic planning and relevant business decision-making
- proficient technical knowledge of the ITS deployed on motorways and how they enable and impact on operations in their jurisdiction
- insight into benefits realisation of ITS.

9.1.6 Project-Operations Interactions

The operations team can have three interactions during each phase of the project:

1. information flow – from operations team to the project
2. collaboration between operations team and project team – on a project task to solve a problem or create a deliverable or outcome
3. information flow – from the project to the operations team.

Table 9.1 provides a matrix and references the relevant sections where the interactions and associated activities are addressed in detail.

Table 9.1: Interaction types versus project phases matrix

Interaction Type	Project Development	Project Delivery: Technology	Project Delivery: Temp. Traffic Management	Project Handover
Information Flow – from Operations Team to the Project	• see Section 9.4.2	• see Section 9.5.2	• see Section 9.6.2	• see Section 9.7.2
Collaboration between Operations Team and Project Team	• see Section 9.4.3	• see Section 9.5.3	• see Section 9.6.3	• see Section 9.7.3
Information Flow – from Project to the Operations Team	• see Section 9.4.4	• see Section 9.5.4	• see Section 9.6.4	• see Section 9.7.4

9.2 Projects Integration Objective

All smart motorway projects will either connect to, or be affected by, the existing transport network and so cannot be considered in isolation. Events must be managed in an integrated manner. All ITS assets and backbone infrastructure that are delivered as part of an infrastructure project must be made available to adjacent sections of the network in a manner that ensures reliable and consistent operation.

The overall objective for motorway project integration is to embed operational requirements into all phases of smart motorway projects.

This objective must be built into the entire project life-cycle (e.g. the contract-design-build process) from the very beginning. Introducing the requirements for integration once the project is underway can be difficult, inefficient and often expensive – this retrofitting can be avoided if the parties understand the requirements at the outset.

Motorway management and operation require the network to be considered as a whole. All new or improved ITS functionality will need to be implemented on the existing systems network (either directly or indirectly), meeting agreed levels of service and quality standards before they are deemed acceptable for connection and operation.

9.3 Preparation for Project Integration

9.3.1 Context

While much of the activity and effort will occur during a project, some fundamental activities will ensure better preparedness by operational staff to interact with projects and project teams. Such fundamental activities include the following:

- develop and agree an organisational policy that defines roles, responsibilities, workflow protocols and expected outputs in the project integration across the project lifecycle



A targeted guide covering motorway operations and requirements such as the *Smart Freeways Policy Framework Overview* (Main Roads Western Australia 2021) would be useful. This report would help planning and project staff better understand operations and how to better assist project development and delivery.

- develop a master specification of operational requirements for all smart motorway projects for use in project documentation:
 - when preparing a master specification, consider the list in Section 9.1.2 for different dimensions that could be covered
 - develop and agree a list of requirements relating to the common control system (e.g. STREAMS™ in QLD, SA and WA).
- develop and maintain technical standards (e.g. network communication standards)
- develop a process for the endorsement of new ITS devices to be added to the ITS network(s) and/or systems
- develop and agree a list of project objectives for the implementation of smart motorways with relevance to operations
- provide and agree on the amount of input, time and effort involved for a dedicated projects coordinator (i.e. central point of contact for major projects) within the motorway operations team.



If starting from scratch, look for inspiration from another jurisdiction. Adopting a technical specification established by another jurisdiction with a few minor modifications may save time and effort.

9.3.2 Technical Requirements Specification Examples

Different jurisdictions have taken different approaches to the development of technical requirements specifications, but overall are working towards the same goal: to achieve successful operational outcomes from projects following handover.

For example, the South Australia DIT Master Specification formally acknowledges operations' role in reviewing engineering and design documentation at the project delivery phase. In a similar vein, the Queensland TMR Specification formally establish witness points for operations' involvement in systems testing (e.g. factory acceptance tests, installation acceptance tests, commissioning tests).

Table 9.2 provides links to example technical requirements and specifications.

Table 9.2: Example technical requirements specification

Jurisdiction	Document Name	Link
SA	Department for Infrastructure and Transport Master Specification	https://dit.sa.gov.au/contractor_documents/masterspecifications
QLD	Transport and Main Roads Specifications	https://tmr.qld.gov.au/business-industry/Technical-standards-publications/Specifications
NSW	Transport for NSW QA Specifications	https://roads-waterways.transport.nsw.gov.au/business-industry/partners-suppliers/document-types/specifications/index.html
VIC	Traffic Engineering Manual Vol 3 Part 2.04 - Managed Freeways Handbook	https://vicroads.vic.gov.au/business-and-industry/technical-publications/traffic-engineering
WA	Main Roads Technical Library Specifications	https://mainroads.wa.gov.au/technical-commercial/technical-library/?q=&node=Specifications

9.4 Project Development (Planning and Design)

9.4.1 Introduction

The Project Development phase covers:

- project planning
- project design
- project procurement
- stakeholder engagement.



The project governance framework should cover representation from operational teams.

For example, operational working groups being established and resourced (during design, construction and proving periods) to review design, operability and defects rectification following 'go-live'. This project governance framework includes attendance and involvement during progress meetings with project delivery teams.

Ideally a 'Responsibility, Accountability, Consulted, Informed' (RACI) matrix should provide clarity for the roles and responsibilities of operational representation.

Table 9.1 describes three overarching interactions during each component of the project development phase listed above. The following sections have examples for each interaction.

9.4.2 Information Flow – from Operations Team to the Project

This information flow comprises the following activities:

- Develop and provide a list of all operational stakeholders throughout the project life



For major projects, where possible, have a person from motorway operations seconded into the project team. This person would effectively and efficiently champion operational needs throughout the project lifecycle to minimise and/or mitigate significant risks for smooth handover and long term operations of new projects (e.g. new smart motorway infrastructure, systems improvements). While this position could be on a part-time basis during the project development phase, the secondment will need to transition to a full-time basis to support the handover phase over the last 6-12 months of the project.

- the provision of any network operating plans, frameworks, or Concept of Operations (ConOps) that cover the location of the project. If the project is large enough, then it may have a ConOps developed specifically for the length of smart motorway that will be created by the project
- the provision of any organisation operational policy that will or could impact the project objectives and/or scope and variations (if any) that might be required for the specific project
- the provision of technical requirements for projects (also see Section 9.3 for a list of standard documentation that can be prepared and used across all projects), noting these operational technical requirements are separate to design and drawing requirements and associated review activities, which are usually well-covered by other documents and standards
- provide and agree instructions, protocols and details for activities including:
 - shortlisting and endorsement of proposed roadside technology
 - raising technical queries relating to operational aspects
 - required asset data requirements (including formats) for the provision of asset information, which is relied upon by the operations team
 - design criteria requirements and the design review process (gateway reviews)
 - definition of handover and go-live process (noting that the more services, systems or increased scope, the more complicated handover and go-live process will be)
 - commissioning and testing
 - connecting to existing networks and/or systems
 - handover documentation requirements e.g. operations manuals
 - change management process
 - risk management register and process.

9.4.3 Collaboration between Operations Team and Project Team

Consistent with operations-led design thinking, the following considerations ensure operational needs and performance will inform motorway planning and design:

- project-specific background context
- articulation of project purpose, objectives, desired end user outcomes (scope of works and technical criteria)
- requirements definition
- finalisation of ConOps (if a project specific ConOps is being prepared)



Having operations staff involved in the development of network operating plans/frameworks, ConOps and business cases brings a different perspective that can support in the identification of value for money solutions. Involvement of operations staff would also ensure that the ideas being developed are achievable and can be implemented without a significant ongoing OPEX cost.

- engage with the development of the business case including advice on whole-of-lifecycle costing based on operational and maintenance outcomes, understanding of operational asset requirements, capital and operational expenditure, and resourcing
- inform and contribute to the development of the project scope of works and technical criteria on:
 - ITS requirements, systems capabilities, device availability and response requirements for operations e.g. future metering sites, systems changes, tidal flow arrangements
 - inter-operability with the current or future operations systems when procuring or selecting ITS field devices
 - functional and detailed design for optimal lanes configurations, ramp designs and other motorway aspects
 - network performance outcomes and construction limitations
 - other existing operational performance issues that may impact on project delivery so that impact on motorway users can be minimised.
- develop, implement, maintain and regularly review:
 - maintenance strategy (and corresponding response plans)
 - continuity of service strategy
 - information about ITS handover to maintenance in a comprehensive handover file covering maintenance and operational aspects
 - operational strategies.



All new ITS equipment should be consistent and compliant with the technical standards for the complete motorway system to minimise the risk of 'stranded' ITS assets that do not fit within the system architecture.

- project gateway reviews with a specific focus on ITS systems scope and design, schematic design, network architecture (including security management), operations systems and user interfaces



The gateway reviews include operational sign-off on design that has operational implications. However there may be times when the project cannot deliver the optimal outcome for operations. These situations should be recorded and acknowledged in the project risk register.

- provide advice and guidance on ITS device and system supplier selection
- involve operations teams to provide insight and understanding of whole-of-life management costs including operational expenditure (OPEX), resourcing, training, maintenance, support and improvement program
- champion the use of managed motorways ITS technologies including targeted, shorter-term, lower-cost, operational improvements that support the intended priority use across the network
- review expected network performance and provide recommendations for adjustments to project or operational system configuration
- review and update tasks, issues and risk registers. The management of issues and risks will often need to be coordinated between both parties.

9.4.4 Information Flow – from the Project to the Operations Team

For continuity and assurance of information flow, operations teams should receive completed project information to which they have contributed advice or guidance, such as:

- maintenance strategy for ITS and systems to be created or modified by the project
- the Concept of Operations (ConOps) when being prepared for the specific project
- project scope and requirements
- project specifications and drawings.

9.5 Project Delivery – Smart Motorways Technology

9.5.1 Introduction

The project delivery phase that involves technology implementation includes:

- systems design
- construction
- operations design.

As described in Table 9.1, there are three overarching interactions during design and construction. Examples for each interaction are described in the following sections.

9.5.2 Information Flow – from Operations Team to the Project

Information flow comprises:

- early identification of system training/operational training needs prior to the handover process
- more detailed advice and guidance for integration to operational systems, including live traffic operations, incident management and ITS maintenance.



The majority of operational needs should be provided to the project during the Project Development phase. Refer to Section 9.4.2 for a check list of information and inputs that should be provided to the project.

9.5.3 Collaboration between Operations Team and Project Team

Collaboration activities during this phase (Project Delivery – Smart Motorways Technology) typically include:

- user process and/or interface (usability) design of any new, expanded or modified operational systems
- gateway reviews for any system and operations design
- co-ordination with external and internal ICT resources to ensure successful outcomes for system integration
- review of new and changed traffic signal plans as a result of the project
- oversight and review to ensure continuity between pre-existing ITS systems/controls, and the future state, to ensure a smooth transition and no loss of current functionality or operations capability
- assessment of impacts on operations caused by new services or scope of operations for systems that are 'created' by the project

- develop induction and training material to support TMC preparedness in understanding the new corridor and/or operations systems
- validation of a maintenance strategy and plan
- review and updating of the 'Tasks, Issues and Risk' Registers. Management of issues and risks will often need to be coordinated between the parties.

9.5.4 Information Flow – from the Project to the Operations Team

The information to be supplied by the project should include:

- ITS design and as-built drawings
- ITS maintenance and user manuals
- operations design report (or an updated version of the ConOps if appropriate).

9.6 Project Delivery – Temporary Traffic Management

9.6.1 Introduction

In general, this phase (project delivery – temporary traffic management) includes:

- traffic management plans
- traffic monitoring
- incident management.

There are three overarching interactions during each of the above listed components for the temporary traffic management phase. The following sections has examples for each interaction type.

9.6.2 Information Flow – from Operations Team to the Project

When projects are undertaken on existing motorways, or connecting to existing motorways, the operations team will continue to undertake traffic monitoring and control around the construction site where they can utilise existing ITS monitoring and control technology as well as existing systems and resources.

Information flow typically covers the following:

- processing of planned network access requests from the project.
- congestion monitoring and performance monitoring during construction to inform project management
- advice on the needs of business-as-usual (BAU) operations including incident management, recurrent congestion management and special events.

9.6.3 Collaboration between Operations Team and Project Team

Collaboration during this phase (project delivery – temporary traffic management) may comprise:

- the review of temporary arrangements and staged traffic schemes to fit with construction programs while maintaining adequate traffic capacity through any construction zones
- assessment of impacts on operations caused by the project construction/installation



Establish a plan, in consultation with TMC, for road closures or lane restricted operations that provides clarity on the maximum allowable threshold of delay before a re-opening contingency must be implemented.

- liaison and coordination with relevant stakeholders to minimise network impacts due to construction works
- supporting the design of temporary traffic signal plans for use during the Project Delivery phase
- review and updating of the 'Tasks, Issues and Risk' Registers. Management of issues and risks will often need to be coordinated between the parties.

9.6.4 Information Flow – from the Project to the Operations Team

The information to be supplied by the project should cover:

- temporary traffic management plans, including:
 - safety protection for site workers and the public using the live motorways and any related side roads
 - contingency plans when congestion gets to unacceptable levels.
- construction staging which involves using different layouts of existing roads during different stages of larger projects.

9.6.5 Case Study

Who | Department of Transport, Victoria

Problem | The Princes Freeway-Forsyth Road interchange upgrade was a major project in 2020 that required an effective and dynamic detour plan factoring in the daily traffic volume exceeding 100,000 vehicles as well as the densely populated suburbs nearby. The detour plan would need to minimise disruption to customers and divert them to the quickest detour route(s) in real time.

Solution | 17 detour routes were developed, each with live traffic monitoring. The DoT operations team provided direct inputs for defining the rules for detour recommendations. The consultation with operations team ensured that drivers were dynamically directed to the quickest detour route(s) depending on their current location and the real-time traffic conditions along all monitored routes. The community messaging helped to limit excessive impacts on traffic even as conditions changed throughout morning and evening peaks.

Benefits | The use of smart motorway technology enabled the TMC to reroute traffic and provide a full road closure for the duration of the works to be considered. This approach delivered significant reduction in the overall impact of the construction works.

9.7 Project Handover (Including Implementation)

9.7.1 Introduction

In general, the project handover phase includes:

- implementation and commissioning of systems
- testing/validation of ITS devices
- formal documentation handover
- operator and maintenance training.

Table 9.1 describes three overarching interactions during each of the above components for the project handover phase. The following sections have examples for each interaction.

9.7.2 Information Flow – from Operations Team to the Project

The operations team should provide the following:

- if not already delivered during earlier phases of the project, define the operational handover process. This handover would include contingencies that define roll-back requirements if system implementation does not pass user testing and other validations
- advice on defining operational handover process to ensure TMC buy-in and acceptance and to ensure contingency roll-back if required
- internal operational planning for resourcing of TMC and other operational tasks during the handover and proving periods of motorway projects
- provide date and time windows when the integration and system switchover(s) can be undertaken.



To reduce the potential impact on customer experience and reputational risk, consider avoiding 'switch-on' or 'go-live' on:

- weekdays that have heavier traffic activity (i.e. avoid Friday) when opening a new motorway or upgrade
- on weekends which usually have fewer field resources and operational specialists on standby.

9.7.3 Collaboration between Operations Team and Project Team

Collaboration during this phase (Project Handover) typically involves:

- testing and commissioning support (usually involving the ITS technology leader/technician role), including:
 - end-to-end (field device to TMC) communications and system testing
 - connection of new ITS field devices into the existing or new communication networks
 - integration of new ITS field devices into the existing or new operations systems
 - full motorway testing ('dry' and 'wet') including system validation of rules-based system.
- prepare 'User Acceptance' test run sheets.



TMC operators can have lulls during the off-peak periods, if the current state is incident-free, project staff could work with TMC management so operators involved in device testing and system 'User Acceptance Testing' (UAT) during these lull periods.

- undertaking a test roll-out of systems for major system changes or changes to critical systems, usually involving a test or backup version of the systems so that this can be done without interfering with the live systems
- conducting media campaign and key message delivery for project opening, including:
 - utilising existing traveller information channels managed by the operations teams
 - coordination and liaison at network interfaces with adjacent road operators, where required, for any operational considerations during the opening.
- rollout induction and training on any new system training to the TMC
- review and updating of the 'Tasks, Issues and Risk' Registers. Management of issues and risks will often need to be coordinated between the parties.



Commissioning and testing should cover operational scenarios based on the relevant experience of operators, with TMC acceptance to form part of sign-off prior to handover of a new motorway project.

9.7.4 Information Flow – from Project to the Operations Team

At handover, the following comprises the minimum documentation to be provided to the operations team:

- ITS field device test records, including:
 - Factory Acceptance Testing (FAT)
 - Site Acceptance Testing (SAT).
- ITS device manuals and user/operator guides (if new to operations)
- system manuals and user/operator guides (if new to operations or modified from the current setup)
- system and device warranties.

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Appendix A Smart Motorways Classification Model Overview

Smart Motorway Operations Characteristics Level	Operating Characteristics					Operational Outcomes	
	Intelligence	Traffic Control	Traveller Information	Incident Management	Planned Network Access Management		
Level 1 "Reactive with no incoming data"	No active monitoring and only incoming calls and information from the public or emergency services	The use of ad hoc resources and response vehicles to support largely passive traffic control	Static traffic information on temporary signs and limited real-time alerts	Incident response is reactive (usually using road maintenance resources) with no plans, directed by emergency services and no coordination by the road agency	Fully ad hoc with no formal controls in place for addressing traffic impacts and road occupancies	Network and Traffic Flow	• Network Demand • Network Capacity • Network Efficiency • Network Delay Distribution • Network Volatility
Level 2 "Reactive with some incoming data"	Some manual visual monitoring and traffic data from limited detection locations	The use of pre-organised field resources and response vehicles to support traffic control with centralised coordination	Information mostly manually created and available via radio and the internet	Part-time TMC with response using standard procedures with local coordination	Application and approval process	Incident Occurrence	• Number of crashes by severity (fatal / serious / moderate / minor / non-injury) • Number of crashes by type (overtaking, same lane rear end, etc.) • Number of crashes across all severity and types
Level 3 "Some Proactive Management"	Comprehensive visual and traffic detection intelligence available including some local road connections	Using field devices and/or equipment to manage and control traffic - mostly manual	Traveller advice and incident information pro-actively pushed out through multiple channels e.g., subscription-based alerts	Full-time TMC utilising pre-prepared response and/or detour plans	Centralised management system to manage applications and access	Incident Clearance	• TMC verification times • Response time to arrive on scene • Clearance time to clear the incident scene • Recovery time for the traffic to return to normal after the incident
Level 4 "Substantial Proactive Management"	Some automated incident and stopped vehicle detection available and congestion alarms to support increased network coverage	Using field devices and/or equipment to manage and control multi-modal traffic - mostly automated	Responding in accordance with established multi-agency response plans	Traveller information able to be tailored to locations or routes	Strong auditing and work completion process as well as coordination with internal works and projects	Informed Road Users	• Number of media briefings / releases • Number of channels used to distribute information • Time to set for an initial response after an incident occurs (e.g. setting a VMS)
Level 5 "Full Proactive Management"	Fully automated incident and traffic monitoring without using manual resources	Coordinated and automated ITS responses in real time for multi-modal and multi-network, often using multiple systems	Information and data made openly available for optimised decision making, mostly automated	Dynamic multi-modal and multi-network response plans that are adaptive using real time traffic info	Sophisticated event and access coordination to reduce impacts on road users	Impacts from Planned Events	• Travel time reliability during a planned event • Duration of lane closure and distance of lane closed (i.e., amount of driver exposure to a planned event) • Percentage of planned events that required an extended duration
						ITS System Performance	• Number of equipment replaced per year • Number of faults per device per year • System "up-time" availability • Fault response time of critical devices

Appendix B Impact of Shortlisted Future Trends on Motorway Operations

Extract taken from Section 5 of the Motorway Future Trends Research Report.

Item	Trend Name	Description	Anticipated Impact Horizon	Impact on TMC Operations	Impact on Live Operations	Impact on Incident Management	Impact on Operations Planning
1	Increasing expectation for enhanced traveller experience	Community expectations in the digital age are ever increasing, including increased pressure for instant responses, constant communication and availability of real-time information, tailored/individualised offerings, increased choice (private vs fleet vs MaaS). At the same time, the availability of more information (be it CCTV, travel information or incident information from across government) is potentially overloading some travellers. Traffic managers may see increased demand for prioritisation and/or coordination of shared, public and active travel modes (e.g. streamlined access to taxi and ride-share services).	1 to 5 years	More resources (staff and/or systems) required to handle the increasing expectations for more and accurate traveller information across the whole customer journey	- Traveller information will need to be delivered through an increasing list of communication channels and the expectation is that all of the information will be consistent and reliable - Increased need for public-facing data to be released in real-time with information being delivered to travellers more and more by third parties, not transport agencies themselves. There is a possible need for agencies to develop new type of relationships and partnerships with the information providers	More incident response resources to support reducing the response and clearance times for minor and moderate incidents (noting that these expectations could get to the point of being unrealistic)	- Political and media risks will escalate as the public becomes less tolerant of systems that do not work on day one, delays caused by system breakdowns and crashes on 'smart' motorways (e.g. the controversy surrounding use of hard shoulders in the UK). - Greater variability in route choice increasing the number of situations to be planned and prepared for. - Increase safety focus causing more lengthened road closures
2	Increasing inter-agency integration	We note both a need and expectation that different agencies will collaborate and integrate their policies, operational responses, data sharing/information flow and work towards joint outcomes. Agencies include industry associations (e.g. Royal Automobile Club), state/territory transport agencies in charge of motorway operations and major projects, local councils in charge of local road network aspects, emergency services, external operating partners and other third parties creating disruptions. The majority of Melbourne's motorway network is now managed or is in the process of being upgraded to a managed motorway. This is to facilitate operating the network as a whole with better integration between arterials and managed motorways. In future, there will be a multi-managed motorway road operator environment established with a system-to-system integration platform (Victorian Department of Transport 2021; presentation at ITS Asia Pacific Forum 2021).	1 to 5 years	- Road users will need to be treated more seamlessly when they go from motorways to local roads and across other jurisdictions - Further increase in the number of agencies working collaboratively out of TMCs - National/Federal Governments directing collaboration if it is not being proactively done by the individual agencies	- Live traffic monitoring and management is improved by being able to see a broader 'picture', through the availability of more information from across the agencies - Reduced clashing of events across agencies (for example, a detour route off the motorway does not go through a planned event on a local street)	- Better coordination of incident response resources - Some improvement to the road users affected by incidents	- Increasing engagement and integration required across all stakeholders (including matters around motorways interface with arterial operations, consideration of future vehicle fleet needs [see Item 11 below], and consistent technical requirements between operating entities) - Further increases to the amount of stakeholder engagement required during some planning activities - Improved ability to share data and information across agencies/organisations (also supported by improving use of data and system standards)
3	Increasing urban/city populations	The main cities of Australia and New Zealand have continued to grow (with a few medium-term impacts caused by the COVID-19 pandemic and natural disasters). This trend is driven by a desire to live, work and study in cities as well as often migrants gravitate to them for similar reasons.	1 to 5 years	More resources (staff and/or systems) are needed to handle the increasing amounts of congestion and the ITS implemented to address the growth in new roads and increasing demand	- Increasing interfaces, and complexity, between motorways and arterial roads - Increasing number of planned events that will need to be processed and coordinated	As congestion grows, incidents can become more frequent but often have a reduced severity because average speeds are reducing	Continuation of capital projects being delivered that will need to be integrated into TMCs and operations

Item	Trend Name	Description	Anticipated Impact Horizon	Impact on TMC Operations	Impact on Live Operations	Impact on Incident Management	Impact on Operations Planning
						For the more heavily congested cities, there may be conflict over the use of hard shoulders to provide additional vehicle capacity vs the increase in risks of vehicles being hit when they have no safe place to pull over	
4	Increasing natural disaster and extreme weather events	There is increasing expectation that events due to climate change, natural disasters and global pandemics are likely to rise in the future. Additionally, these events would impact certain areas differently and unequally e.g. increased storms in one area increased droughts in another	1 to 5 years	- Increased focus on contingency planning and resilience for the operation - The increasing desire to embrace working from home will require TMCs to balance what critical functions need to be delivered from the TMC vs what can be done remotely	Changing work patterns, such as working from home, could lead to less predictability of volume and general travel patterns	A likely increase in major weather events that will have to be managed	- Major disasters can leave an impact on infrastructure or communities that significant shifts work and travel patterns. - Facilities may become obsolete/inadequate more quickly - Need to consider network and operations resilience in preparation for these events
5	Increasing amount of real time network performance information	There is likely to be a continual growth in the availability, quantity and sharing of real time network performance information to support traveller information needs. This information will likely be: - consumed by systems that are wholly integrated and achieve seamless information management (collect, analyse, process, distribute) - used by the general public - garner interest from private companies (e.g. application developers)	1 to 5 years	- Increasing data capability will need to increase over time in TMCs i.e. need to understand how this (mostly) automated data is created and how to intervene when it loses accuracy or no longer works as expected - New relationships will continue to emerge with technology companies providing mobile apps, vehicle manufacturers providing in-vehicle navigation systems and automated vehicles that capture data	- Providing a larger volume of accurate information that supports travellers making informed decisions will influence route choices and whether someone even starts a journey. This provides a modest benefit in the reduction in possible congestion. - Ability to reduce traffic demand bound for motorways when at capacity	- Faster and more accurate traveller information will support more road users avoiding roads that are impacted by current and recent incidents - Information will help the road users to better understand the impacts of an incident into the future, hence helping them make better travel choices to avoid congestion - Ability to better disperse traffic over greater geographic areas in the event of significant network disruptions	Agencies increasingly need to do more in assessing, aggregating, and deriving operational insights from an increasing range of data sources
6	Increasing cyber-security risks and data protection	Increasing quantity, likelihood and complexity of digital technologies progressively opens up more avenues for and vulnerability to cyber-attacks, hence greater cyber-security risks posed to communication networks and systems (e.g. NHTSA 2021).	1 to 5 years	- TMCs are almost completely dependent on systems and communications technology so could be severely affected by a cyber-security attack - Systems for traffic control (e.g. traffic signals) will always pose an attractive target to cause chaos	As systems get more complicated to manage some normal operations (e.g. reversible motorways) the impact could be very significant	- While incident sites are mostly managed by emergency services or incident response staff, there will be moderate impacts on response times for dealing with the incident and reopening roads during a communication network/systems outage - Could neutralise the ability to manage and influence traffic away from the incident and therefore significantly increasing the amount of congestion caused by the incident	- Some delays to operational planning could occur if system outages were longer than a few days - Malfunctioning or non-responsive ITS and traveller information systems which may cause loss of trust (EY 2019), opportunity costs and potentially slowing down the uptake of technology.
7	Increasing use of big data and artificial intelligence (AI)/machine learning/systems automation	While Trend 5 deals with the availability and use of more network performance data, this trend is focused on how AI, machine learning and other smart automations will be used to derive new insights from the network performance and other data sets that can then be acted upon.	1 to 5 years	- Automation of some aspects of operator roles but this mostly frees up the operators to add more value connecting across different aspects of the network for incident response and live operations - Evolution of current employee roles and need for higher order duties	- Improved Automated Incident Detection systems leading to less manual monitoring of CCTV by TMC operators - Loss of sensor/detector feedback or control abilities may cause loss of motorway performance	- Improvements in incident detection, confirmation, response, and recovery - Improved Automated Incident Detection systems will allow quicker response times to incident locations, reducing the safety risks to occupants in stopped vehicles	- Increased need to ensure TMC resilience despite reliance on automation (e.g. developing necessary capabilities for human operators to take over and when a manual override may be required) - Increased need for data interpretation and data application because data sources may no longer be fixed sensors but connected vehicles and portable smart devices

Item	Trend Name	Description	Anticipated Impact Horizon	Impact on TMC Operations	Impact on Live Operations	Impact on Incident Management	Impact on Operations Planning
		This type of analysis is initially likely to be used for operational planning and then the ability to connect live data and mesoscopic modelling together would allow this analysis to extend into supporting real time operations and decision making.		• Need for upskilling and a deeper understanding of the systems being used to implement safer operational responses • Requires a dedicated person or team for the calibration, monitoring, reporting, and evolution supporting the use of these technologies • More variable workload peaks as reliance on automation increases exposure to device failures • Risks of incorrect operational outcomes compared to manual operation • Need for elevation in support SLA from support teams • Less workload on resources • Increased expectations to be adaptive and support adaptive operations • Increasing engagement with smart vehicle manufacturers to facilitate access to relevant data	• Increased sensitivity to communications and power outages • Highly granular network-level data available for decision making • ITS equipment (especially electronic signs) can be more dynamically respond to different situations • Additionally, use of more data from uncontrolled sources increases the potential for error, noise, overwhelming of operators and distraction – potentially slowing responses or quality of response (and consuming valuable resources)	• Opportunity to better identify the right response resources and the timeliness of getting them to the incident site to help reduce the clearance times. This is particularly applicable to getting tow vehicles identified and to site as quickly as possible. • Improved response times • More consistent responses	
8	Increased use of smart motorways to respond to incidents and manage impacts on broader network	Smart motorways (also referred to as 'managed motorways') use intelligent transport systems (e.g. automated algorithms such as ramp signalling, queue detection/ queue protection, high flow) to increase capacity and reduce congestion along a section of motorway. When an incident occurs, consequence management is needed for the consequential impacts (e.g. congestion) on the broader network. As congestion grows there will be continual pressure to better utilise the existing road network. The availability of faster and more economical third party communication networks more broadly (e.g. 5G, 5G+, the Australian National Broadband Network [NBN]) may lead to greater access for rural motorways and off-motorway devices.	1 to 15 years* * There is some impact now, with further growing impacts as new technology is implemented and smart motorway coverage continues to expand.	• Increased system sophistication, increased geographical areas • Increasing staff training and development requirements • Further trade-offs required between specialist operators vs generalists • While more smart motorways do not always lead to more operators being required, this is often the case when a new smart motorway brings in some new technology or a complexity that hadn't needed to be managed before (e.g. a tunnel or a busway or phasing in AVs) • Operators having to process multiple unintegrated sources of data • Reduction of operator consistency as individuals take different strategies to interpret/manage data overload • Fault diagnosis may take longer • Difficulty in recruiting experienced staff • More systems, will likely lead to more fault logging	• Provide the ability to be more dynamic in response to different needs happening on the network • More 'eyes' on the road and information will allow more accurate and responsive management of the normal traffic and traffic resulting from incidents • Increase reliability and throughput • Reduced congestion • Improved safety	• Increasing need to be adaptive • Quicker response (traffic management actions and Incident Response System Dispatch) • Reduced number of incidents (and their severity), including secondary crashes • Increased ability to directly influence the road users through electronic signs and the growing means to communicate with drivers in their cars	• Increasing complexity for integration of new or improved smart motorways into existing operations • Increasing workload on processing temporary traffic management and access approvals • Increased flexibility to balance loads on road networks through technology-facilitated collaboration with MaaS providers to influence driver behaviours

Item	Trend Name	Description	Anticipated Impact Horizon	Impact on TMC Operations	Impact on Live Operations	Impact on Incident Management	Impact on Operations Planning
9	Increasing percentage of the vehicle fleet with automated safety features	While this trend has been underway for a while now, there is increasing momentum as car manufacturers incorporate more automated safety features into each new model release during the next decade. Examples of such safety features include hazard/intersection awareness messages and curve speed warning messages (ITS Australia 2020).	1 to 10 years	Increased need for operators at TMCs to keep an up-to-date understanding of vehicle capabilities, with possibility of new data sourced from these automated features (either real-time or not)	No significant impact	Reduction in incidents, and their severity, reducing the number of responses required	Still evolving, but could be some infrastructure requirements (e.g. line marking, readability of electronic signs) and need for agencies to assess/understand/support some of the features being included in cars and their impact on smart motorway operations
10	The introduction of fully connected and automated vehicles (CAVs) through Cooperative Intelligent Transport Systems (C-ITS)	Vehicles are increasingly enabled to communicate with other vehicles and roadside infrastructure especially when part of the same Cooperative Intelligent Transport Systems (C-ITS). C-ITS devices share and receive quality and reliable information between other equipped vehicles/infrastructure to determine in real time if a conflict is likely to occur. Additionally, C-ITS devices can warn drivers about risks on the road ahead. Other names: Vehicle-to-Vehicle, Vehicle-to-Infrastructure, Vehicle-to-Other	11 to 15 years	- More data points will potentially be made available to the TMC (also refer to details for Trend 7 above) - Step increase on demand and expectations on I-V communications - Greater demand on technically competent personnel will be required as issues will be lesser in number, but greater in complexity	- Risk of vehicle vendors systems prioritising different objectives to road operators - Automated Vehicles (AV) and classical driver interactions may impact (negative/positive) to efficient use of motorway - AV pursuing driving techniques that benefit AV vehicle and potentially result in overall a less efficient use of the roadway. For example, forcing a merging vehicle to stop at the end of their lane - Different skill sets would be needed - Fundamental traffic flow changes - Awkward transition period of mixed fleet vehicles that are not CAV enabled - Opportunity to use data/AI-enabled aids and tools (such as 'digital twin')	- Reduction in incidents, and their severity, reducing the number of responses required - Obsolescence of some of the existing incident management processes - In-vehicle communication technologies, ability to divert vehicles more rapidly	- Still evolving, but could be some infrastructure requirements (e.g. line marking, readability of electronic signs) and need for agencies to assess/understand/support some of the features being included in cars and their impact on smart motorway operations - Need to classify the level of C-ITS (e.g. EU LOS A to LOS C) that will be important for AVs to understand whether it can receive orders, information or no information from the C-ITS
11	Increasing need and expectations for decarbonisation including lower emissions from vehicles	The Australian Commonwealth and New Zealand national governments have identified emissions reduction targets under the Paris Agreement. New Zealand and each of the states/territories in Australia have also identified an ambition to achieve net zero emissions by 2050, which would help move towards limiting global temperature increase to less than 1.5°C above pre-industrial levels. This trend also follows stronger growing prominence of the United Nations' Sustainable Development Goals in New Zealand and Australia (Australian Department of Foreign Affairs and Trade, 2018; New Zealand Department of Foreign Affairs and Trade, 2019). The ambition is paired with considerable focus on vehicle electrification and increased uptake of low and zero emission vehicles (LZEVs) to ensure a stable future climate (Austroads 2020c; Queensland Government 2017; Victorian Government Department of Environment, Land, Water and Planning 2021).	1 to 15 years* *There is some impact now, with further growing impacts as new technology is implemented and smart motorway coverage continues to expand.	No significant impact	The focus on decarbonisation will encourage further pushes towards the use of low emission public transport. This could impact on future mode share for different motorways	Increased risk of hazardous conditions and materials in the event of major incidents that involve LZEVs, requiring specific training to manage such events (Health and Safety executive 2021)	Still evolving but would be need for agencies to assess/understand changing emission levels within tunnel systems including ventilation management and air quality requirements

Appendix C Maturity Self-Assessment Checklist

(When applicable)			Assessment (Yes / Partial / No)		
Sub Function	SMCM Level	Action/Task/Responsibility	Current	Future	Comments
Intelligence	Level 1	Use the available information to verify called in incidents are in fact correct and confirm the location. This should also include any intelligence on the severity of incidents			
Intelligence	Level 1	Raise general awareness towards reporting incidents (e.g. if a staff member drives past an incident that is outside of the TMC systems coverage)			
Intelligence	Level 2	Monitor the live motorway network (e.g. using incoming traffic volume data and video feeds) to manually detect breakdowns, incidents or unusual congestion			
Intelligence	Level 2	Use the available data and information to verify detected incidents are in fact correct and confirm the location. This should also include any intelligence on the type and severity of incidents			
Intelligence	Level 2	Monitor changes in weather and environment to aid operational decision making			
Intelligence	Level 3	Monitor the live motorway network and the local road connections (e.g. using incoming traffic volume data and video feeds) to manually detect breakdowns, incidents or unusual congestion			
Intelligence	Level 3	Prioritise surveillance of high-risk locations (e.g. wind on bridges, queued traffic in tunnels)			
Intelligence	Level 3	Establish strategy for data management and intelligence gathering, ensuring a wholistic network intelligence			
Intelligence	Level 3	Maintain working relationships with other agencies involved in incident mitigation / response to share intelligence			
Intelligence	Level 3	Maintain a high level of situational awareness across the motorway network			
Intelligence	Level 4	Monitor the live motorway network (e.g. using incoming traffic volume data and video feeds) to automatically detect breakdowns, incidents or unusual congestion			
Intelligence	Level 4	Use the available data and information to verify automated detection of incidents are in fact correct and confirm the location. This should also include any intelligence on the type and severity of incidents			
Intelligence	Level 5	Use data collection and analytics to predict potential incidents and alert agencies			
Traffic Control	Level 1	Use ad hoc resources and response vehicles to support largely passive traffic control			
Traffic Control	Level 1	Traffic control done by field resources			
Traffic Control	Level 2	Use pre-organised field resources and response vehicles to support traffic control with centralised coordination			
Traffic Control	Level 2	Provide some coordination of field resources including between emergency services and the road authorities' resources			
Traffic Control	Level 3	Use, control, adjust, monitor field devices and ITS technologies manually to manage traffic impacts from incidents, planned events and recurrent congestion			
Traffic Control	Level 3	Manually manage traffic impacts, on the wider network, resulting from detour routes			
Traffic Control	Level 3	Apply speed controls across the managed motorway, in accordance with operational rules, with manual use of standard response plans			
Traffic Control	Level 3	Apply lane controls across the managed motorway, in accordance with operational rules, with manual use of standard response plans			
Traffic Control	Level 3	Apply shoulder controls across the managed motorway, in accordance with operational rules, with manual use of standard response plans			
Traffic Control	Level 3	Manage strategic routes by giving them priority during incidents and managing unusual congestion			
Traffic Control	Level 4	Use, control, adjust, monitor field devices and ITS technologies with some automation to manage traffic impacts from incidents, planned events and recurrent congestion			
Traffic Control	Level 4	Use some automation to manage traffic impacts, on the wider network, resulting from detour routes			
Traffic Control	Level 4	Apply speed controls across the managed motorway, in accordance with operational rules, with some automation of standard or dynamic response plans			
Traffic Control	Level 4	Apply lane controls across the managed motorway, in accordance with operational rules, with some automation of standard or dynamic response plans			
Traffic Control	Level 4	Apply shoulder controls across the managed motorway, in accordance with operational rules, with some automation of standard or dynamic response plans			
Traffic Control	Level 4	Clear and manage multi-modal traffic congestion with some automation in a coordinated manner			
Traffic Control	Level 4	Actively manage queues at on and off ramps using ramp signals and arterial traffic signals			
Traffic Control	Level 5	Use, control, adjust, monitor field devices and ITS technologies with full automation to manage traffic impacts from incidents, planned events and recurrent congestion			
Traffic Control	Level 5	Use full automation to manage traffic impacts, on the wider network, resulting from detour routes			

(When applicable)			Assessment (Yes / Partial / No)		
Sub Function	SMCM Level	Action/Task/Responsibility	Current	Future	Comments
Traffic Control	Level 5	Apply speed controls across the managed motorway, in accordance with operational rules, with full automation of standard or dynamic response plans			
Traffic Control	Level 5	Apply lane controls across the managed motorway, in accordance with operational rules, with full automation of standard or dynamic response plans			
Traffic Control	Level 5	Apply shoulder controls across the managed motorway, in accordance with operational rules, with full automation of standard or dynamic response plans			
Traffic Control	Level 5	Select and apply operational rules using automated dynamic plans that involve several device types and systems			
Traffic Control	Level 5	Actively manage motorway inflows and lane capacity to maximise network productivity (speed x flow)			
Traveller Information	Level 1	Call out field resources to put up static temporary information signs			
Traveller Information	Level 2	Create traveller information message content manually			
Traveller Information	Level 2	Provide real-time travel information and messaging to radio stations for them to broadcast and support driver being informed to make their own route choices			
Traveller Information	Level 2	Update a simple traveller information website to enable drivers to make their own informed route choices			
Traveller Information	Level 3	Foster a culture of 'the customer at the heart' and facilitate understanding of customers			
Traveller Information	Level 3	Create traveller information message content with some automation			
Traveller Information	Level 3	Pro-actively push out accurate, timely live traveller advice and incident information to road users through multiple channels with some automation e.g. subscription-based alerts			
Traveller Information	Level 3	Coordinate incident notification and responses to ensure consistent messaging			
Traveller Information	Level 3	Update and manage the traffic website for incident information, with some of the congestion levels now automated			
Traveller Information	Level 3	Undertake 'holiday weekend' media campaigns to mitigate the worst of the congestion often experienced on the major routes to and from the major urban centres on holiday weekends			
Traveller Information	Level 3	Communicate externally about upcoming planned events (e.g. roadworks) and alternative routes to use prior to key decision points on the network			
Traveller Information	Level 3	Provide for media-trained or media staff in the TMC			
Traveller Information	Level 3	Establish communications strategy for traveller information – e.g. Campaigns around new technology and road management, social media policy and updates for radio stations			
Traveller Information	Level 4	Provide tailored traveller information, for road users, to certain locations or routes			
Traveller Information	Level 4	Using all of the available traveller information technologies and communication channels, inform customers of incidents or unexpected congestion resulting from planned events or other situations on a mostly automated basis			
Traveller Information	Level 5	Provide accurate, timely traffic information to road users and to potential future road users across multiple modes fully automatically			
Traveller Information	Level 5	Provide open information and open data for optimised decision making, mostly automated			
Incident Management	Level 1	Call out and use road maintenance resources for incident management response, clearance and recovery			
Incident Management	Level 2	Assess the situation, to determine the level of incident by considering the time of day, type of incident, severity and possible impacts			
Incident Management	Level 2	Call out, notify and liaise with emergency and repair services			
Incident Management	Level 2	Conduct incident management response using standard procedures with local coordination			
Incident Management	Level 2	Ensure any incoming information used for incident management planning is reliable through cross-checking with multiple sources prior to deploying significant resources			
Incident Management	Level 3	Facilitate swift roadside assistance/towing			
Incident Management	Level 3	Coordinate with traffic control on local roads as needed to:			
Incident Management	Level 3	Install temporary signage			
Incident Management	Level 3	Implement, develop, operate detour routes			
Incident Management	Level 3	Monitor traffic operations			
Incident Management	Level 3	Conduct incident management response using relevant incident response plans (including detour plans)			
Incident Management	Level 3	Monitor and obtain updates from the incident scene			
Incident Management	Level 3	For longer incidents, provide up-to-date information to customers through the available traveller information technologies and communication channels			
Incident Management	Level 3	During the incident, determine and operate alternative travel routes for both the inner and outer cordons			
Incident Management	Level 3	Assess, direct, dispatch incident response (field) resources and clearance activities:			
Incident Management	Level 3	Active management of field resources such as incident management crews, towing, recovery through direct liaison and contact			

(When applicable)			Assessment (Yes / Partial / No)		
Sub Function	SMCM Level	Action/Task/Responsibility	Current	Future	Comments
Incident Management	Level 3	Coordinate police and emergency support for response resources getting to the incident site			
Incident Management	Level 3	Protect the incident site by implementing traffic control strategies			
Incident Management	Level 3	Identify if any emergency road work and infrastructure repair is required			
Incident Management	Level 4	Coordinate with traffic control on local roads and public transport as needed			
Incident Management	Level 4	Follow agreed communication and response protocols between agencies as established through multi-agency response plans			
Incident Management	Level 4	Provide quickest route guidance to the response team and provide signal priority if warranted			
Incident Management	Level 4	After all of the initial dispatching and planned implementations for a major incident, it is best to start considering the reopening options early so that options can be discussed and planned for			
Incident Management	Level 4	Use positive 'road open' VMS messages after an incident is cleared, the road is open again but there is still resulting congestion. This helps manage road user expectations by communicating progress and status of the situation			
Incident Management	Level 5	For major incidents, aim to disperse the impact, rather than concentrate it, balancing the resulting unusual traffic load across the strategic network as far as possible			
Incident Management	Level 5	Follow agreed dynamic multi-modal and multi-network response plans that are adaptive using real time traffic information			
Incident Management Planning	Level 1	None			
Incident Management Planning	Level 2	Agree upon a protocol with emergency services for who controls the site/event under different scenarios			
Incident Management Planning	Level 2	Plan and maintain incident management procedures			
Incident Management Planning	Level 3	Plan and maintain an incident classification matrix or framework including classification levels			
Incident Management Planning	Level 3	Plan and maintain incident response plans including potential detour routes for different incident types			
Incident Management Planning	Level 3	Plan and maintain external communication channels to the public and to incident response stakeholders/resources			
Incident Management Planning	Level 3	Plan and maintain ITS static response plans including the use of specific devices or technologies e.g. variable message signs, speed control and lane management systems to help manage motorway incidents and divert traffic flow to arterial roads			
Incident Management Planning	Level 3	Ensure external operating partners are involved in incident management planning to ensure integrated/optimal outcomes			
Incident Management Planning	Level 3	Coordinate closely with Local Government Authorities (LGAs) including agreed diversion planning			
Incident Management Planning	Level 3	Liaise with police and emergency services and establish a formalised communication channel			
Incident Management Planning	Level 3	Contract heavy towing/salvage equipment to be on standby during peak periods			
Incident Management Planning	Level 3	Assist with towing regulations proposals			
Incident Management Planning	Level 3	Hold 'hot' and 'cold' major incident debriefings to ensure knowledge gain and learnings			
Incident Management Planning	Level 3	Allocate and maintain dedicated staff resources for incident management, incident readiness, incident response activities			
Incident Management Planning	Level 3	Collect and analyse response time data and information to support continuous improvements			
Incident Management Planning	Level 3	Undertake multi agency training to improve communication			

(When applicable)			Assessment (Yes / Partial / No)		
Sub Function	SMCM Level	Action/Task/Responsibility	Current	Future	Comments
Incident Management Planning	Level 3	Provisioning for heavy and light tow trucks to manage the impact of truck incidents			
Incident Management Planning	Level 4	Plan and maintain ITS dynamic response plans including the use of specific devices or technologies e.g. variable message signs, speed control and lane management systems to help manage motorway incidents and divert traffic flow to arterial roads			
Incident Management Planning	Level 4	Establish an agreed approach to incidents at road authority boundaries with clear and defined roles and responsibilities for all people involved and agreement with the local authorities for diversion planning			
Incident Management Planning	Level 4	Directly control all towing on the network (e.g. avoid competition for towing leading to too many tow trucks at the site or no tow trucks turning up)			
Incident Management Planning	Level 4	Develop agreed advanced communication and response protocols between agencies (including who controls the incident site and the transfer of roles at different phases of the incident)			
Incident Management Planning	Level 4	Establish quick clearance targets and establish the necessary coordination to achieve these, e.g. clearing all incidents within 90 minutes			
Incident Management Planning	Level 4	Implement a clear shoulder policy using towing compounds for abandoned or disabled vehicles			
Incident Management Planning	Level 5	Continuous improvement: Review actions and plans to maximise the influence over driver behaviours			
Planned Network Access Management	Level 1	Respond to ad hoc network access events (if approached) and provide traffic management commentary and/or support.			
Planned Network Access Management	Level 2	Prepare and maintain Standard Operating Plans for regular activities and events			
Planned Network Access Management	Level 3	Assess applications received in accordance with approvals process			
Planned Network Access Management	Level 4	Issue road work permit approvals (or similar) for any planned event or road work proposed			
Planned Network Access Management	Level 5	Identify detour routes as part of assessing the possible traffic impacts			
Planned Network Access Management	Level 6	Assess the impact on a wider horizon not just local impacts, but surrounding areas too			
Planned Network Access Management	Level 3	Maintain and use a centralised management system to manage applications and access			
Planned Network Access Management	Level 3	Develop and regularly update formalised guides for traffic and transport management at the jurisdiction level relating to planned road works and special events			
Planned Network Access Management	Level 3	Involvement with temporary traffic management approvals and intervention measures including:			
Planned Network Access Management	Level 3	Planning and implementing alternative routes			
Planned Network Access Management	Level 3	Updating signs and signals to alert passengers on the network			
Planned Network Access Management	Level 3	Coordinate with internal works and projects			
Planned Network Access Management	Level 3	Seek approval / authorisation for partial (lane/road) or full motorway closure / Road Occupancy License (ROL)/permit to access			
Planned Network Access Management	Level 3	Conduct auditing and work completion process			
Planned Network Access Management	Level 4	Coordinate and manage planning and approval of future maintenance, road works, utility works and special events:			

(When applicable)			Assessment (Yes / Partial / No)		
Sub Function	SMCM Level	Action/Task/Responsibility	Current	Future	Comments
Planned Network Access Management	Level 4	Work closely through a multi-agency approach including contractors, event organisers and venue managers			
Planned Network Access Management	Level 4	Notify the relevant government bodies (e.g. state highway owner, local area command police, local council) of potential impacts			
Planned Network Access Management	Level 4	Facilitate operator access to Traffic Management Plans (e.g. with LUMS plans) for coordinated roadworks outcomes			
Planned Network Access Management	Level 4	Enter planned activities into the TMC facing incident system			
Planned Network Access Management	Level 4	Proactively use signage, devices and technologies (e.g. LUMS, VMS) to support planned maintenance activities and communicate event information to road users			
Planned Network Access Management	Level 4	Formalise the roles and responsibilities of all groups involved, for example:			
Planned Network Access Management	Level 4	Over dimension, over mass vehicles			
Planned Network Access Management	Level 4	Any construction that might conflict with the occupancy			
Planned Network Access Management	Level 4	Any impacts on public transport, local residents and businesses			
Planned Network Access Management	Level 4	The hours during which the occupancy will be in effect			
Planned Network Access Management	Level 5	Sophisticated event and access system with multi-agency coordination to reduce impacts on road users			

Appendix D Example of Incident Management Levels

Figure D 1: Transport Incident Severity Categorisation

Incident Level	People	Reputation	Property	Environmental	Delay to Customer		Service Delivery	Accessibility
(a)	(b)	(c)	(d)	(e)	(f)		(h)	(i)
Severity level of incident	Level of harm to staff at work, agents/contractors on AT/NZTA worksite and/or customers whilst using our transport network/services	Impact to AT and/or NZTA reputation	Damage to assets owned by AT or NZTA - Need to determine whether we want to include assets operated by AT/NZTA or their service providers	Actual or potential damage to land, water or air	Delay in travel time for the customer (user of the transport system). These timings should take into consideration whether the incident occurs during peak or non peak. If not during peak periods then the impact to customer delays is much less significant.		Impact on our ability to deliver BAU services	Ease of access to location of incident. Constraint could be physical (tunnel, water or single access road into location), or time based (2hrs to travel to rural location).
					Urban	Rural		
5 (Catastrophic)	Widespread deaths	Sustained (beyond the incident) negative media coverage Breakdown in relationships with external groups	Multiple assets impacted. Critical assets impacted.	Extensive damage to the environment requiring significant and immediate clean-up effort	> 24 hrs	> 24 hrs	Services not available for > 24 hrs	Inability to access location without major civil defence support
4 (Headline)	Multiple serious injuries or deaths CAVEAT: This people measure must combine with at least one other category (b - i) across this row to be categorised as a Headline (level 4) incident. If this is the only 'box ticked' on this row then it is deemed a level 3 incident.	Significant negative impact on stakeholder confidence High profile community and/or area High profile group or event impacted	Significant damage making the area unusable - instant repairs and diversion required	Contained environmental damage requiring immediate clean up	3 - 24 hrs	5 - 24 hrs	Major disruption to services but likely to be fully operating within 5 - 24 hrs	Ability to access location is restricted and will cause delays of >3 hrs before appropriate response arrives on site
3 (Serious)	Serious harm or death	National media coverage Immediate relationship concerns in resolving the incident	Obvious damage and repair required. Workarounds can be put in place for immediate management.	Clean up and remediation work required in the foreseeable future	1 - 3 hrs	2 - 5 hrs	Significant disruption to services but likely to be fully operating within 2 - 5 hrs	Ability to access location is restricted and will cause delays of between 1 - 2 hrs before appropriate response arrives onsite
2 (Significant)	Minor injuries	Some community complaints Isolated stakeholder relationship issues	Minimal damage (e.g. broken barrier)	Contained pollution requires clean up	30 - 60 mins	30 mins - 2 hrs	Minor impact (service still available but reduced i.e. lane reduction, delay in bus/train service, partial reduction in parking availability)	Access is restricted but response is set up to manage i.e. water based or tunnel incident but standard response capability well established
1 (Minor)	No injuries	Short term, localised media attention	No damage	Slight, short term damage to land and/or eco systems	< 30 mins	< 30 mins	Negligible impact	No access issues

Source: Waka Kotahi NZ Transport Agency from their Wellington TOC

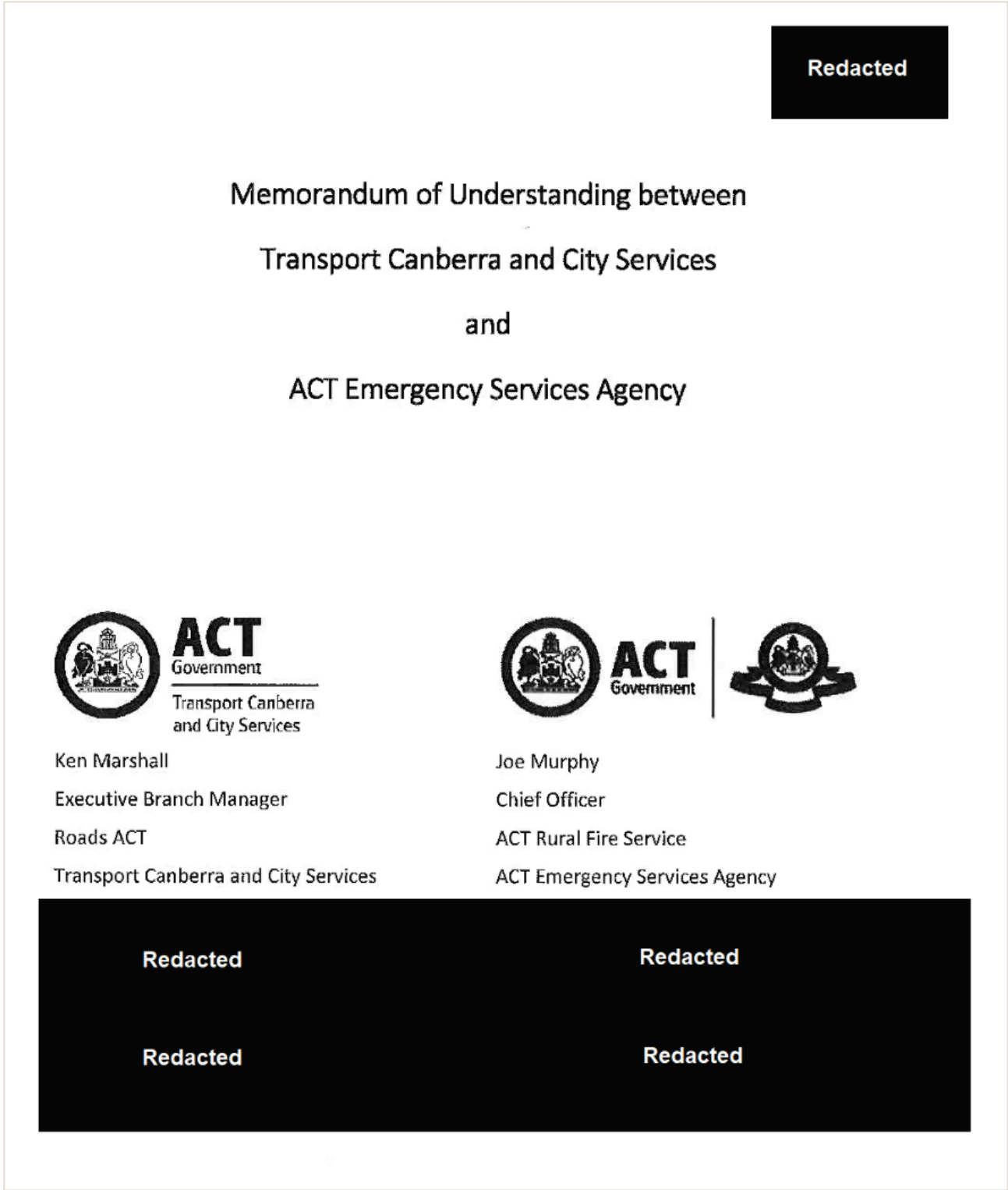
Figure D 2: Transport Portfolio Incident Example

	Level 1 Localised but could escalate	Level 2 Larger size, more complex, needs additional resources, multiple hazards	Level 3 Major emergency, multi-agency, very complex, state level control required
Transport Roads Disruption to roads, bridges and tunnels	Minor travel time delay, generally >30 minutes and < 60 minutes - Vehicle incident: - Single vehicle collision - Nose to tail - Breakdown - Any incident causing localised traffic delays: - Single lane closure - Unplanned minor works - Isolated signalling outage / damage (not at a critical site) - Planned / permitted low key events / unplanned incident/event: - Road incident with fatality - Major Collision Investigation Unit attending - Localised hazmat incident - Over-run of planned works into peak travel periods - Minor disruption to tourist / freight routes - Weather event impacting signalling / transport network - Self-harm / community threat on / near network - Infrastructure failure (traffic signals / managed motorway / key assets).	Moderate travel time delay, generally > than 60 minutes and < 4 hours - Road incident with multiple fatalities - Critical infrastructure closure e.g. West Gate Bridge, tunnel - Prolonged closure of state significant road (major tourist or freight route) - Cyber-attack or another criminal act - HAZMAT incident - Short term interruption or outage; power, telecommunications, liquid fuel, gas or water - BCP issue reducing capability or capacity by < 25%.	Major travel time delays >4 hours - Catastrophic failure of critical infrastructure - Natural hazard event with state-wide consequence - Extended essential service interruption, limitation or outage; power, telecommunications, liquid fuel, gas or water, act of extreme violence crossing jurisdictional boundaries - Cyber-attack impacting government systems - BCP issue reducing capability or capacity by >25%.
Public Transport⁴ Disruption to public transport	A <u>non-major</u> public transport disruption causing or threatens to cause disruption to public transport leading to the full or partial suspension of services for a limited time with no significant consequences. The response to a non-major public transport disruption emergency or threat can be effectively managed by the Public Transport Operator (PTO) at the incident level. A minor public transport disruption may affect a single mode and have a service disruption of less than 4 hours, examples may include: - Police operation - Rallies, demonstrations and mass gatherings - Cancellation of services - Severe weather impacts (extreme heat, flooding, storm – wind/lightning etc.) - Power outage - Medical emergency - Rolling stock or network infrastructure fault/emergency - Minor infrastructure and resource planning failures - Level crossing incident (near miss). - Short duration shutdown of public transport network due to demonstration/civil unrest - Risk of injury and/or death.	A <u>non-major</u> public transport disruption that has the <u>potential</u> to escalate into a <u>major</u> disruption. The incident is managed by the Public Transport Operator (PTO) but requires oversight by DoT. A public transport disruption, which has the <u>potential</u> to become a <u>major</u> disruption, multiple modes, (service disruption of more than 4 hours). Incidents can include: - Small scale telecommunication outage possibly causing network signalling issues and failure to communicate with transport modes - An infrastructure failure, collision or derailment or hazmat incident which has the potential for loss of life or injury - Public transport disruption caused by capital works - Small scale fire, flood or storm impacting single or multiple modes of transport - Single day heat event - a period of high fire danger day is declared with combined high heat event or power outages leading to significant network delays, shutdowns and service cancellations - Mass gathering, rally or demonstration or other incident that is causing or has the potential to cause significant disruption to single or multiple modes of transport - Risk of multiple injuries and/or deaths.	A <u>major</u> public transport disruption that requires state level coordination by DoT due to the following factors: - The impacts affecting more than a single PTO and/network and requires the joint response of two or more PTOs/agencies to combat the event - The incident is likely to exist for a substantial span of time, involves resources beyond the supply capacity of the sector and has a widespread impact on the community - Has resulted in multiple injuries or death. Examples may include: - Widespread and protracted telecommunication outage possibly causing network signalling issues and failure to communicate with transport modes - Significant loss of life or multiple injuries or damage due to infrastructure failure, collision or derailment or hazmat incident - Major security/ terrorism incident leading to mass casualties/ injuries or threat directed at transport hub or network - Large scale fire, flood, storm or earthquake impacting single or multiple modes of transport - Prolonged shutdown of public transport network due to large scale demonstration/civil unrest - Pandemic - High fire danger forecast combined with extended heat event or power outages causing prolonged and numerous network delays, shutdowns and cancellations occurring to large blocks of the transport network affecting multiple modes.

Source: DoT VIC

Appendix E Example Memorandum of Understanding

Figure E 1: Memorandum of Understanding between TCCS and ACT ESA



Redacted

Purpose

This MOU sets out the arrangement between Transport Canberra and City Services (TCCS) and ACT Emergency Services Agency (ESA) to have the Permanent Variable Message Signs (PVMS) display Total Fire Ban messaging during declared Total Fire Bans (TOBAN).

Roles of the Directorate/Agency

TCCS is responsible for:

- All management of the PVMS
- Having the PVMS display TOBAN messaging as agreed with ESA for the period of any declared ACT Total Fire Ban.
- Prioritising TOBAN messaging

ESA is responsible for:

- Providing the canned messages to TCCS
- Notifying TCCS of a declared TOBAN
- Providing any amended messaging

Financial Responsibilities

Each party is wholly responsible for the costs associated with their actions, employees and infrastructure.

Dispute

For any matter in the MOU the parties will attempt to resolve the matter at the lowest possible level and escalate where agreement is not reached.

Review

This MOU will be reviewed as necessary.

Duration of MOU

This MOU remains in effect until terminated.

Termination

Either party can seek termination of the MOU in consultation with the other party.

Canned message

Screen 1	Screen 2
TOTAL FIRE BAN TODAY, [Date]	TOTAL FIRE BAN www.esa.act.gov.au

Notification process

ESA will notify TCCS via email to benjamin.hubbard@act.gov.au

TCCS will email back to rfs@act.gov.au when the signs schedule has been updated with required messaging and declared duration.

Source: Roads ACT, a division within TCCS

Appendix F Example of Incident Management Operator Checklist

Figure F1 is a generic checklist of key points that would need to be considered when an incident occurs.

Figure F 1: Example incident management operator checklist

Name:				Position:			
Date:				Time:			
Type of Incident:							
Incident Site under control of:							
ACT Emergency Services Agency ☐ ACT Policing ☐ TCCS ☐							
Estimated time for the incident to be fixed:							
LOCATION OF INCIDENT							
	Road Name (s)			Classification:		Direction of Travel	
1							
2							
3							
4							
If midblock, distance to nearest intersecting road of same classification:							
Road Name (s)			Classification:		Direction of Travel		Distance
COMMUNICATION (HAVE THE FOLLOWING BEEN NOTIFIED)							
Director General ☐		Deputy Director General ☐		Director of Roads ACT ☐		Road Maintenance Manager ☐	
TCCS Media Unit ☐							
Roads ACT TMS Emergency Contact ☐							
RMS Support Staff ☐							
Others (if required):							
NSW RMS ☐		Council (list):					
WorkSafe ☐		Service Providers (list):					
Other:							

TRANSPORT NETWORK IMPACT FROM INCIDENT		
Is a road closure required: Full ☐ Lane ☐		
Name of nearest intersecting roads of same classification:		
Direction:	Road:	
Direction:	Road:	
Direction:	Road:	
Direction:	Road:	
If additional road capacity is required, additional approaching roads:		
Direction:	Road:	
Direction:	Road:	
Direction:	Road:	
Direction:	Road:	
Is property access impacted:	Yes (consult with owners/tenants)	No
Has the incident occurred on a heavy vehicle route:	Yes (refer below)	No
Is there an alternative route:	Yes	No (consult with Management Group)
Does the incident impact on Public Transport:	Yes (refer below)	No
Has the TCCS Media informed ACTION:	Yes	No (consult with TCCS Media)
TRAFFIC MANAGEMENT PLAN		
Has a qualified person prepared a TTM	Yes	No (contact TMS or consultant)
Has the TTM accounted for active travel modes	Yes	No (develop appropriate TTM)
Has the TTM accounted for heavy vehicles (including oversize/ overmass vehicles)	Yes	No (develop appropriate TTM)
Has large vehicle manoeuvrability been checked on detour routes	Yes	No (review detour routes)
Are detour routes provided on the same road classification (if possible)	Yes	No (review detour routes)
Is there adequate capacity on detour routes	Yes	No (extend detour coverage)
Have traffic signals been adjusted	Yes	No (contact TMS)

Roads ACT
8 September 2020

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Have TTM signs been erected	Yes	No (contact RMS Support staff or approved provider)
If VMS are used, do they provide the correct information	Yes	No (consult with TMS)
Are there any conflicting message provided along detour routes	Yes (cover conflicting messages)	No
Will special events/ other incidents impacts on this incident	Yes (combine TTMs)	No
INCIDENT CLOSURE		
Have conditions restored to pre-incident conditions	Yes (advise relevant parties)	No (TTM to remain)
Advise relevant parties and obtain approval to remove TTM devices:		
Director General ☐	Deputy Director General ☐	Director of Roads ACT ☐ Road Maintenance Manager ☐
TCCS Media Unit ☐		
Roads ACT TMS Emergency Contact ☐		
RMS Support Staff ☐		
Others (if required):		
NSW RMS ☐	Council (list):	
WorkSafe ☐	Service Providers (list):	
Other:		
Have all TTM devices been removed	Yes	No (contact RMS Support staff or approved provider)
Inform relevant parties that the incident is closed	Yes	No (contact all relevant parties)
Time of Incident Closure:		Date:

Appendix G Example TMC Operator Training Timeline Overview

Acronyms used in the example timeline below are defined in the Glossary of these guidelines (see Section 1.5). Note all operator training activities are held on weekdays only.

Timeline	Day of week	Training Item(s)
Week 1	Monday	Induction
	Tuesday	Induction–Brief Site Visits
	Wednesday	CCTV
	Thursday	CCTV
	Friday	CCTV
Week 2	Monday	Review/Roadworks
	Tuesday	Roadworks/ABMIS
	Wednesday	Roadworks/ABMIS
	Thursday	Roadworks/ABMIS
	Friday	Roadworks/ABMIS
Week 3	Monday	Review/STREAMS
	Tuesday	STREAMS/Motorways
	Wednesday	STREAMS/ACH
	Thursday	STREAMS/ACH
	Friday	STREAMS/ACH
Week 4	Monday	Review/USW
	Tuesday	STREAMS/Motorways
	Wednesday	STREAMS/Motorways
	Thursday	STREAMS/Motorways
	Friday	STREAMS/Motorways
Week 5	Monday	Response Plans
	Tuesday	Response Plans
	Wednesday	STREAMS
	Thursday	Port River Expressway 'PREXY'
	Friday	Port River Expressway 'PREXY'
Week 6	Monday	Review/SCATS
	Tuesday	SCATS
	Wednesday	SCATS
	Thursday	SCATS
	Friday	SCATS
Week 7	Monday	Review
	Tuesday	SCATS
	Wednesday	SCATS

Timeline	Day of week	Training Item(s)
	Thursday	SCATS
	Friday	SCATS
Week 8	Monday	Review
	Tuesday	SCATS
	Wednesday	SCATS
	Thursday	SCATS
	Friday	SCATS
Week 9	Monday	TMC – Incident Management
	Tuesday	TMC – Incident Management
	Wednesday	TMC – Incident Management
	Thursday	TMC – WIKI
	Friday	TMC – South Australian Government Radio Network
Week 10	Monday	Review
	Tuesday	TMC
	Wednesday	TMC
	Thursday	TMC
	Friday	TMC
Week 11	Monday	Review
	Tuesday	TMC
	Wednesday	TMC
	Thursday	Conditions of Tendering
	Friday	Conditions of Tendering
Week 12	Monday	Shift
	Tuesday	Shift
	Wednesday	Shift
	Thursday	Shift
	Friday	Shift

Source: Traffic Management Centre, Network Management Services Directorate, Department for Infrastructure and Transport, SA.

Appendix H Improving Fault Management with an Agile Platform



STREAMLINING STATE TRANSPORT MANAGEMENT

IMPROVING FAULT MANAGEMENT WITH AN AGILE PLATFORM

"In just four months, we have already seen significant benefits from Pega and our fault management solution, including improved utilization of engineering resources and prioritization of fault handling leading to faster response times."

Chris Ruwoldt

Principal Manager Transport Operations Systems
New South Wales (Australia) Transport Management Centre

PUBLIC SECTOR

BUSINESS GOALS

- Better manage device fault response
- Reduce time to respond
- Track and report on device faults
- Improve engineer efficiency

RESULTS

Go-live in

JUST 4 MONTHS

FASTER RESPONSE

to device faults

SEAMLESS, TRANSPARENT

fault management across network

VISION Optimize the Safety and Efficiency of the State Road Network

The Transportation Management Centre (NSW TMC) is a key part of the Transport for New South Wales (NSW), the state government authority dedicated to improving the customer experience on the NSW transport network. The NSW TMC is focused on enhancing transport coordination services, as well as monitoring and managing the NSW road network to minimize delays and provide timely and accurate information to transport users.

The agency wanted to develop a proactive incident management system, incorporating its existing road sensor network, intelligent transportation systems, electronic message boards and billboard signs for thousands of users.

EXECUTION Increased Efficiency and Agility in 4 Months

NSW TMC turned to Pega for an agile incident and case management system that would enable sophisticated and intelligent response. The agency chose Pega's Build for Change® technology because it can support current requirements, while providing an agile foundation that would enable NSW TMC to expand as varied and complex requirements increase within the agency and associated organizations, such as the need for collaborative incident management.

Using Pega, NSW TMC built a seamless, decision-based incident management solution to more efficiently track, manage and respond to a myriad of events. It used agile methodology to deliver rapid results in just four months. The new Fault Management Service (FMS) enables the agency to dynamically route and resolve faults reported from more than 20,000 remote devices, including variable message and speed limit signs, traffic signals and monitoring devices. Using Pega's business rules to automate prioritization and escalation and dynamic processes to manage the process flow to technicians, the agency can make sure staff works as expeditiously as possible to resolve incidents.

OUTCOME Faster, More Responsive Service with an Award-Winning Incident Management System

The agency has enhanced its abilities to respond to both planned and unplanned events. With Pega, NSW TMC has improved utilization and prioritization of remediation activities, and can evaluate and respond to events more quickly. It has reported improved citizen service levels and reduced costs for providing service. Over time, the agency expects to continuously reduce response times as processes are further refined based on data, which will lead to significant improvements in citizen satisfaction levels. The improvements the agency has already achieved were recognized last year when it was awarded "Best Use of BPM Technology" at the annual Gartner BPM Summit 2013 in Sydney, Australia.



New South Wales (Australia) Transportation Management Centre controls all vehicle, rail, ferry and bus operations across 18,000 kilometers of roads and more than 5,000 bridges and tunnels.

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